Environmental Excellence through Experience, Endeavour and Evaluation.

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Environmental Dust Monitoring

Summernats Car Festival
Watson
Canberra
ACT 2911

29 June 2010

Client: ACT EPA

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TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

At the request of the ACT Environmental Protection Authority (EPA), Robson Environmental Pty Ltd was commissioned to carry out particulate monitoring of ambient air at two sites in the suburb of Watson, ACT during the Summernats car festival held at the Exhibition Park in Canberra (EPIC) in Mitchell between 7 January and 11 January 2010. Monitoring of particulates less than 10 µm in diameter (PM_{10}) was used to assess the impact of this event on ambient air quality because PM_{10} is the current particulate indicator for assessing ambient air quality as part of the *National Environment Protection (Ambient Air Quality) Measure* 2003 (NEPM) framework. The current exposure standard for PM_{10} in ambient air is no more than 5 daily exceedences of greater than 50 µg m^{-3} (24 hours) in a year.

Monitoring of PM_{10} was conducted during the weekend of the Summernats Car festival from Friday 8 January 2010 at 10:00am to Monday 11 January 2010 around 9:45am. Follow up monitoring was conducted one week later, commencing on Friday 15 January 2010 around 10:00am and finishing on Monday 18 January 2010 around 9:30am. The results from the follow up monitoring were used as a control sample to compare ambient air quality when burnouts and other Summernats activities were being carried out, with ambient air quality during regular traffic conditions. At Site A, located adjacent to the riding track in Watson (Map 1), gravimetric monitoring was carried out according to AS/NZS 3580.9.6:2003 to give a time weighted average of PM_{10} concentrations over a 24 hour period (PM_{10} $TWA_{(24\ hours)}$), as well as real time monitoring of PM_{10} concentrations with a DustTrak, which were calculated as geometric means for each day (mean daily PM_{10}). At Site B, adjacent to the Federal Highway in Watson (Map 1) only real time monitoring of PM_{10} with a DustTrak was carried out.

The results show that the PM_{10} $TWA_{(24\ hour)}$ concentrations were below the NEPM of 50 µg m^{-3}. PM_{10} concentrations ($TWA_{(24\ hour)}$ and mean daily) were higher on the weekend of the Summernats, in comparison to follow up monitoring. Concentrations of Copper, Lead and Chromium in the PM_{10} particulate fraction were also higher on the Saturday of the Summernats weekend, in comparison to the following Saturday. A review of Summernats activities shows that when burnout activities occurred there was an increase in real time PM_{10} concentrations measured at either one or both monitoring sites on a number of occasions. There was also an increase in real time PM_{10} concentrations which coincided with the fireworks and main stage concert on the Saturday night. The PM_{10} concentrations measured may have been influenced by changes in wind direction, ambient air temperature, and the occurrence of rain on the Sunday during the follow up monitoring.

In conclusion, Robson Environmental Pty Ltd advises that while $TWA_{(24\ hour)}$ PM_{10} concentrations were below the NEPM of 50 µg m^{-3}, Summernats activities appeared to have an adverse effect on PM_{10} concentrations at both monitoring sites. However, there are a number of uncertainties due to the small number of sampling sites and indicators monitored.

2. SCOPE OF WORK

The aim of the monitoring was to determine if concentrations of atmospheric particulate matter measuring less than 10 µm in diameter (PM_{10}) were within the National Environmental Protection Measure (NEPM) guideline for acceptable ambient air quality of 50 µg m^{-3} over a 24 hour period (EHPC, 2003).

The scope of the work was as follows:

- Gravimetrically measure ambient PM_{10} concentrations (24 hour samples) according to AS/NZS 3580.9.6:2003 for the duration of the Summernats at one location (Site A), please refer to Map 1 below;

- Log real-time PM_{10} concentrations for the duration of the Summernats at two locations (Site A & Site B), please refer to Map 1 below;

- Monitor background PM_{10} concentrations in ambient air using both gravimetric and real-time monitoring methods;

- Assessment of PM_{10} concentrations against the NEPM for ambient PM_{10} over a 24 hour period, and best practice;

- Report on the findings of the assessment, and Make recommendations where appropriate based on these findings.

Map 1: Location of Monitoring Sites in Relation to Summernats Burnout Strip

3. METHODOLOGY

Sampling of PM_{10} during the Summernats commenced around 10:00am on Friday 8 January 2010, and finished on Monday 11 January 2010 around 9:45am. Background PM_{10} sampling commenced the following week on Friday 15 January 2010 around 10:00am, and finished on Monday 18 January 2010 around 9:30am.

Gravimetric sampling of PM_{10} particulates was carried out at Site A according to AS/NZS 3580.9.6:2003, which is the specified method for statutory monitoring of PM_{10} in ambient air according to the *National Environment Protection (Ambient Air Quality) Measure* 2003. Prior to sampling, PVC filters were conditioned for 24 hours in a controlled environment, and weighed on a calibrated microbalance (Mettler Toledo, Model No. AT201). On completion of sampling, the PVC filers were re-conditioned for 24 hours prior to reweighing, and the difference in weights recorded. The High Volume Sampler (Thermo Scientific Model VFC-PM10) was fitted with a PM_{10} size selective inlet and the flow rate calibrated at 1.13 L min^{-1}.

Real-time monitoring of PM_{10} particulates was conducted at Sites A and B with TSI DustTraks (model 8520; serial № 23651 & 85202572, respectively). The PM_{10} size selective inlet was attached and the flow rates calibrated at 1.7 L min^{-1}. The monitors were placed at a height of approximately 0.5-1m, and logging set for 1 minute intervals. Data from the DustTraks was analysed with TSI TrakPro software version 4.0.3.0.

Meteorological data was obtained from the Australian Bureau of Meteorology (BOM) website at www.bom.gov.au/products/IDN60801/IDN60801.94926.shtml. Information on scheduled hazard reduction burns and bushfires in the surrounding area was downloaded from the ACT Department of Territory and Municipal Services www.tams.act.gov.au/includes/whats_new/hazard_reduction_burns and NSW Rural Fire Service http://www.rfs.nsw.gov.au/dsp_content.cfm?cat_id=689.

Site A was located in an east south easterly direction from the Summernats burn out strip and Site B was located to the south/south east of the Summernats burn out strip (please refer to Map 1).

4. RESULTS

Table 1 shows the $TWA_{(24\ hour)}$ PM_{10} concentrations for each sample collected during the monitoring periods. The $TWA_{(24\ hour)}$ PM_{10} concentrations during the Summernats monitoring sessions were higher in comparison to follow up monitoring sessions, but none of the samples exceeded the PM_{10} NEPM of 50 µg m^{-3}.

The PM_{10} control sample for Sunday 17 of January 2010 was voided because the calculated concentration was higher than would be realistic (>100 µg m^{-3}) given the data from the DustTrak indicated that PM_{10} concentrations on the Sunday were lower in comparison to those collected during the Summernats weekend. The BOM also reported that 1.6mm of rain was recorded on Sunday 17 January 2010, and it is possible that moisture gain may have affected the filter condition and subsequently, the result.

Additional information on PM_{10} concentrations could be sought from the ACT Government Analytical Laboratory (GAL), which monitors daily PM_{10} concentrations in accordance with the *National Environment Protection (Ambient Air Quality) Measure 2003*. Results of monitoring conducted by the ACT GAL could be used as an indication of background PM_{10} concentration on the monitoring days.

Table 1: $TWA_{(24\ hour)}$ PM_{10} Concentrations (µg m^{-3}) **at Site A, January 2010**

Sampling Day	**Summernats**			**Control**			**NEPM**
	Start Date	PM_{10} (µg m^{-3})	Wind Direction	Start Date	PM_{10} (µg m^{-3})	Wind Direction	**PM_{10}** (µg m^{-3})
Friday	8/01/10	17	WNW	15/01/10	7	NE	50
Saturday	9/01/10	34	WSW	16/01/10	9	NNW	50
Sunday	10/01/10	14	W	17/01/10	Void	W	50

Table 2 shows that the mean daily PM_{10} concentrations were all below 50 µg m^{-3} during both Summernats and follow up monitoring sessions. The mean concentrations declined significantly at both Site A and Site B between the initial and subsequent monitoring periods. Site A PM_{10} concentrations declined from a range of 12 to 14 µg m^{-3} during Summernats, to 1 to 11 µg m^{-3} on the following weekend. At Site B, mean daily PM_{10} concentrations declined from a range of 15 to 22 µg m^{-3}, to 4 to 13 µg m^{-3} after the event.

The daily PM_{10} graphs for the DustTraks show an increase in real time PM_{10} concentrations, which coincides with various Summernats activities including the burnouts and fireworks, as well as a large reduction in the number of peaks that exceeded 50 µg m^{-3} during post Summernats monitoring sessions. The full set of graphs is provided in Appendix A.

Site B had higher mean daily PM_{10} concentration during the Summernats monitoring in comparison to Site A PM_{10}. However, statistical analysis indicated that the difference was not significant. The mean daily PM_{10} concentrations at Sites A and B during the Summernats weekend were strongly correlated, indicating that PM_{10} concentrations at both sites were being influenced by the same source.

The mean daily PM_{10} concentrations measured with the DustTrak at Site B were correlated with the $TWA_{(24\ hour)}$ PM_{10} concentrations measured at Site A with the High Volume Sampler. Site A had a weaker correlation between the mean daily PM_{10} concentration and the $TWA_{(24\ hour)}$ PM_{10} concentration. The correlation suggests that the PM_{10} concentrations at both sites indicate that all samples were being influenced by the same source. However, it must be noted that there was a difference between the sampling periods for the two types of data reported. Gravimetric TWA PM_{10} concentrations are based on the amount of sample collected over 24 hours starting from 10:00am, while the daily mean PM_{10} concentrations are based on DustTrak data starting from 12:00am each day, with the exception of Fridays at 10:00am.

Table 2: Mean Daily (±Standard Error) **PM_{10} Concentrations Measured with Dust Traks at Sites A and B, January 2010**

Date	Daily PM_{10} Mean^ (±SE) (µg m^{-3})		Temperature* (ºC)	Relative Humidity* (%RH)	Wind Speed* (km/h)	Wind Direction*
	Site A	Site B				
8/01/10	13 ±1	22 ±5	30.7	28	17	WNW
9/01/10	14 ±1	22 ±3	33.6	24	24	WSW
10/01/10	14 ±0	20 ±5	37.6	11	28	W
11/01/10	12 ±0	15 ±0	34.6	26	24	NW
15/01/10	10 ±0	10 ±1	28.3	41	9	NE
16/01/10	11 ±0	13 ±1	29.2	43	17	NNW
17/01/10	1 ±0	6 ±0	25.0	19	33	W
18/01/10	3 ±0	4 ±0	17.5	22	31	SW

^ Geometric mean, data log normally distributed
* 15:00 data sourced from Bureau of Meteorology website

Table 3 shows that concentrations of lead, copper and chromium in the PM_{10} particulate fraction were higher on Saturday 9 January 2010 during the Summernats Car Festival in comparison with Saturday 16 January 2010 on the following weekend. Potential sources of heavy metals in the atmosphere would have included tyre particles emitted during the burnout competitions and the fireworks on Saturday the 9 January 2010.

Table 3: Metals Analysis of For Gravimetric PM_{10} Samples Collected on Saturday the 9 & 16 January 2010

Sampling Day	Date	Metals Analysed		
		Lead (µg m^{-3})	Copper (µg m^{-3})	Chromium (µg m^{-3})
Summernats Saturday	9/01/10	0.008	0.010	0.001
Control Saturday	16/01/10	0.001	0.001	0.000

5. DISCUSSION

Gravimetric monitoring of PM_{10} according to the AS3580.9.6:2003 indicated that ambient air quality was acceptable during both the Summernats and the following weekend because the PM_{10} NEPM of 50 µg m^{-3} was not exceeded. However, the $TWA_{(24\ hour)}$ PM_{10} and daily mean PM_{10} concentrations shown in Section 4 indicate that Summernats activities affected ambient PM_{10} concentrations, with higher concentrations recorded on the weekend of the Summernats in comparison to the following weekend. Analysis of gravimetric filters showed a higher concentration of lead, copper and chromium was present in the PM_{10} particulate fraction on the Saturday of the Summernats (9 January 2010) in comparison with the following Saturday (16 January 2010), although the lead concentration did not exceed the NEPM of 0.5 µg m^{-3}.

Further evidence of the impact of Summernats activities on ambient air quality was the simultaneous increase in real time PM_{10} concentrations at both sites when burnout trials were scheduled for Friday 8 January 2010 between 2:00pm and 6:00pm, and at Site B on Sunday 10 January 2010 between 12:45 and 4:30pm, as shown in Appendix A. There was also a large reduction in the frequency of short term PM_{10} peaks in the daily real time DustTrak graphs which exceeded 50 µg m^{-3} during follow up monitoring. The wind direction at 3:00pm on the Friday 8 January 2010 was west-north-west, heading in the general direction of both Site A and Site B from the burnout track and on the Sunday 10 January 2010 the wind was blowing in a westerly direction at 3:00pm in the general direction of Site B. On Saturday 9 January 2010 burnout trials were scheduled between 4:30pm to 6:30pm, but this activity did not appear to affect real time PM_{10} concentrations as significantly as the other monitoring days. This difference may be because the wind direction on the Saturday 9 January 2010 was different to the Friday 8 January 2010 (west south west at 3:00pm). A change in wind direction would also explain the greater frequency and concentration of real time PM_{10} peaks during burnout finals on Sunday 10 January 2010, in comparison to the PM_{10} peaks during the burnout semi finals (please refer to Appendix 2). For future monitoring, it would be advisable that a weather station be placed at each monitoring location to capture changes in wind speed and direction that may influence air borne particulate concentrations. In addition, videoing of smoke plumes at each location could be a powerful tool for confirming if spikes in real time PM_{10} data are related to Summernats activities.

The BOM reported 1.6 mm rain fell on Sunday 17 January, which would have affected airborne PM_{10} concentrations on this day, due to particle wash out from the atmosphere. Ambient air temperature may also have been affecting PM_{10} concentrations because the two indicators were significantly correlated at both sites, and ambient air temperatures, as reported at 3:00pm were significantly lower during follow up monitoring. The PM_{10} concentrations reported for the Summernats weekend were not likely to have been impacted by hazard reduction burns or major bushfire activity, because there were no reports of these activities in the Canberra region over the Summernats weekend from either the NSW Rural Fire Service or ACT Territory and Municipal Services.

The increase in ambient air PM_{10} in relation to the Summernats activities represents a potential health risk to people in the monitoring locations because it was related to motor vehicle emissions. Wallenius *et al*., (2005) observed that short term increases in air pollution relating to motor vehicles emissions may trigger acute heart congestion in heart failure patients. In addition, Larrieu *et al*., (2009) reported that an increase of 10 µg m^{-3} above mean ambient concentrations (21 µg m^{-3}) was linked with increases in general practitioner visits for upper and lower respiratory disease, headaches and asthenia, skin rash and conjunctivitis, while Medina Raton *et al*., (2006) reported that 10 µg m^{-3} increase (mean 30 µg m^{-3}) during the warm season was associated with an increase in hospital admissions for chronic obstructive pulmonary disease and pneumonia. There has also been a link between increased mortality rates and hospital admissions when the average ambient PM_{10} concentration increased by 10 µg m^{-3} in comparison to the previous day (Dominici *et al*., 2004). A number of researchers have also reported links between mean ambient PM_{10} concentrations and hospital admissions for respiratory diseases (Atkinson *et al*., 2001; Lee & Ferguson 2009).

The relationship between the occurrence of burnouts and airborne PM_{10} concentrations is of particular concern because dust from car tyres can contain potentially hazardous materials including heavy metals such as iron (5.5%), copper (0.1%), zinc (1.6%) and lead (0.1%), as well as asphalt materials which include aluminium (7.5%), calcium (10.1%) and silica (21.2%) (Adachi & Tainosho, 2004). This indicates that the increase in lead and copper concentrations in the PM_{10} fraction recorded on the Saturday of the Summernats may be related to the burnouts.

A large peak in real time PM_{10} concentrations occurred at both sites on the Saturday night which started around 9:00pm, and declined at approximately 2:00am on the Sunday morning. The peak occurred in conjunction with main stage activities including the super Summernats concert and fireworks. The use of fireworks has been reported to cause increases in ambient PM_{10} concentrations (Vecchi *et al*., 2008), as well as atmospheric concentrations of lead from 0.017 to 0.379 µg m^{-3} and copper from 0.012 to 0.071 µg m^{-3} (Moreno *et al.*, 2007). Therefore the fireworks on the Saturday 9 January 2010 may also have contributed to increases in lead and copper concentrations, in comparison to the concentrations measured on the following Saturday 16 January 2010. To determine whether the fireworks or the burnouts are causing the higher atmospheric metal concentrations during the Summernats, future monitoring would need to involve metals analysis of daily PM_{10} samples when there were burnout events scheduled, but no fireworks, and vice versa.

6. CONCLUSION AND RECOMENDATIONS

In conclusion, Robson Environmental Pty Ltd advises that Summernats activities appeared to have an adverse effect on both PM_{10} and atmospheric metal (copper, lead and chromium) concentrations; although none of the concentrations exceeded the Australian NEPM $TWA_{(24\ hour)}$ of 50 µg m^{-3} for PM_{10} in ambient air or 0.5 µg m^{-3} for atmospheric lead. However, there are a number of uncertainties due to the small number of sampling sites and indicators monitored and further assessment would be recommended to confirm the potential impact of Summernats activities on ambient air quality in the Canberra region.

To address the uncertainty caused by changing wind direction, future monitoring would need to be conducted at discrete distances around the entirety of the park using a minimum of 4 locations to the north, east, south and west of the burnout strip. Additional sampling for air pollutants such as heavy metals, PAH, and diesel particulates should also be included to help differentiate between PM_{10} sources. PAH monitoring could include analysis for specific tracer compounds such as retene for wood smoke and benzo[ghi]perylene for motor vehicle emissions (Bostrom *et al*., 2002; Li *et al*., 2009). The monitoring of particulates less than 2.5 µm in diameter ($PM_{2.5}$) could be carried out and compared with the NEPM $TWA_{(24\ hour)}$ advisory standard of 25 µg m^{-3} to help differentiate between combustion source pollution and mechanically generated particulates which contribute substantially to the PM_{10} particulate mass fraction. However, it must be noted that the $PM_{2.5}$ particulate fraction does not exclusively measure combustion particulates, and will contain some mechanically generated particles. The collection of meteorological data (wind speed, direction, temperature and relative humidity) at each sampling site is also recommended to help identify the potential origin of pollution incidents, which could be combined with videoing of the smoke plume direction.

Robson Environmental Pty Ltd would be happy to assist the EPA with the formulation of a more comprehensive study for future events. However, a 6 month lead time would be recommended to ensure that suitable sampling equipment and media is readily available prior to the event.

7. REFERENCES

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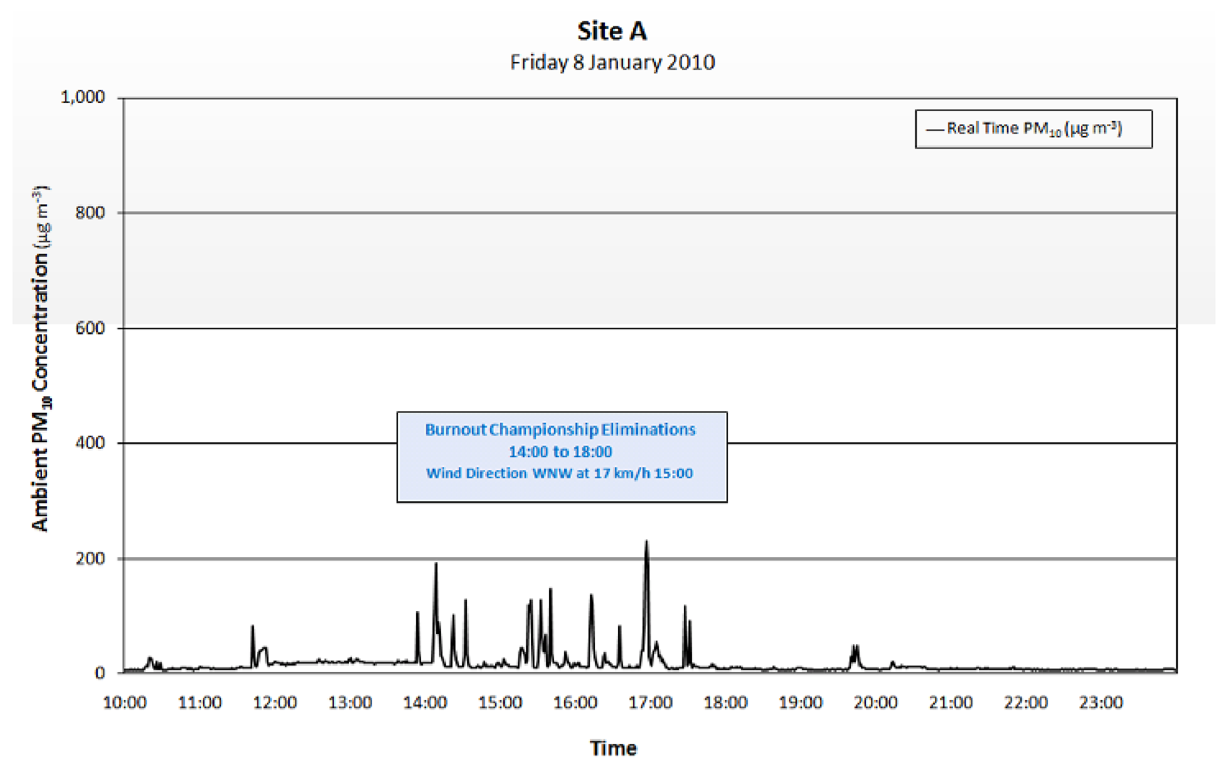
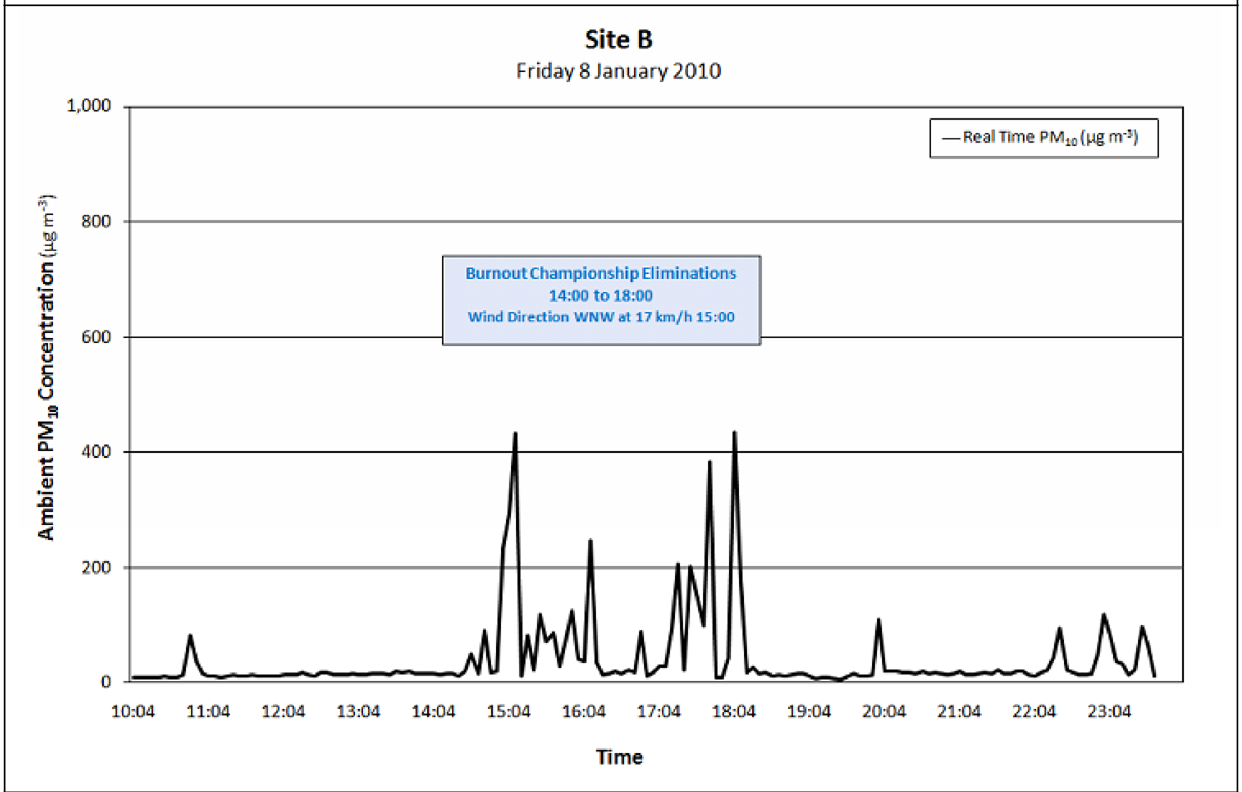
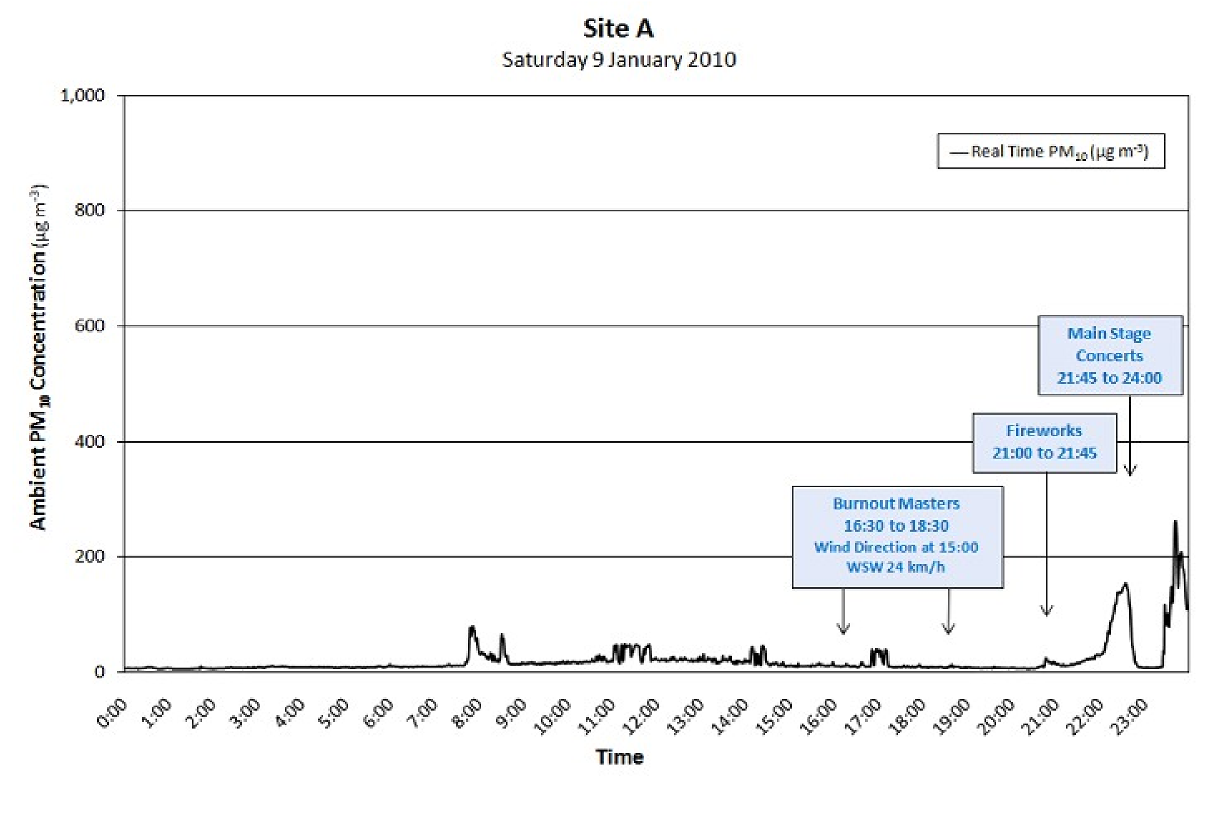
8. APPENDIX A – DustTrak Real Time Dust Monitoring Graphed Results

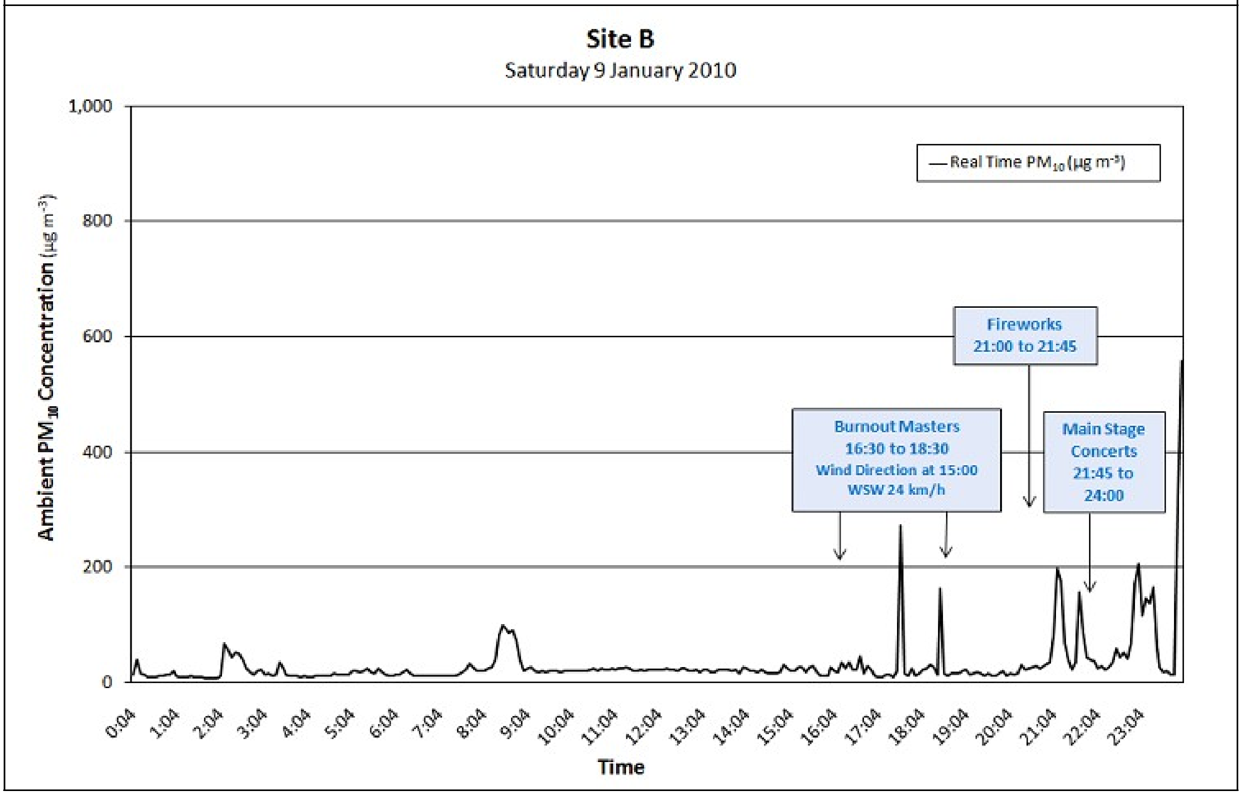
DustTrak Data Friday 8 January 2010



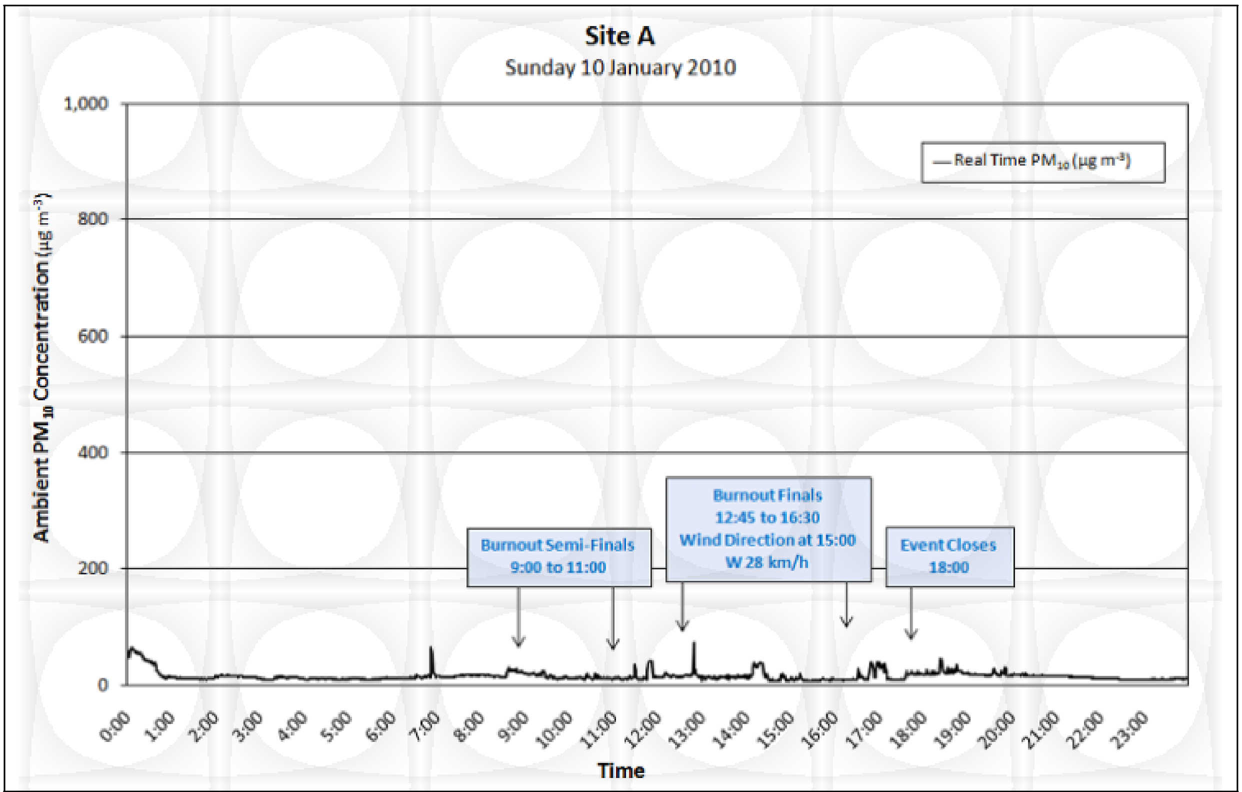


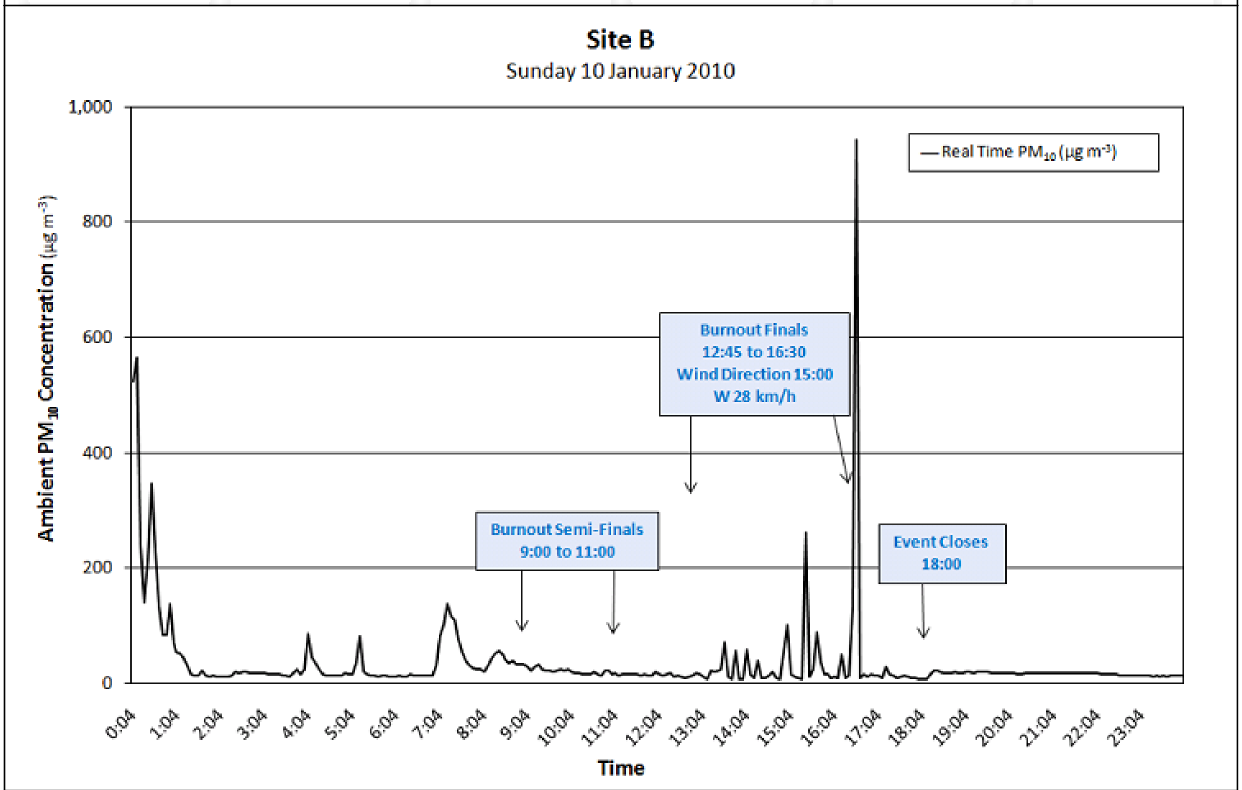
DustTrak Data Saturday 9 January 2010



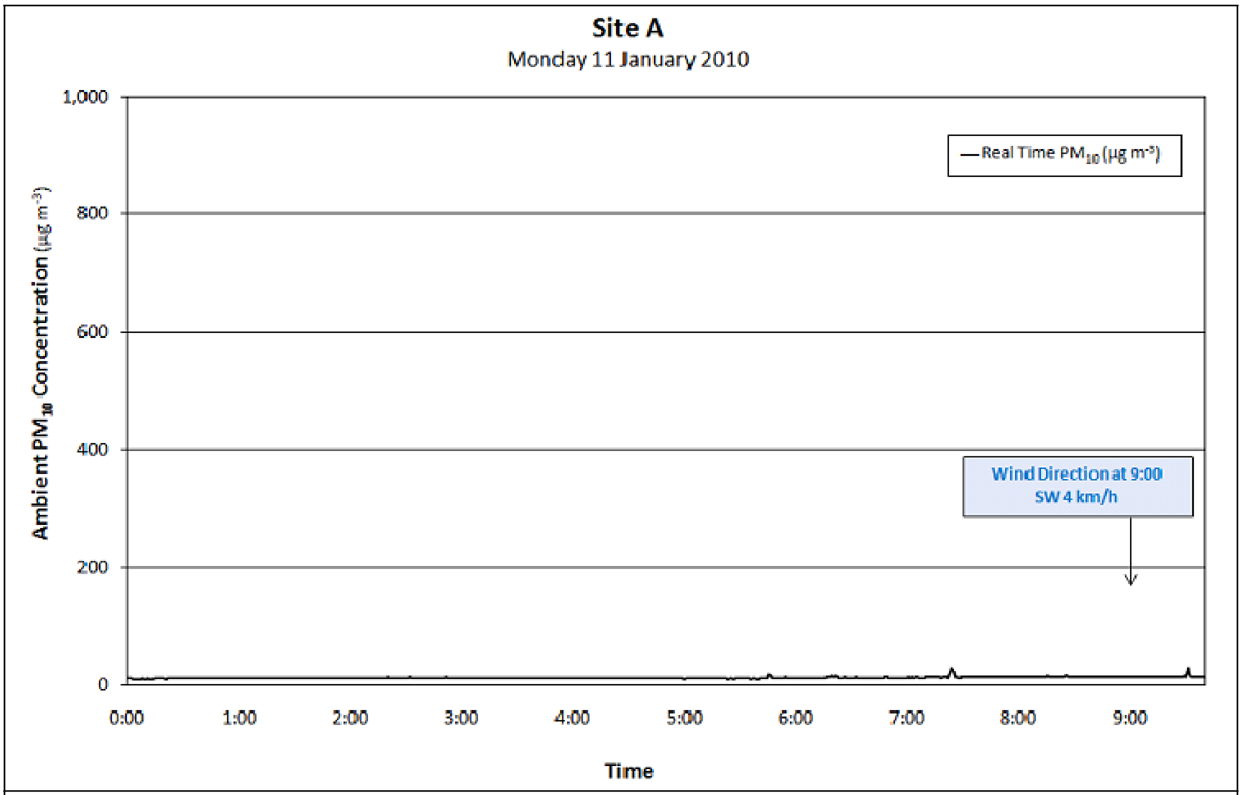


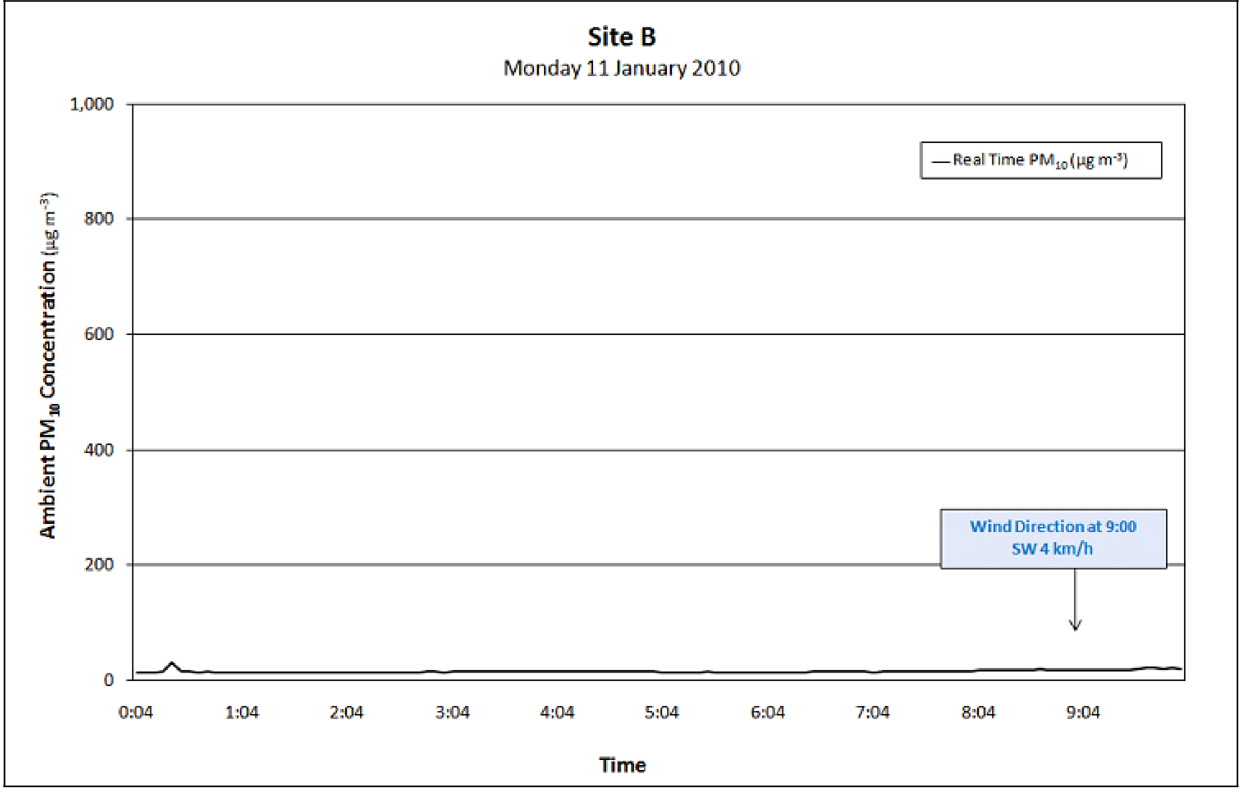
DustTrak Sunday 10 January 2010



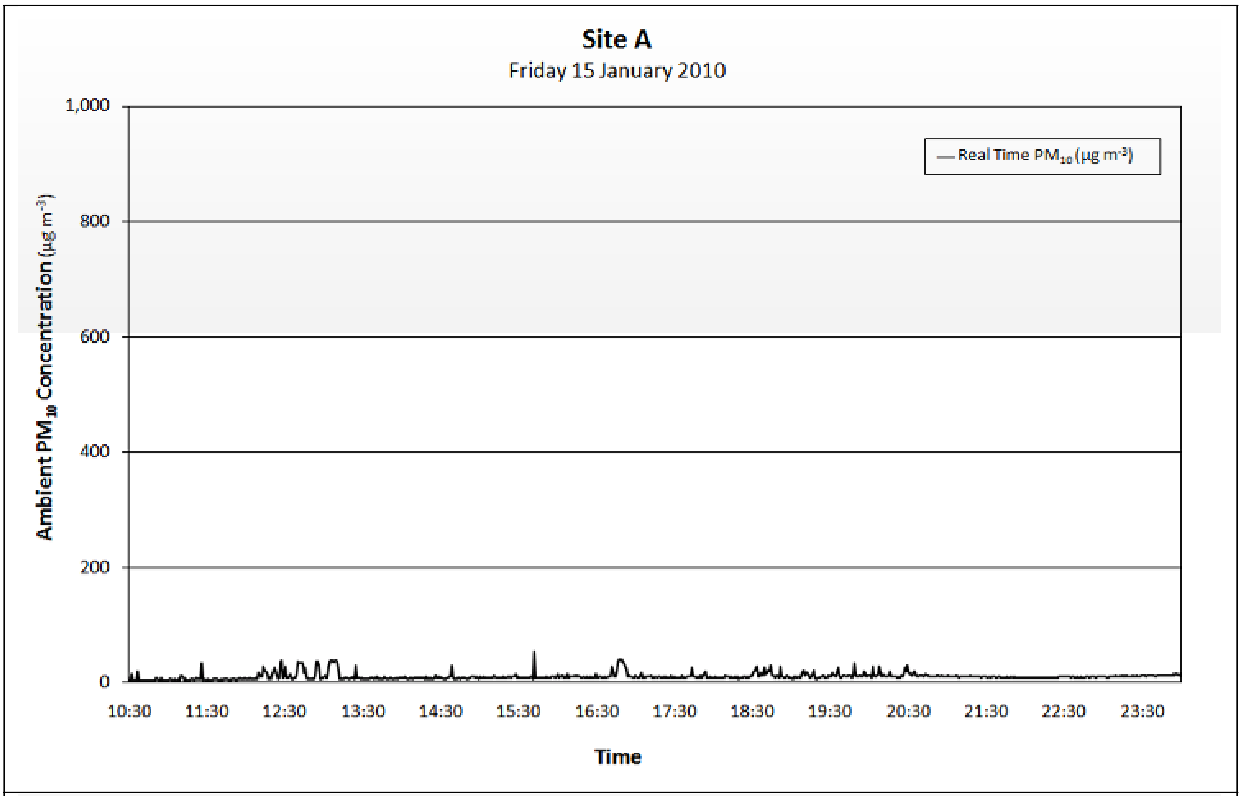


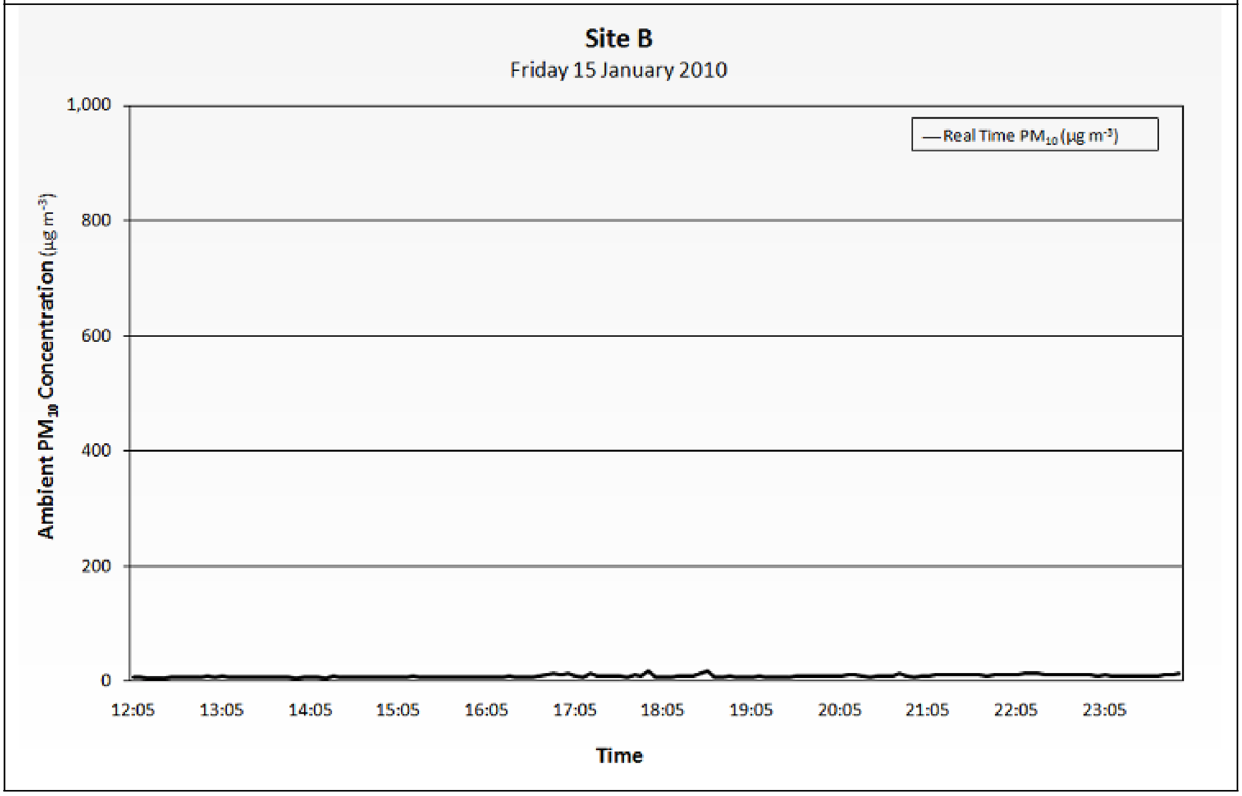
DustTrak Monday 11 January 2010





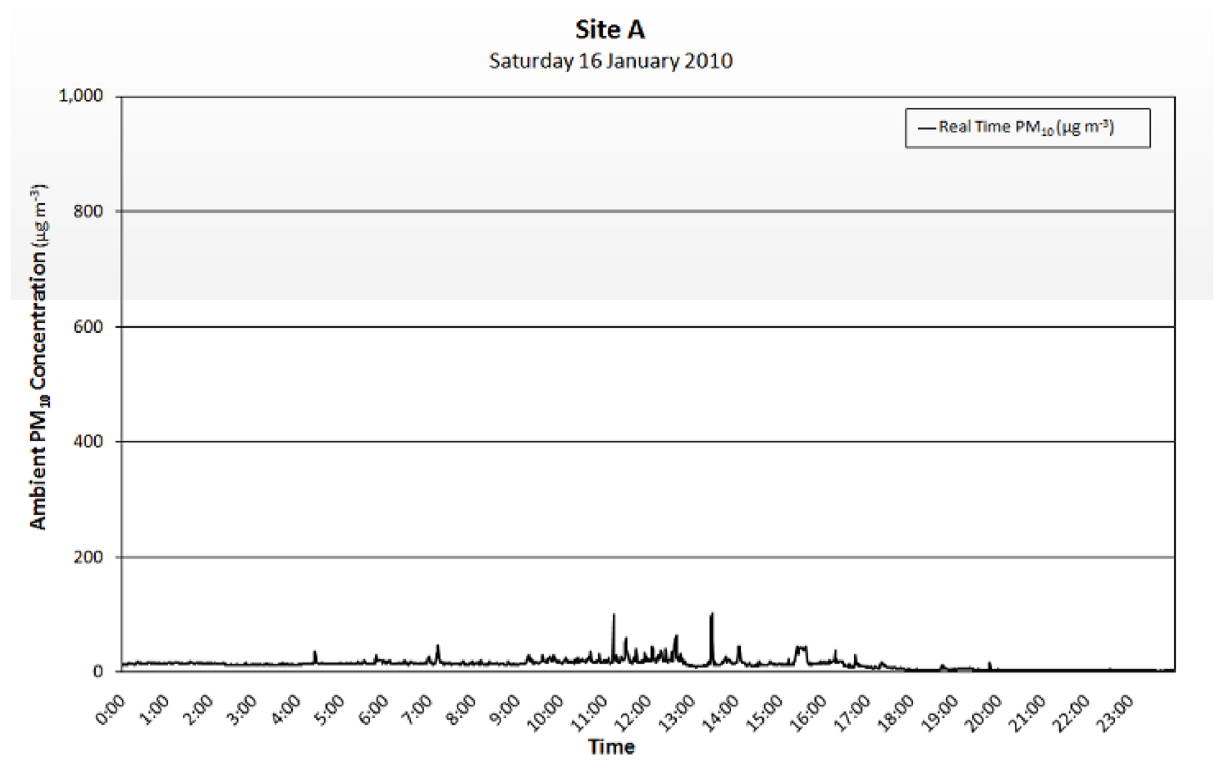
DustTrak Friday 15 January 2010

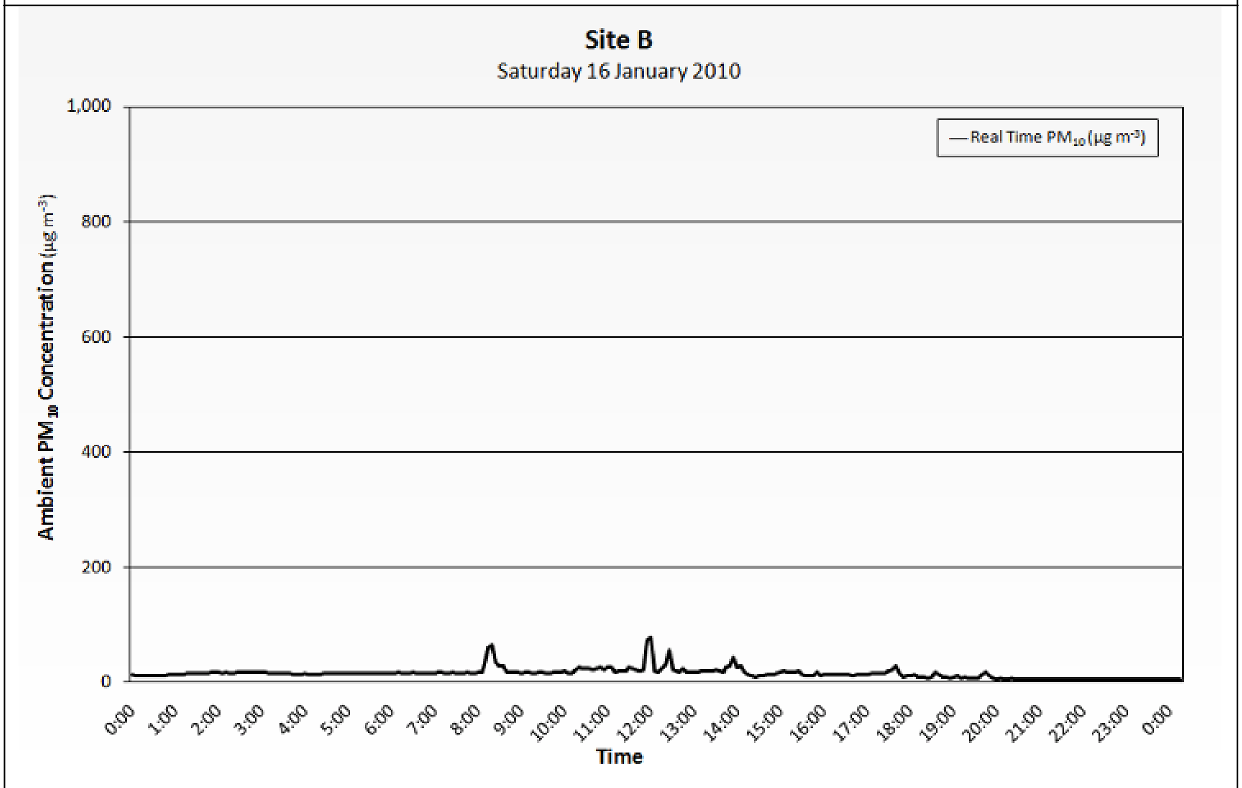




- Hazard reduction burn scheduled for Cotter Road (20x20m) from 19:00
- Small grassfire at Tumbarumba NSW (0 Ha) under control at 10:00

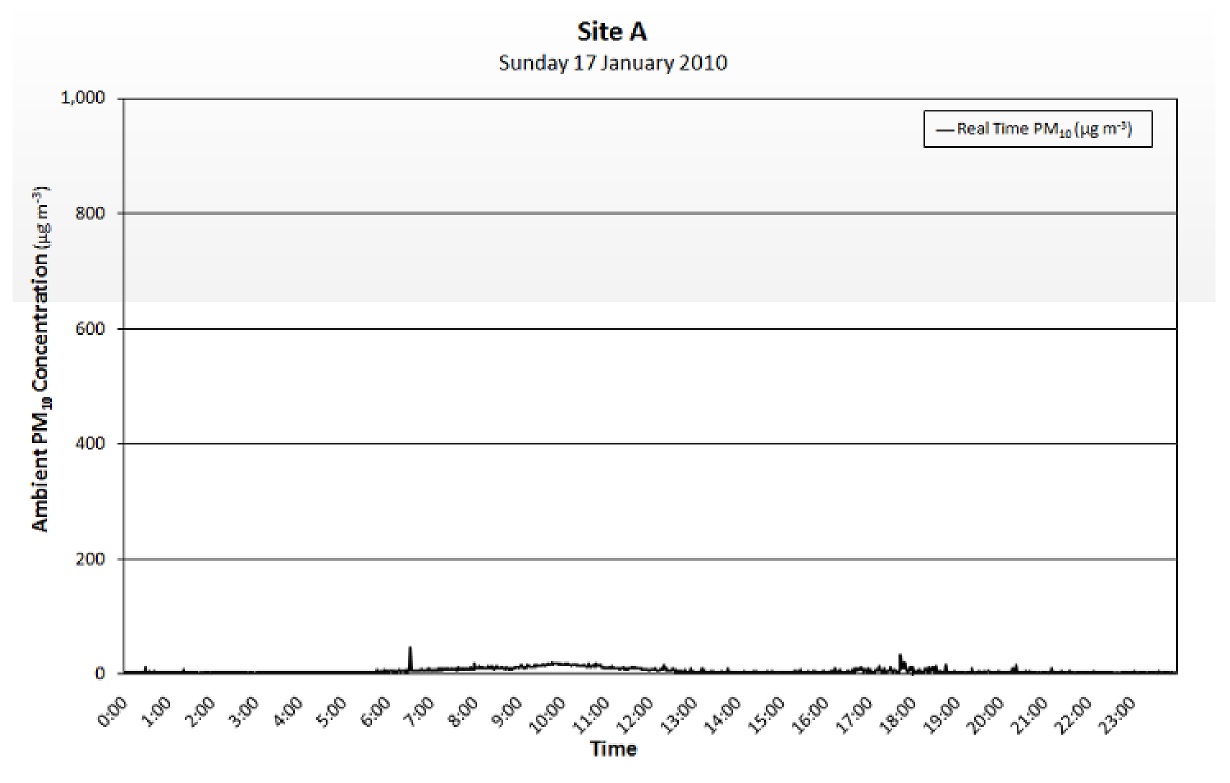
DustTrak Saturday 16 January 2010

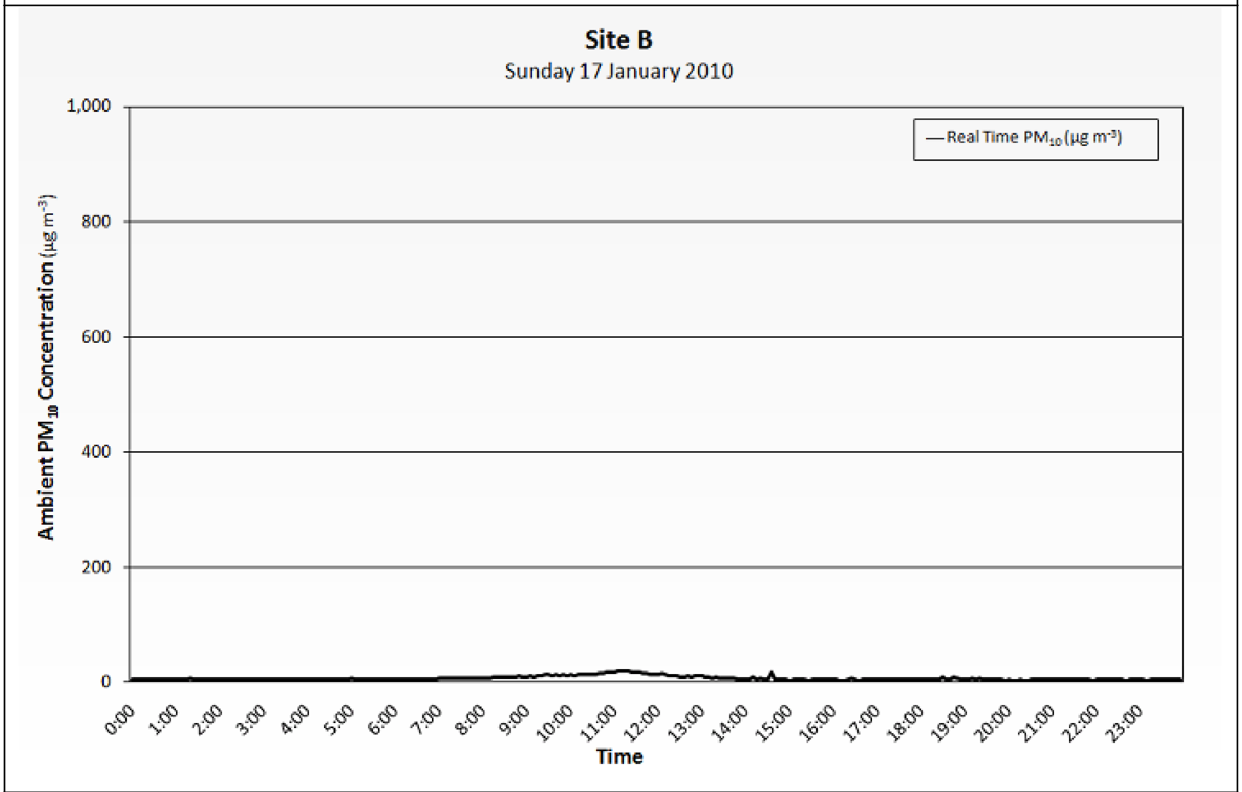




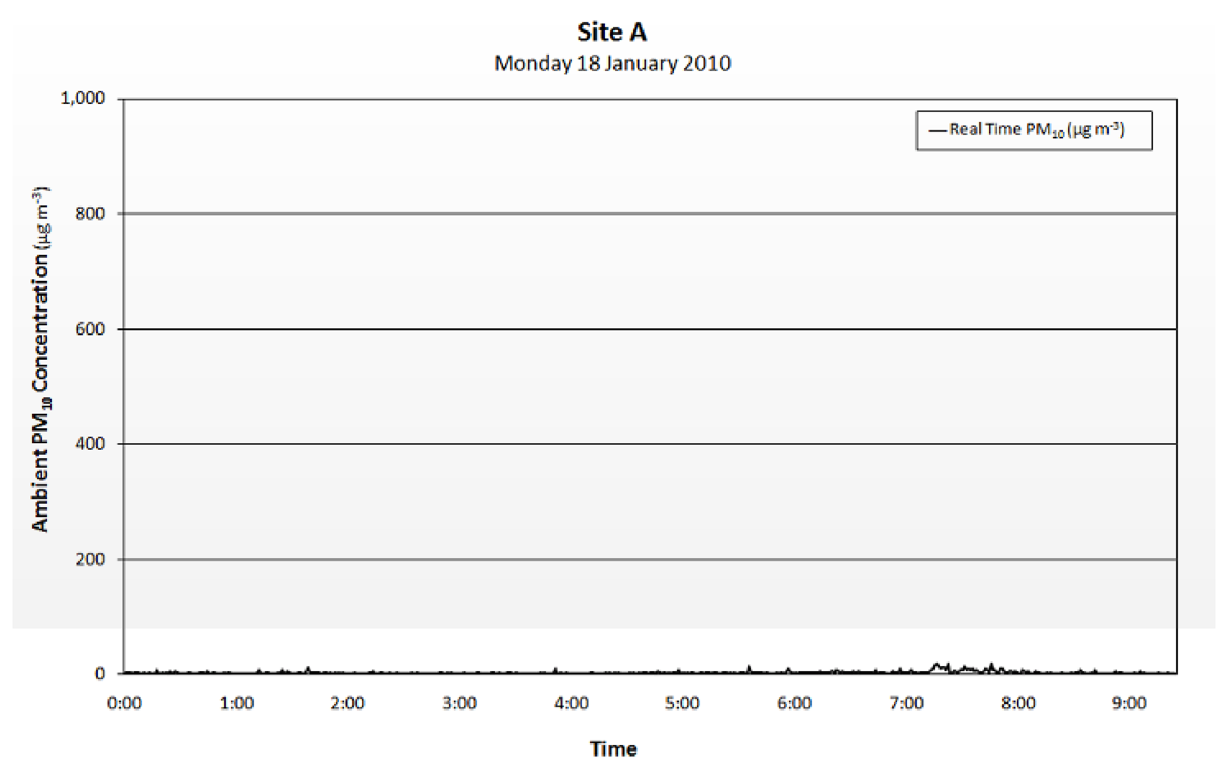
- Hazard reduction burn scheduled for Cotter Road (20x20m) from 8:00

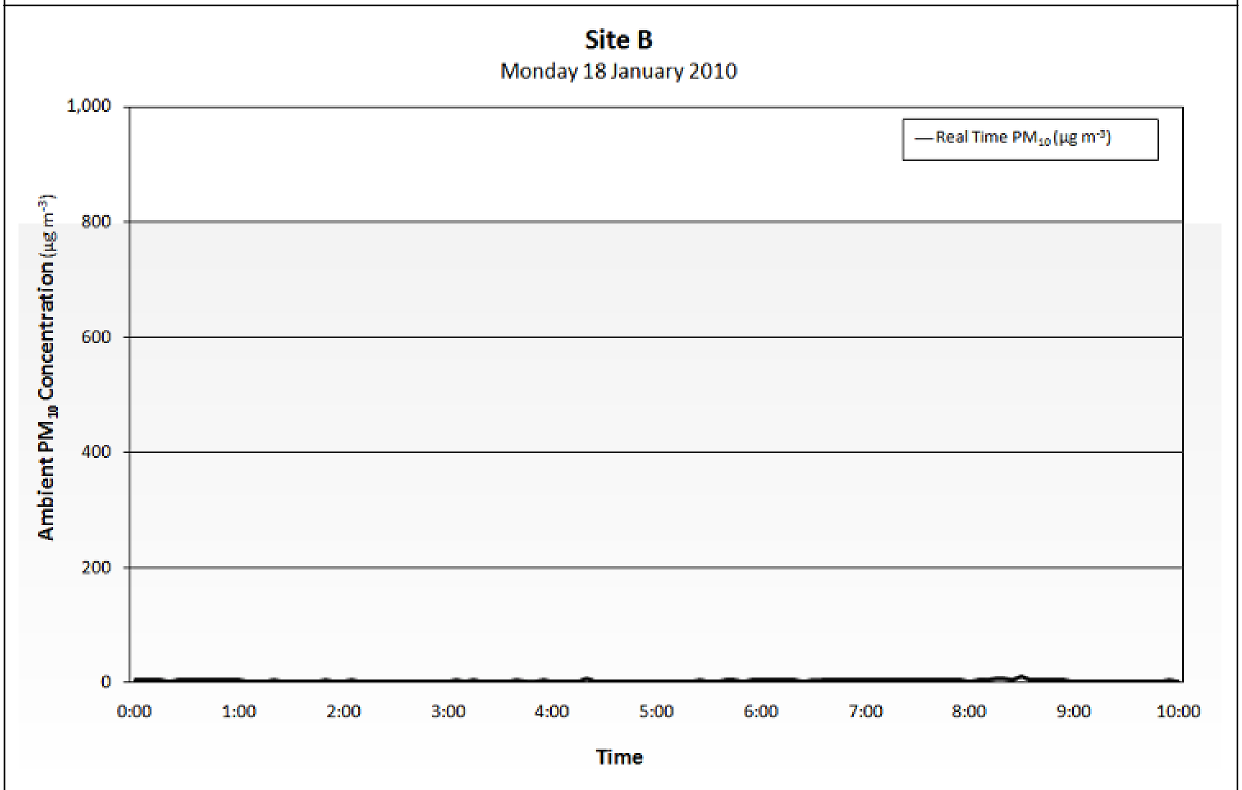
DustTrak Sunday 17 January 2010





DustTrak Monday 18 January 2010





9. APPENDIX B – Calibration Certificates for DustTrak Monitors

KENELEC SCIENTIFIC PTY LTD
CALIBRATION LABORATORY

CALIBRATION CERTIFICATE

Page 1 of 2
Form KF 157Rev 8

Certificate Number **2730** **Date of Test 18 December 2009**

CLIENT	**Robson Environmental** **9 Lyell Street** **FYSHWICK, ACT 2609**
Contact	**Marcus Donnelly**

Test Method	**Kenelec test method LABP 1**	
Client Instrument details	**TSI DustTrak Model 8520**	
	Serial No. 85202572	
Condition as received	*As left*	
Environmental Conditions	Ambient Temp.	25.0°C
	Humidity	25.0%RH
	Barometric Pressure	745.0mmHg

This calibration certificate shall not be reproduced except in full, without the written approval of Kenelec Scientific Pty Ltd.

Signed

Mark Williams
Laboratory Manager

Page 1 - Cover Sheet
Page 2 - Calibration after adjustment

Path: F:\Calibration\Certificates\2009\2730-8520-85202572-12-09.doc

Kenelec Scientific

KENELEC SCIENTIFIC PTY LTD
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Page 2 of 2
Form KF 157 Rev B

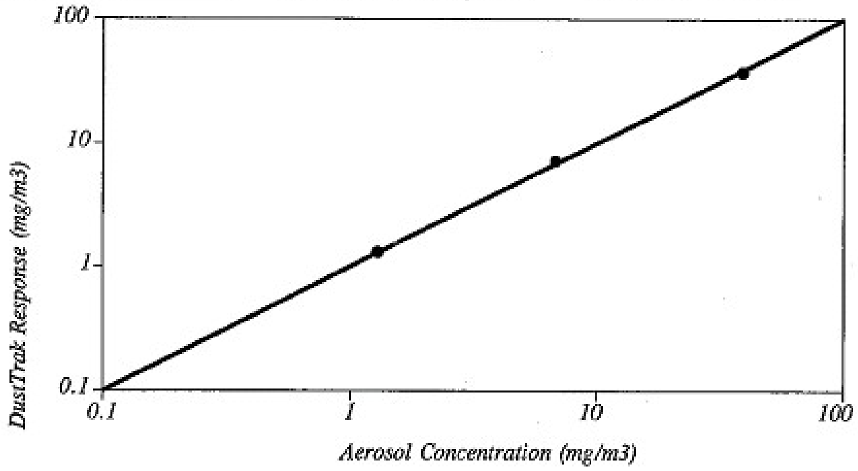
CERTIFICATE OF CALIBRATION AND TESTING

Model 8520 TSI Serial No. 85202572

Description DustTrak

Calibration Standard Aerosol Calibration Bench #1

DustTrak Linearity Plot



Environmental Conditions:

Temperature: 25.00 ° C Pressure: 745.00 mmHg

Humidity: 25.00 %RH

KENELEC SCIENTIFIC does hereby certify that all performance and acceptance tests required were successfully conducted according to required specifications. All test and calibration data supplied by KENELEC SCIENTIFIC has been obtained using respirable mass standard ISO 12103-1 A1 Ultra Fine Test Dust. Prior to calibration the instrument was cleaned and the flow rate was adjusted to 1.70 l/min.

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Applicable Test Report	Report Number	Date Last Verified	Date Due
DC Voltage	8786	24-04-09	24-04-10
Barometric Pressure	RGA20148-2	21-04-09	21-04-10

Calibrated by

☐ Final Function Check

18/12/2009
Calibration Date

Kenelec Scientific

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KENELEC SCIENTIFIC PTY LTD
CALIBRATION LABORATORY

CALIBRATION CERTIFICATE

Page 1 of 2
Form KF 157Rev B

Certificate Number	**2729**	**Date of Test**	**18 December 2009**

CLIENT	**Robson Environmental** **9 Lyell Street** **FYSHWICK, ACT 2609**
Contact	**Marcus Donnelly**

Test Method	**Kenelec test method LABP 1**	
Client Instrument details	**TSI DustTrak Model 8520**	
	Serial No. 23651	
Condition as received	*As left*	
Environmental Conditions	Ambient Temp.	25.0°C
	Humidity	25.0%RH
	Barometric Pressure	745.0mmHg

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Signed
Mark Williams
Laboratory Manager

Page 1 - Cover Sheet
Page 2 - Calibration after adjustment

Path: F:\Calibration\Certificates\2009\2729-8520-23651-12-09.doc

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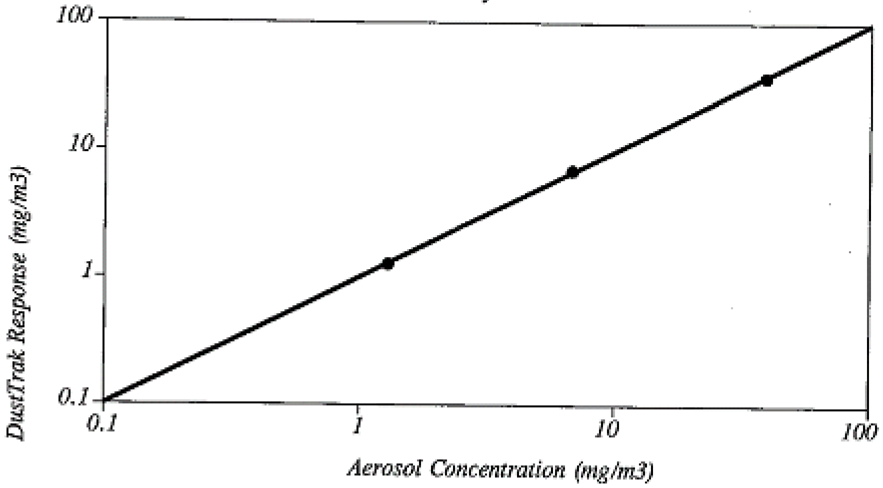
CERTIFICATE OF CALIBRATION AND TESTING

Model 8520 TSI Serial No. 23651

Description DustTrak

Calibration Standard Aerosol Calibration Bench #1

DustTrak Linearity Plot



Environmental Conditions:

Temperature: 25.00 ° C Pressure: 745.00 mmHg

Humidity: 25.00 %RH

KENELEC SCIENTIFIC does hereby certify that all performance and acceptance tests required were successfully conducted according to required specifications. All test and calibration data supplied by KENELEC SCIENTIFIC has been obtained using respirable mass standard ISO 12103-1 A1 Ultra Fine Test Dust. Prior to calibration the instrument was cleaned and the flow rate was adjusted to 1.70 l/min.

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DC Voltage	8786	24-04-09	24-04-10
Barometric Pressure	RGA20148-2	21-04-09	21-04-10

Calibrated by

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