MT ARTHUR COAL

U1 Particulate Matter Control Best Practice Implementation Report – Wheel Generated Dust

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1. Introduction

Hunter Valley Energy Coal (HVEC) Pty Ltd operates the Mt Arthur Coal Complex in the Upper Hunter Valley, NSW approximately five kilometres south west of Muswellbrook.

HVEC operates Mt Arthur Coal under Environment Protection Licence (EPL) 11457. On 21 March 2013, EPL 11457 was modified to include the following new condition:

- U1: Particulate Matter Control Best Practice Implementation – Wheel Generated Dust

Condition U1 (as at 21 March 2013) required a monitoring program to be developed and implemented to assess compliance with the requirements to achieve and maintain a dust control efficiency of 80 per cent or more on all active haul roads under varying meteorological conditions. Condition U1 is reproduced in full in **Appendix 1**.

HVEC prepared and submitted *Pollution Monitoring Program – Wheel Generated Dust* (the monitoring program) to the Environment Protection Authority (EPA). The EPA confirmed on 9 August 2013 that the monitoring program was found to be generally compliant with the requirements of Condition U1.1.

On 5 September 2013, Condition U1 of EPL 11457 was revised based on the approved monitoring program. Condition U1.3 requires HVEC to submit a report to the EPA that documents the results of the assessment undertaken in accordance with Condition U1.1. This report has been prepared to satisfy this requirement.

2. Program Components

2.1. Program development and implementation

Following the introduction of Condition U1 into EPL 11457 on 21 March 2013, the monitoring program was developed and implemented according to the following sequence:

- *27 May 2013:* Initial submission of the monitoring program for EPA approval;
- *26 July 2013:* Final submission of the monitoring program following EPA review and request for further information;
- *9 August 2013:* Approval of the monitoring program by the EPA, which initiated the commencement of an assessment of meteorological data required to identify the most appropriate meteorological conditions for monitoring.
- *5 September 2013:* Revision of Condition U1 based on the approved monitoring program;
- *3 October 2013:* Finalisation of meteorological assessment to determine to identify the most appropriate meteorological conditions for monitoring;

- *8 November 2013:* First monitoring period;
- *16 January 2014:* Second monitoring period; and
- *15 April 2014:* Third monitoring period.

From the period 22 March 2013 through to effective commencement of operating the monitoring program on 8 November 2013, HVEC continued to implement its existing dust management measures at the Mt Arthur Coal operation in accordance with the Air Quality and Greenhouse Gas Management Plan, which is approved by the Department of Planning and Environment.

Mt Arthur Coal uses water carts for all active haul roads and a dust suppressant on major arterial haul roads. The suppressant is a liquid polymer which is added to the water cart using an automated dosing system. It is sprayed onto haul roads to improve water penetration, bind fine dust particles and consolidate haul road surfaces.

Mt Arthur Coal undertook a trial in November 2013 to investigate the dust reducing properties of six different suppressants. As a result of the trial, Mt Arthur Coal is currently undertaking a project to apply a bitumen product to 7km of haul roads. An improved liquid polymer product is now been applied to all other haul roads which do not have the bitumen product applied.

2.2. Analysis of meteorological data

Five years of meteorological data (July 2009 to July 2013) from Mt Arthur Coal's Industrial Area meteorological station (WS09) was analysed to determine the seasonal variation in meteorology at the site. The variations included temperature, rainfall, humidity, and solar radiation. Figures showing annual variations in temperature, humidity, solar radiation and rainfall are found in **Appendix 2.**

This analysis was used to determine four appropriate periods throughout the year for potential monitoring to capture the effects of meteorological variation on PM_{10} control efficiency. From the analysis of meteorological data, it was determined that October, January, April and August would show the greatest variation in meteorological conditions. As such all attempts were made to target sampling during these months.

The REX system was unavailable until early November; therefore the first monitoring period took place on 8 November 2013. Two additional monitoring periods occurred on 16 January 2014 and 15 April 2014.

2.3. Monitoring methodology

The Road Emissions eXpert (REX) system was used to measure particular matter (PM) emissions generated from active haul roads at Mt Arthur Coal. Control efficiencies were calculated by comparing data collected from controlled active haul roads and an uncontrolled section of haul road.

The REX system is a mobile dust monitoring system, mounted on a mine-specification vehicle. It uses a high-volume cyclone pre-separator and a continuous laser photometer (TSI DustTrak 8530) configured to measure PM_{10}.

The inlet to the DustTrak is located at the side of the vehicle, directly downstream of the emission source, in this instance the interface between the tyre and the road surface. The inlet is positioned high enough above the surface to collect truly airborne material and close enough to the surface to collect an adequate sample mass. DustTrak is used within this study to determine a relative difference between controlled active haul road emissions and uncontrolled haul road emissions, and as such, is not required to meet reference method standards.

Samples were taken while travelling at 40 kilometres per hour (km/h) around a pre-determined circuit. The circuit consisted of all active haul roads and a 250-400 metre (m) section of uncontrolled haul road. All circuits on the day of monitoring were the same, however due to mine progression and planning, there was variation on circuits used on the three monitoring occasions.

The monitoring method is described in more detail in the monitoring program. All monitoring was conducted according to the internal Quality Management Plan for the use of REX (Pacific Environment, 2013).

2.4. Identification of uncontrolled and controlled haul roads

A ‘controlled’ haul road is a section of haul road where a road sealant or dust suppressant product, including water, has been applied to reduce the effect of wheel generated dust created by the movement of vehicles. Meteorological conditions also provide a certain level of natural control. Conditions such as high humidity, fog, mist and low evaporation also afford a certain level of dust control to a haul road surface.

Critical to the determination of haul road dust control efficiency is the definition of what constitutes an ‘uncontrolled’ section of haul road. In reality, it is difficult to identify a section of active haul road that is completely uncontrolled. For example, the correct construction and maintenance of a haul road is, in itself, a method of controlling dust, notwithstanding the influence of meteorological conditions.

For the purposes of determination of dust control efficiency, HVEC in consultation with an air quality specialist defined an uncontrolled haul road as:

“A section of an active haul road where no water has been applied for at least 12 hours and up to 48 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).”

To determine the control efficiency, as approved by the EPA and to take into account the role which meteorological conditions play in controlling dust, the maximum uncontrolled result from all monitoring periods is used to determine the control efficiency for all monitoring periods. The maximum measured uncontrolled concentration occurred during the summer monitoring period (16 January 2014), corresponding to the ambient conditions when little or no natural control is expected.

2.5. Preparation for sampling day

To ensure that all preconditions for sampling were met

- meteorological data was reviewed to ensure that no more than 0.3 mm of precipitation have been recorded at the closest meteorological station in the preceding 12 hours.
- it was confirmed that the uncontrolled section of haul road had remained untreated for at least 12 hours prior to monitoring.

3. Monitoring Program Results

3.1. Key Performance Indicators

The key performance indicators (KPIs) presented in the monitoring program to determine compliance with Condition U1.1 are provided in Table 1, along with Table 5comments on the achievement of the KPIs during the reporting period.

Table 1: Key performance indicators

Key Performance Indicator	Justification	Performance During Reporting Period
A maximum of four monitoring campaigns will be conducted during appropriate meteorological conditions for monitoring.	Ensure sampling and subsequent assessment of compliance will be undertaken under varying meteorological (seasonal) conditions as determined by analysis of meteorological data.	**Achieved**. Three monitoring periods were undertaken in varying (seasonal) meteorological conditions.
Sampling to be repeated at varying times throughout day shift (both morning and afternoon).	Ensure sampling and subsequent assessment of compliance will be undertaken under varying meteorological (diurnal) conditions.	**Achieved**. During monitoring periods, sampling took place at various times of the day to ensure that samples represented varying meteorological conditions.
All haul road types to be sampled during each monitoring campaign.	Ensure comprehensive dataset representative of the overall performance of haul road dust management practices across the mine.	**Achieved**. Active haul roads been used during the monitoring period were sampled and data used to calculate dust control efficiency. This provides a representation of overall performance of haul road dust management across the mine.

3.2. First Monitoring Period – 8 November 2013

The results for the monitoring period for 8 November 2013 are presented in Table 2. Only two circuits were completed on this day due to a lengthy delay following a flat tyre on the mobile dust monitoring system. Sufficient data was collected during the day from the two circuits to fulfil monitoring requirements.

The mobile dust monitoring system is not a reference method for determining PM concentrations, therefore the dust samples collected during the study were used to determine a relative difference between controlled active haul road emissions and uncontrolled haul road emissions, and as such, a relative difference between active and uncontrolled haul roads are shown in this report.

Table 2: 8 November 2013 monitoring period results

Circuit	Average Controlled ($\mu g/m^3$)	Average Uncontrolled ($\mu g/m^3$)	Control Efficiency* (%)
1	0.07	1.15	**95**
2	0.27	0.50	**80**

*Control Efficiency calculated using the maximum average uncontrolled result of 1.39$\mu g/m^3$.

3.3. Second Monitoring Period – 16 January 2014

The results for the monitoring period for 16 January 2014 are presented in Table 3.
Five circuits were completed on this day.

Table 3: 16 January 2014 monitoring period results

Circuit	Average Controlled ($\mu g/m^3$)	Average Uncontrolled ($\mu g/m^3$)	Control Efficiency* (%)
1	0.06	0.00	**96**
2	0.11	0.21	**92**
3	0.10	0.54	**93**
4	0.31	1.39	**78**
5	0.25	1.17	**82**

*Control Efficiency calculated using the maximum average uncontrolled result of 1.39$\mu g/m^3$.

3.4. Third Monitoring Period – 15 April 2104

The results for the monitoring period for 15 April 2014 are presented in Table 4.
Four circuits were completed on this day. The uncontrolled section of haul road was compromised prior to sampling, preventing an uncontrolled measurement to be recorded for the monitoring period. As for all monitoring periods, the maximum average uncontrolled PM_{10} concentration was used to determine the control efficiency..

Table 4: 15 April 2014 monitoring period results

Circuit	Average Controlled ($\mu g/m^3$)	Average Uncontrolled ($\mu g/m^3$)	Control Efficiency *(%)
1	0.05	Uncontrolled watered	**97**
2	0.03	Uncontrolled watered	**98**
3	0.05	Uncontrolled watered	**96**
4	0.04	Uncontrolled watered	**97**

*Control Efficiency calculated using the maximum average uncontrolled result of 1.39$\mu g/m^3$.

3.5. Overall Results

The average controlled PM_{10} concentrations, maximum average uncontrolled PM_{10} concentration and dust control efficiency are presented in Table 5. The dust emissions from controlled sections of active haul roads were consistent across all monitoring periods, with the lowest concentrations measured in April 2014. The calculated site wide haul road dust control efficiency demonstrates that HVEC has satisfied compliance with the requirement to achieve and maintain 80 per cent dust control efficiency on active haul roads.

Table 5: Summary of measured PM_{10} concentration and control efficiency

Sample Date	Controlled PM_{10} concentration ($\mu g/m^3$)	Uncontrolled PM_{10} concentration ($\mu g/m^3$)	Average Control Efficiency (%)	Range of Control Efficiency (%)
8 Nov 2013	0.17	1.39	**88**	80 - 95
16 Jan 2014	0.16		**86**	78 - 96
15 Apr 2014	0.04		**97**	96 - 98
		Overall Average	**91**	78 - 98

3.6. Meteorological Conditions

Real-time meteorological data is record continuously at Mt Arthur Coal and used to provide support to operations in the prevention of dust generation. A summary of meteorological conditions during the monitoring periods (7am-5pm) are shown in Table 6. Although there is close similarity in meteorological conditions for the monitoring periods on 8 November 2013 and 16 January 2014, a seasonal variation can clearly be seen between these two monitoring periods and the 15 April 2014 monitoring period.

Table 6: Summary of meteorological conditions during the monitoring period (7am-5pm)

Parameter (units)	8 November 2013	16 January 2014	15 April 2014
Average Wind Speed (m/s)	4.5	2.1	2.6
Average Temperature (°C)	30.4	30.2	18.1
Average Relative Humidity (%)	22.2	39.6	60.2
Average Solar Radiation (W/m^2)	1062.8	1011.7	451.3
Total Rainfall (mm)	0.00	0.00	0.2[(a)]

a) Rainfall recorded after sampling was completed.

3.7. Dust Suppression Controls

Mt Arthur Coal uses water carts for all active haul roads and a dust suppressant on major arterial haul roads. The suppressant is a liquid polymer which is added to the water cart using an automated dosing system. It is sprayed onto haul roads to improve water penetration, bind fine dust particles and consolidate haul road surfaces. The amounts of water and dust suppressant used during the monitoring periods are presented in Table 7.

Table 7: Summary of dust suppression controls.

Parameter (units)	8 November 2013	16 January 2014	15 April 2014
Number of Operational Water Carts	8-10	10-11	9-11
Total Water Cart Hours (h)	67.5	96.1	73.8
Water used for haul road dust suppression. (ML)	1.5	3.1	1.2
Dust Suppressant used (L)	600	1,500	1,400

Water cart movements are recorded by the mine equipment tracking system Modular, providing continuous but indirect monitoring of the areas on site where water and suppressant is being applied to haul roads. The length of time and the exact location of application of dust suppressants are not directly monitored in real-time. The quantity of suppressant product and dosage rates are monitored on a daily basis, however the allocation of suppressant is not tracked through to an individual water cart.

4. Site Specific Relationship

HVEC investigated whether a site specific relationship or correlation could be derived between the measured particulate matter control efficiency and surrogate parameters using the monitoring campaign dataset. For example, operational watering or suppressant use that achieves 80 per cent control.

Direct measurement enables determination of the combined effect of the large number of factors that could potentially influence dust control efficiency on active haul roads and which can vary markedly across the mine. These include, but are not limited to:

- Environmental variables - humidity, temperature, wind speed
- Operational variables - truck weight (different size trucks on different routes), truck speed, traffic volumes, time between water/suppressant application and road condition/type.

Development of a statistical relationship (correlation) is not feasible where a large number of variables exist, as the relative contribution of each variable to dust control efficiency cannot be readily determined. It was determined that this approach would only be valid in a controlled environment where the range of other variables could be kept constant.

HVEC considers direct measurement to be the most accurate and thorough assessment of compliance when compared to the application of surrogate parameters (that have not been scientifically validated and correlated to haul road dust generation) as indirect measures of dust control efficiency compliance. Lack of scientific rigour using a limited dataset will likely result in invalid correlations being developed and has the potential to misguide dust management practices.

It has been determined through the completion of the Australian Coal Association Research Program (ACARP) Project C20023 *'Improvement of Haul Road Dust Emission Estimation and Controls at Coal Mines'* (**Cox & Laing, in press**) that whilst on average the open-cut mines (including Mt Arthur Coal) are meeting (and often exceeding) the PRP requirement of 80 per cent control efficiency, the variability in the mobile sampling data across the site renders it unfeasible to determine a relationship between measured concentrations and water/suppressant application rate.

However, the ACARP study has shown that consideration of site-specific operational factors is critical to minimising the level of dust generated from unleaded roads, including:

- Roads under construction.
- Roads recently graded.
- Coal operation areas.
- Roads adjacent to stockpiles.
- Highly-trafficked areas.

The data collected at Mt Arthur Coal also supports some of the conclusions drawn in from the ACARP study in relation to meteorological conditions. Namely that particular attention should be paid to haul road management measures when any of the following meteorological conditions are present or predicted:

- Temperatures are above 25^{o}C.
- Relative humidity is 40 per cent or below.
- Solar radiation is 600 W/m^2 or above.

5. Conclusion

Air quality is a key environmental issue for the communities of the Hunter Valley. Mine operations, such as HVEC's Mt Arthur Coal in the Upper Hunter Valley, play a key role in the management of air quality in the region. HVEC has recognised this through the implementation of a number of controls outlined in the operation's Air Quality and Greenhouse Gas Management Plan.

HVEC has further improved the systems and tools used to improve dust control efficiency on active haul roads at the Mt Arthur Coal operation to minimise dust generation.

The calculated site wide haul road dust control efficiency demonstrates that HVEC has satisfied compliance with the requirements of Condition U1 (Particulate Matter Control Best Practice - Wheel Generated Dust) by achieving a dust control efficiency of 80 per cent or more on all active haul roads. The KPIs to determine compliance with Condition U1.1 were successfully achieved.

HVEC determined that the development of a statistical relationship (correlation) would be not feasible with such a large number of variables that exist, as the relative contribution of each variable to dust control efficiency cannot be readily determined. This approach would only be valid in a controlled environment where the range of other variables could be kept constant.

HVEC considers direct measurement to be the most accurate and thorough assessment of compliance when compared to the application of surrogate parameters (that have not been scientifically validated and correlated to haul road dust generation) as indirect measures of dust control efficiency compliance. Lack of scientific rigour using a limited dataset will likely result in invalid correlations being developed and has the potential to misguide dust management practices.

6. Definitions and Abbreviations

Definitions of some of the terms used in this report are as follows:

Active Haul Road	A road used for hauling material during the shift when sampling is taking place.
Control efficiency	As per the equation I EPL Condition U1.1.
GPS	Global Positioning System.
REX	Road Emission eXpert, the mobile haul road monitoring device.
Haul Road	A site road that is used for hauling material.
Monitoring implementation period	The period following approval of the *Mt Arthur Coal Mine Pollution Monitoring Program – Wheel Generated Dust* Program by the EPA and prior to the submission of this report.
PM	Particulate matter.
Uncontrolled section	A section of road, at least 150m in length, left untreated with either water or dust suppressant for a minimum of 12 hours prior to sampling.
Site-specific control efficiency	Site averaged control efficiency.
Wet Weather	More than 0.3mm (0.1 inches) of rain in the 12-hour period before sampling (**USEPA, 1974**)

7. References

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

HVEC (2013). *Mt Arthur Coal Mine Pollution Monitoring Program – Wheel Generated Dust.* 18 July 2013.

HVEC (2013) *Mt Arthur Coal Air Quality and Greenhouse Gas Management Plan*. 27 May 2013.

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

USEPA (1974). Development of Emission Factors for Fugitive Dust Sources. U.S Environmental Protection Agency, Office of Air and Waste Management. Research Triangle Park, North Carolina 27711.

Appendix 1. EPL Condition U1

U1 Particulate Matter Control Best Practice Implementation – Wheel Generated Dust

U1.1 The Licensee must achieve and maintain a dust control efficiency of 80% or more on all active haul roads by 22 March 2013.

The control efficiency is calculated as:

$$CE = \frac{E\ (\text{uncontrolled}) - E\ (\text{controlled})}{E\ (\text{uncontrolled})} \times 100$$

Where E = the emission rate of the activity.

U1.2 To assess compliance with Condition U1.1, the Licensee must:

- measure uncontrolled and controlled haul road emissions on at least 3 occasions using a mobile dust monitoring system;

- continuously measure and record 'additional site data' including:
  - meteorological conditions, and
  - water and suppressant frequency, rate and quantity applied to haul roads.

- determine if a site specific relationship can be derived between the measured control efficiency and the additional site data.

The measurement of uncontrolled and controlled haul road PM10 emissions must be undertaken under varying meteorological conditions, including at those times when analysis of meteorological data indicates that elevated levels of dust are most likely at the Premises.

Note: The EPA acknowledges that in order to determine uncontrolled PM10 emissions, the section of haul road to be sampled will need to be left untreated for a period of up to 48 hours prior to the sampling taking place.

U1.3 The Licensee must submit a report to the EPA which documents the results of the assessment undertaken in accordance with Condition U1.1. The report must include an assessment of:

- the dust control effectiveness,
- the dust levels recorded, and
- any relationship established between control effectiveness and the additional site data.

The report must be submitted by the Licensee to the Environment Protection Authority Regional Manager, Hunter, at PO Box 488G, NEWCASTLE by 15 August 2014.

U1.4 The report required by condition U1.3 must be made publicly available by the Licensee on the Licensee's website by 29 August 2014.

Appendix 2. Summary of Annual Meteorological Conditions

Figure A1-A4 show the following,

- Average monthly temperature and temperature on sampling days
- Average monthly humidity and humidity on sampling days
- Average monthly solar radiation and solar radiation on sampling days
- Total monthly rainfall by year.

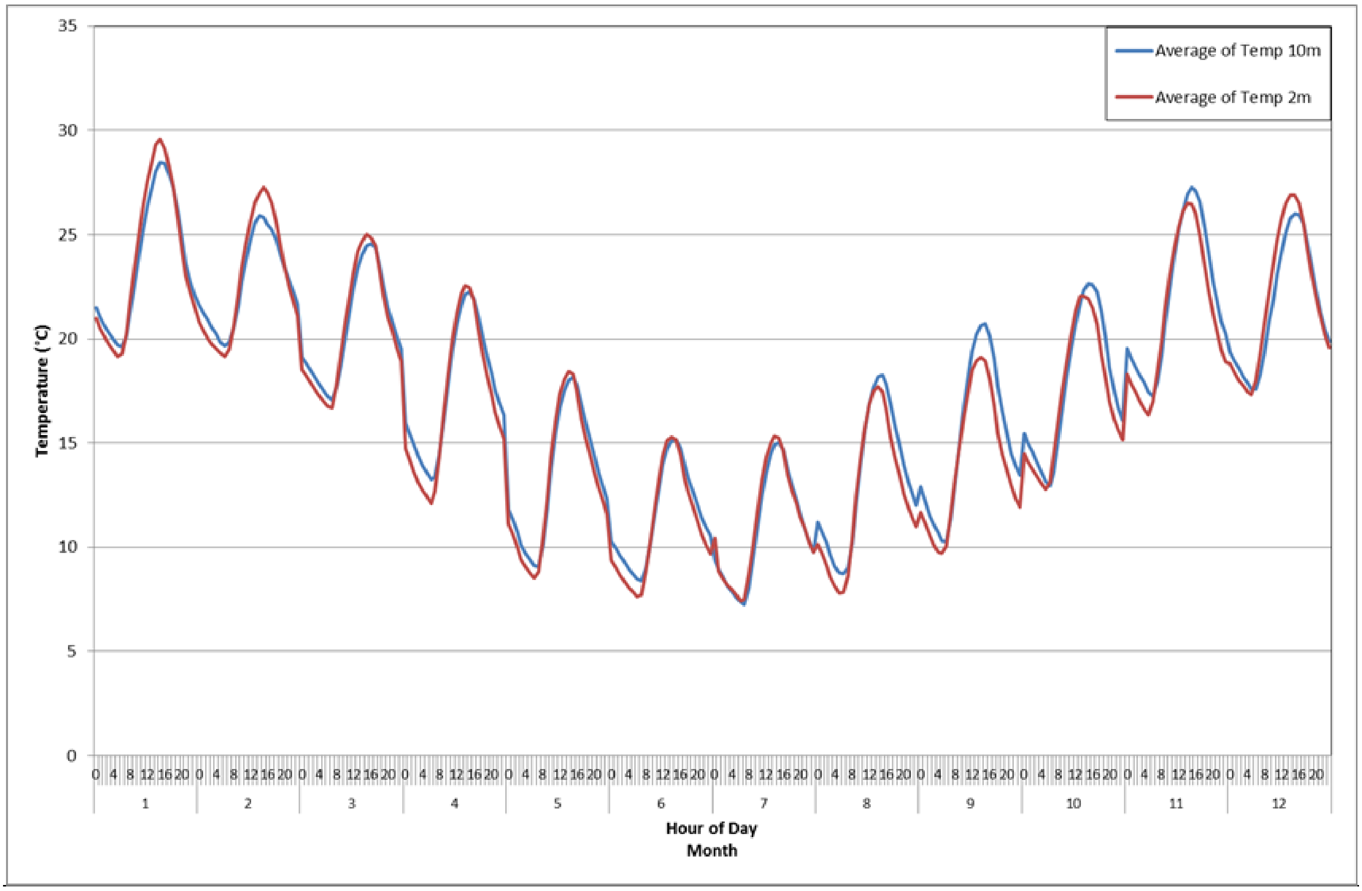

Figure A1: Average monthly temperature (^oC) – July 2009 to July 2013

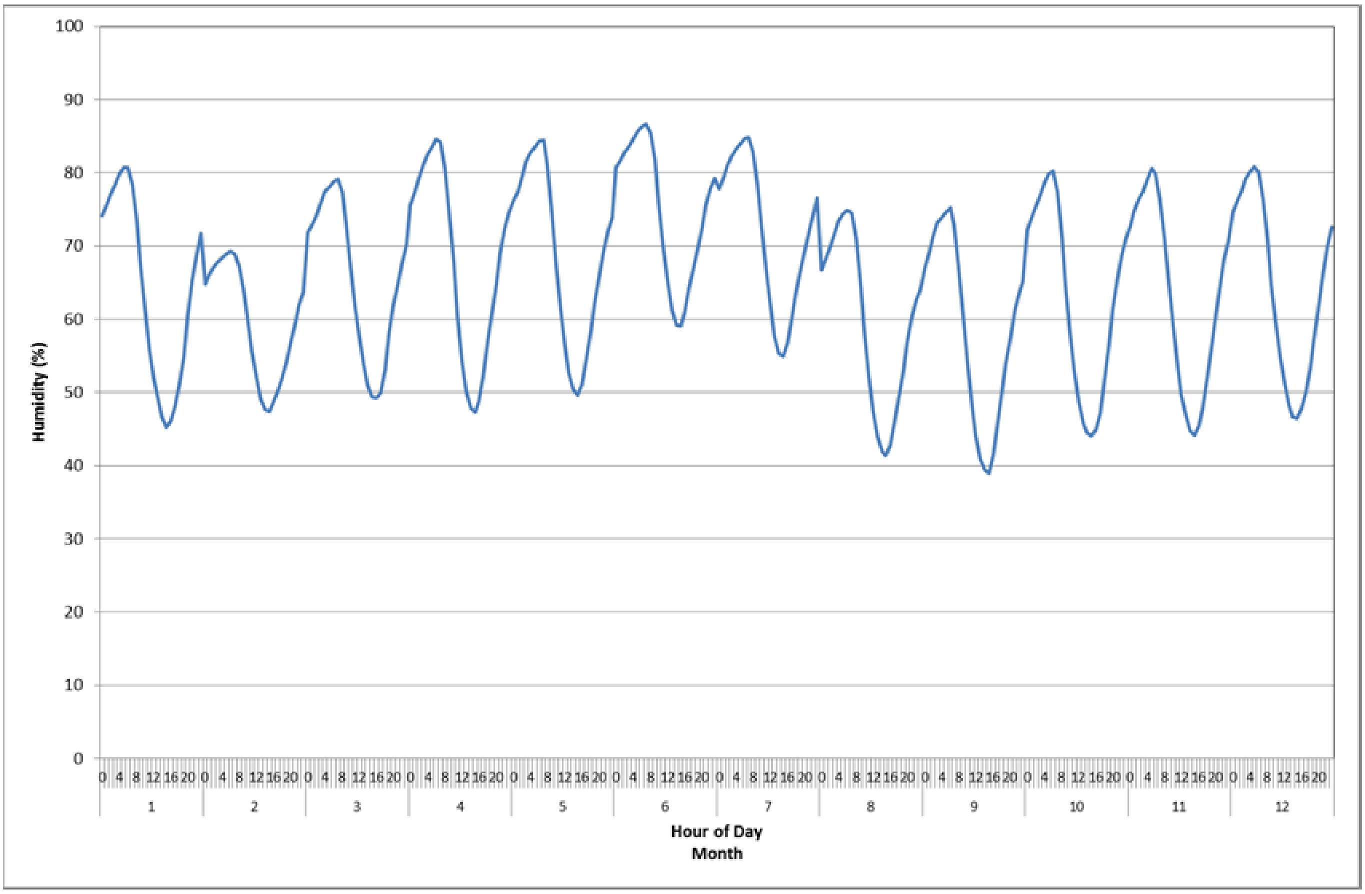

Figure A2: Average monthly humidity (%) – July 2009 to July 2013

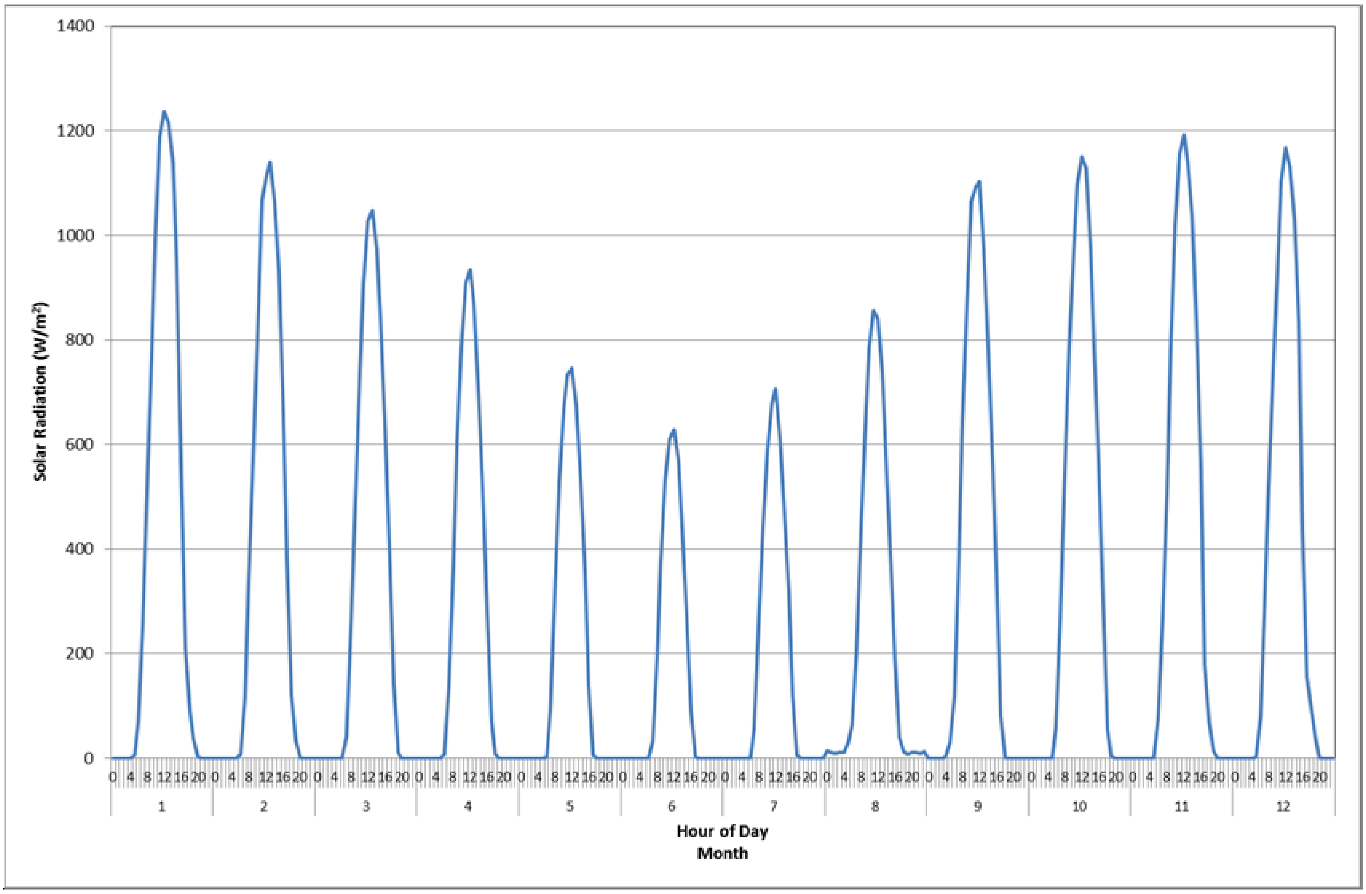

Figure A3: Average monthly solar radiation – July 2009 to July 2013

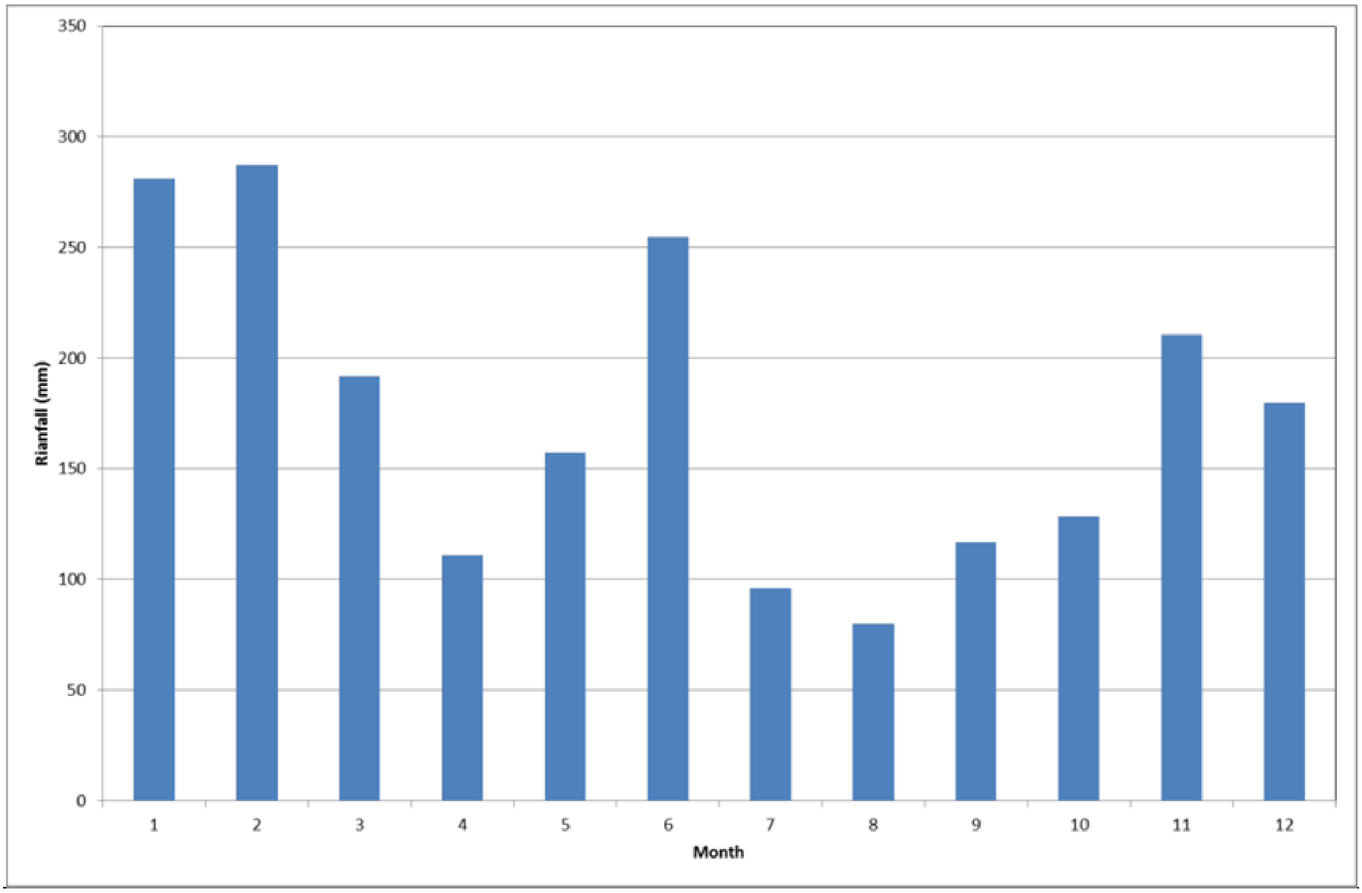

Figure A4: Total monthly rainfall (mm) – July 2009 to July 2013