Yaldhurst Air Quality Monitoring

22 February – 23 March 2018

Report 3

19 April 2018

Prepared for

Environment Canterbury

by Paul Baynham

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Client: Environment Canterbury

Prepared by:

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Revision History

No.	Date	Author(s)	Reviewer(s)	Details
1	9 Apr 2018	**Paul Baynham** Senior Air Quality Specialist (Mote)	**Brett Wells** Managing Director (Mote) **Louise Wickham** Director & Senior Air Quality Specialist (EIL)	Draft report to client for comment
2	19 Apr 2018	**Paul Baynham** Senior Air Quality Specialist (Mote)	**Brett Wells** Managing Director (Mote)	Section on transect data added in addition to minor changes following comments from client

Executive summary

In November 2017, Environment Canterbury contracted Mote Ltd to undertake ambient air quality monitoring for three months around the Yaldhurst quarries. Installation and commissioning commenced in December 2017 with the first month monitoring report (for the period 22 December 2017 – 21 January 2018) provided on 1 February 2018 and the second report (for the period 22 January to 21 February) provided on 14 March. This is the third report, which covers the period from 22 February 2018 through to 23 March 2018.

Mote undertook ambient air quality monitoring at six locations in the vicinity of quarries in the Yaldhurst area, west of Christchurch. The monitoring stations consisted of nine continuous PM_{10} and three continuous $PM_{2.5}$ nephelometers for measurement of hourly dust nuisance. Two sites further employed beta attenuation monitors (BAM – a reference method) for reference measurement of PM_{10} as a 24-hour average.

There were three exceedances of the Ministry for the Environment hourly suggested trigger threshold for dust nuisance (150 µg/m3) at one site north of the quarry and two sites south of the quarry:

- Site 2 North (east) rural/residential – 183 µg/m3 at 2 – 3 pm on 8 March 2018.
- Site 3 South (east) rural – 167 µg/m3 at 7 – 8 am on 15 March 2018.
- Site 5 South (west) rural – 197 µg/m3 at 7 – 8 am on 15 March 2018

The first exceedance at Site 2 occurred during a north-easterly wind and coincided with a fire on a neighbouring property. The coincidental exceedances at sites 3 and 5 on 15 March occurred during light variable winds which were predominantly from the north-west. It is likely that the source of these events originated to the north-west, but given the variability in wind direction immediately prior to and during the event, it is also possible that the source of the dust could have originated from the north or north-east of Sites 3 and 5.

There were no exceedances of the national environmental standard for PM10 as a 24-hour average during this reporting period. However, daily PM_{10} concentrations were elevated at all monitoring sites in the vicinity of the quarries (Sites 1, 2, 3, 5 and 6) compared with previous monthly reports.

In additional to this, from 9 February Mote operated four PM10 nephelometers at transect locations (50 m, 250 m, 500 m and 650 m) to the south-east of the quarry. The purpose of the monitoring was to investigate dust attenuation during strong north-westerly wind events. There were no strong north-westerly wind events recorded during the period from 22 February – 23 March. However, a moderate wind speed event provides indicative, attenuation for very short-term (i.e. 1-minute) peak concentrations of PM_{10}.

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1.0 Background

In November 2017, Environment Canterbury contracted Mote Ltd to undertake ambient air quality monitoring for three months around the Yaldhurst quarries. Installation and commissioning commenced in December 2017 with the first month monitoring report (for the period 22 December 2017 – 21 January 2018) provided on 1 February 2018 and the second report (for the period 22 January to 21 February) provided on 14 March. This is the third report, which covers the period from 22 February 2018 through to 23 March 2018.

The background and terms of reference of this monitoring project are detailed in the programme design recommendations report (Mote, 2018).[1]

1.1 Monitoring locations

To respect resident's privacy, this report will not disclose the exact locations of monitoring equipment on residents' private property. Their general locations may be typified as:

- **Site 1: East** - rural/residential location a few hundred metres to the east of the quarries
- **Site 2: North (east)** - rural/residential location a few hundred metres to the north of the quarries
- **Site 3: South (east)** – rural location a few hundred metres in the prevailing wind direction to the south east of the quarries
- **Site 4: Background** - background (rural/residential) location
- **Site 5: South (west)** - rural location a few hundred metres to the south west of the quarries
- **Site 6: North (west)** - rural/residential location a few hundred metres to the north of the quarries
- **Site 7**: **Transect 1** – rural location 250 metres south of quarries
- **Site 8: Transect 2** – rural location 500 metres south of quarries
- **Site 9: Transect 3** – rural location 650 metres south of quarries

The sites general locations are in **Figure 1**.

[1] Mote & Emission Impossible Ltd, 2018. Yaldhurst Air Quality Monitoring Programme Design Recommendations. Prepared for Environment Canterbury. 12 Jan 2018.

Table 1 presents a summary of monitoring undertaken around the Yaldhurst quarries for the period 22 February 2018 through to 23 March 2018.

Figure 1 Indicative (only) locations of monitoring sites

Table 1 Summary Yaldhurst Air Quality Monitoring: Jan – Feb 2018

Site	Location	Type	Monitoring
1	East	Rural/residential	Nephelometer PM_{10}
2	North (east)	Rural/residential	Nephelometer PM_{10} BAM PM_{10} Nephelometer $PM_{2.5}$ Meteorology
3	South (east)	Rural	Nephelometer PM_{10} Nephelometer $PM_{2.5}$
4	Background	Rural/residential	Nephelometer PM_{10} BAM PM_{10} Nephelometer $PM_{2.5}$
5	South (west)	Rural	Nephelometer PM_{10}
6	North (west)	Rural/residential	Nephelometer PM_{10}
7	Transect 1	Rural 250m south of quarries	Nephelometer PM_{10}
8	Transect 2	Rural 500m south of quarries	Nephelometer PM_{10}
9	Transect 3	Rural 650m south of quarries	Nephelometer PM_{10}

1.2 Monitoring methods

Nephelometer monitoring

An air quality nephelometer is an optical sensor that uses light scattering from particulate matter to provide a continuous real-time measurement of airborne particle mass. The light source is a visible laser diode and scattered light is measured in the near forward angle using focusing optics and a photo diode. The nephelometer has an on-board temperature sensor, which corrects for thermal drift, sheath air filter to keep the optics clean, automatic baseline drift correction and a fibre optic span system to provide a check of the optical components.

The near-forward nephelometers used in this study are more accurate that comparable side scattering nephelometers. However, as the near-forward scattering is less sensitive to particle size, they require a particle size inlet or sharp cut cyclone to provide a mechanical means of separating the size fraction prior to measurement. For this study, we have deployed a PM_{10} sharp-cut cyclone co-located with each nephelometer. We have also included a $PM_{2.5}$ sharp cut cyclone with an additional nephelometer at three sites (Sites 2, 3 and 4).

Our nephelometers take a reading once per second, we use a small single board computer to record these readings and calculate the average concentration each minute. The same single board computer uses a GPS to determine the local time very accurately – this way we can time stamp the data. Every 10 minutes, we transmit the previous data to our server using a cellular modem. We take

the data and plot this on our website. Interested persons can access this data through a secure web-portal.

We have installed the nephelometers on poles and tripods at heights of between 1.5 and 2 metres above ground level. Excepting Site 2 and Site 4 (which are connected to mains power), the remainder of nephelometers are powered using a 12 volt battery which itself is charged using solar panels. To assist with smooth site operation and data interpretation, we have mounted ultrasonic wind sensors on poles alongside the nephelometers.

The nephelometer utilises a heating control system based on relative humidity concentrations. When the relative humidity exceeds the set point (30% RH), the inlet heater switches on. This reduces the relative humidity down to below the set point at which point the heater switches off.

NB: Nephelometers are not reference instruments. This means we cannot directly compare PM_{10} data from nephelometers with the 24-hour average national PM_{10} standard. (For this reason, we have also co-located a Beta Attenuation Monitor (BAM) at Sites 2 and 4. PM_{10} data from a BAM can be directly compared with the 24-hour average national PM_{10} standard).

Figure 2, which follows, illustrates the types of nephelometers we have deployed around the Yaldhurst quarries.

Figure 2 Typical nephelometer installations. The unit on the left is battery powered, while the unit on the right provides a close up of the instrument.

Beta Attenuation Monitoring

A Beta Attenuation Monitor or BAM is a widely used air monitoring technique employing the absorption of beta radiation by solid particles extracted from airflow. We are using Thermo FH62 C14 beta attenuation monitors inside temperature-controlled enclosures. These are located at Site 2 (to the north of the quarries) and Site 4 (background site).

We operate the FH62 BAM in accordance with the *Good Practice Guide for Air Quality Monitoring and Data Management* (MfE, 2009) and in accordance with the standard method specified in the Resource Management (National Environmental Standards for Air Quality) Regulations 2004:

Australian/New Zealand Standard AS/NZS 3580.9.11:2008, Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM_{10} beta attenuation monitors

Due to the power requirements of both the instrument and the temperature-controlled enclosure, both sites operate using mains power.

Figure 3, which follows, shows a typical BAM installation.

Figure 3 An example of a temperature controlled BAM enclosure with the doors open to illustrate the BAM inside

Respirable Crystalline Silica (RCS)

In addition to the PM_{10} nephelometers, respirable crystalline silica monitors were deployed at sites 1 through 6. Each monitor consists of a pre-weighed PVC filter housed within a polycarbonate cassette. Air is sampled at a rate of 2.5 litres per minute through an aluminium cyclone. The cyclone removes particles larger than 4 µm in diameter. The air flow itself is measured using a flow sensor connected to a flow controller. This ensures that the flow through the cyclone is maintained at 2.5 litres per minute throughout the sampling period. The aluminium cyclone is heated by 10 degrees above the ambient air temperature to remove water droplets from the sample air.

The purpose of this sampling is to collect sufficient monthly respirable crystalline silica (RCS) samples to enable comparison with the annual guideline.

1.3 Data validation

We undertook data quality assurance and validation in accordance with good practice (MfE, 2009). In summary, this involves:

- Data review to ensure no drift or baseline shift
- Examination of check and calibration records
- Removing data collected during calibration and maintenance, including sufficient time for instrument stabilisation
- Removing negative values (except where data within system uncertainty)
- Removing spurious positive/negative spikes[2]

There will inevitably be differences between (raw, un-validated) data reported online and the data in this report. Some of these arise as a result of differences from data validation, as discussed above, and some are structural.

Structural differences arise from differences in the way the data are reported. For example, **Figure 4** provides a screenshot of nephelometer PM_{10} data from Site 1 for the month of January 2018.

[2] NB: Occasionally, large negative spikes may occur due to instrumental error. These negative (and positive) spikes are reviewed during the data analysis process to evaluate whether they are real or spurious. Unless there is good evidence to remove a value, they are left in and a comment made in the metadata (MfE, 2009).

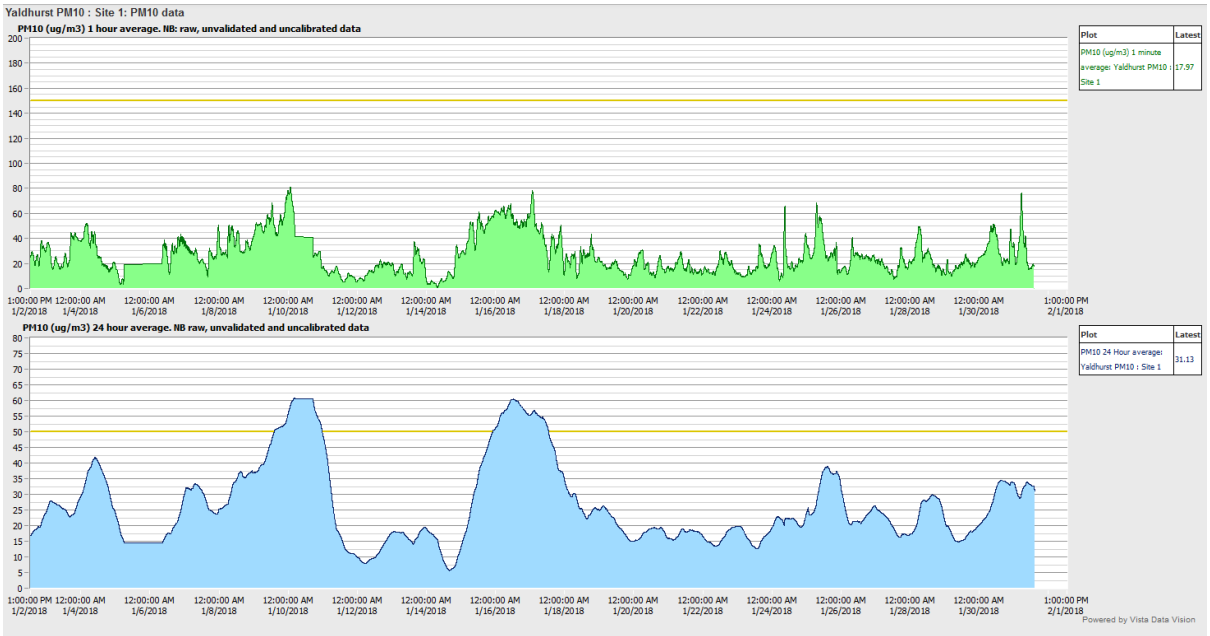

Figure 4 Screenshot of online nephelometer PM_{10} data for Site 1: East rural/residential 1:00 PM 2 Jan 2018 – 3:00 PM 31 Jan 2018

The top graph in **Figure 4** is hourly PM_{10}, and the hourly averages are updated each minute, hence the data have a spiky appearance. This will look different to the hourly data shown in **Figure 5**, which is updated once an hour and has a slightly smoother appearance.

Similarly, the daily PM_{10} averages in the bottom graph in **Figure 4** are updated every hour, each and every day. The rolling 24-hour average is thus a smooth line and looks very different to the bar chart in **Figure 6**, which presents true daily averages for each day (i.e. the full 24-hours of each day commencing at midnight, continuing through the early hours of the morning, noon and finishing at midnight that night).

Being raw, the data also include measurements during calibration and maintenance as well as site outages. Details of events that may impact the monitoring data are discussed in Section 2.0.

1.4 Frequently Asked Questions

What is an exceedance?

When we measure a concentration on our instruments around Yaldhurst that is higher than assessment criteria, we refer to this as an “exceedance”.

The concentrations are measurements taken and averaged over the relevant time period (i.e. one hour or 24 hour averages). Each of the nephelometers used in this study makes a reading every second, we average these readings to produce one minute concentrations. We then use these 1 minute concentrations to plot the 1 hour average and 24 hour average graphs (which can be seen on our website).

To calculate an average 1 hour concentration we add each minute of data between the start of the hour and the end of the hour and divide this by the number of minutes of data (e.g. 60 minutes).

The ongoing monitoring data generate running or continual 1 hour average and 24 hour average plots. For reporting purposes, we calculate a separate 1 hour average for each hour of the day and then average these 1 hour averages for each 24 hour day (starting at one minute past midnight and finishing at midnight).

What is the suggested PM_{10} trigger threshold for dust nuisance?

In 2016, the Ministry for the Environment published a document titled "Good practice guide for assessing and managing dust" (MfE, 2016). This document includes a section on setting trigger levels for proactive on-site dust management and suggests a dust nuisance trigger level of 150 $\mu g/m^3$ as a 1-hour average.

NOTE: while we have adopted the Ministry's suggested trigger threshold of 150 $\mu g/m^3$ it is important to note that there are site specific factors which mean that an appropriate trigger level could be higher or lower (to indicate actual dust nuisance). For more information on this, please refer to the good practice guide for assessing and managing dust on the Ministry for the Environment website.

Why do the 24 hour PM_{10} website graphs sometimes show values above the national environmental standard and why are these not reported as 'exceedances'?

The data for the website PM_{10} graphs comes from nephelometers. While these instruments are very useful for identifying short term issues over minutes or hours, they are not as accurate as (more expensive) reference instruments for comparing against longer term standards such as the 24 hour national environmental standard for PM_{10}.

The regulations relating to the PM_{10} national environmental standard mandate that only reference instruments may be used (for direct comparison with this standard). We are operating two reference instruments (beta-attenuation monitors or BAM's) around Yaldhurst.

2.0 Results

The first month monitoring report detailed instrument installation and commissioning. In the second month we deployed transect monitors 1, 2 and 3 as detailed.

Please note that time averages are retrospective. Thus, we report data collected between 2:00 PM and 3:00 PM as an hourly average for 3:00 PM. Similarly, a 24-hour average for Monday 25 December is for the full 24-hours of Monday commencing at (1 minute after) midnight Sunday 24 December and finishing at midnight on Monday 25 December.

NB: As noted above in Section 1.2, we cannot compare nephelometer PM_{10} data directly with the 24-hour average national PM_{10} standard. This is because nephelometer PM_{10} data are indicative only (for indicating dust nuisance and investigating spatial and temporal resolution). However, we can (and do) compare PM_{10} data measured by the beta attenuation monitor (BAM) directly with the 24-hour average national PM_{10} standard. BAMs are deployed at Site 2 (North) and Site 4 (Background).

Table 2 presents the data capture and per cent valid data obtained at each site during the monitoring period 22 February – 23 March 2018.

Table 2 Per cent valid monitoring data 22 Feb - 23 Mar 2018

Site	Monitoring	% Valid Data[1]	Comments
1	Nephelometer PM_{10}	100%	
2	Nephelometer PM_{10}	100%	
	BAM PM_{10}	100%	Daily calibration data removed
	Nephelometer $PM_{2.5}$	100%	
	Meteorology	100%	
3	Nephelometer PM_{10}	100%	
	Nephelometer $PM_{2.5}$	100%	
4	Nephelometer PM_{10}	100%	
	BAM PM_{10}	99.4%	Daily calibration data removed
	Nephelometer $PM_{2.5}$	100%	
5	Nephelometer PM_{10}	100%	
6	Nephelometer PM_{10}	100%	
7	Nephelometer PM_{10}	100%	

Site	Monitoring	% Valid Data[1]	Comments
8	Nephelometer PM_{10}	100%	
9	Nephelometer PM_{10}	100%	

Notes

[1] Calculated on hourly average data

2.1 Site 1: East rural/residential

PM_{10}

We installed and commissioned a nephelometer (PM_{10}) monitor at Site 1 in December 2017. There were no incidents or outages at this site during the period 22 February – 23 March 2018.

Figure 5 presents hourly PM_{10} for site 1 for the period 22 February - 23 March 2018. There were no exceedances of the 1-hour suggested trigger threshold (150 µg/m^3) during this monitoring period at Site 1.

Figure 6 presents daily PM_{10} measured by the nephelometer between 22 February and 23 March 2018.

NB: Nephelometers are not reference instruments. This means we cannot directly compare PM_{10} data from nephelometers in **Figure 5** with the 24-hour average national PM_{10} standard. However, Figure 6 shows that daily average concentrations of PM_{10} at Site 1 were elevated compared with levels reported in the previous two monthly reports.

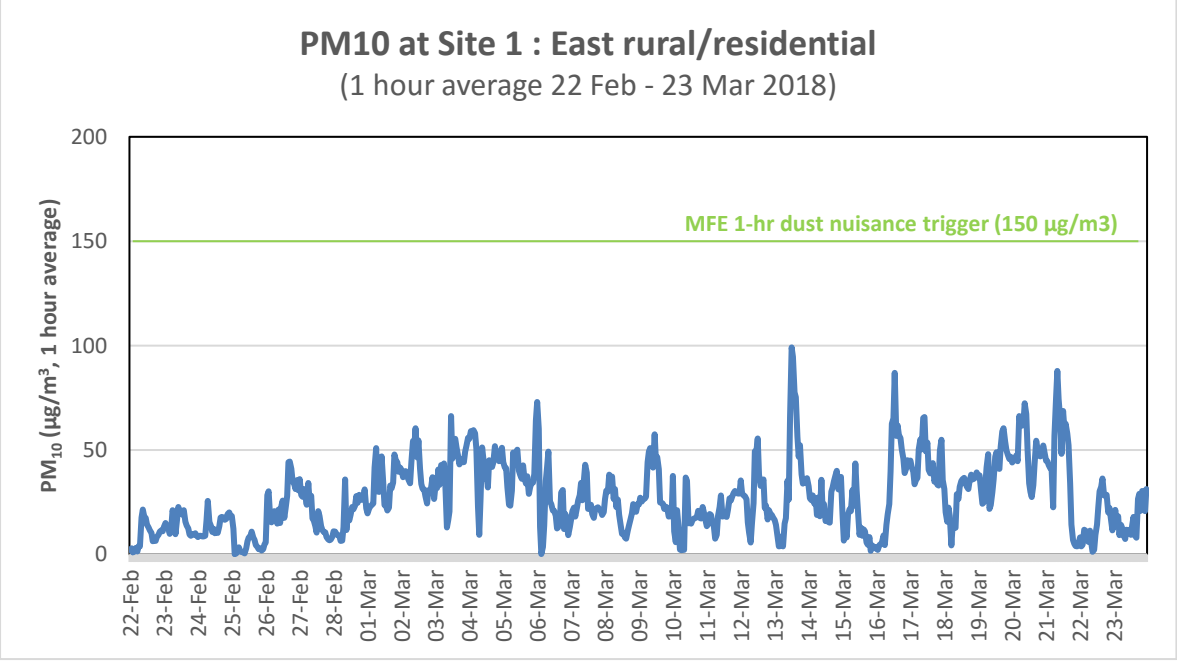

Figure 5 Hourly PM_{10} (nephelometer) at Site 1: East rural/residential for period 22 Feb - 23 Mar 2018

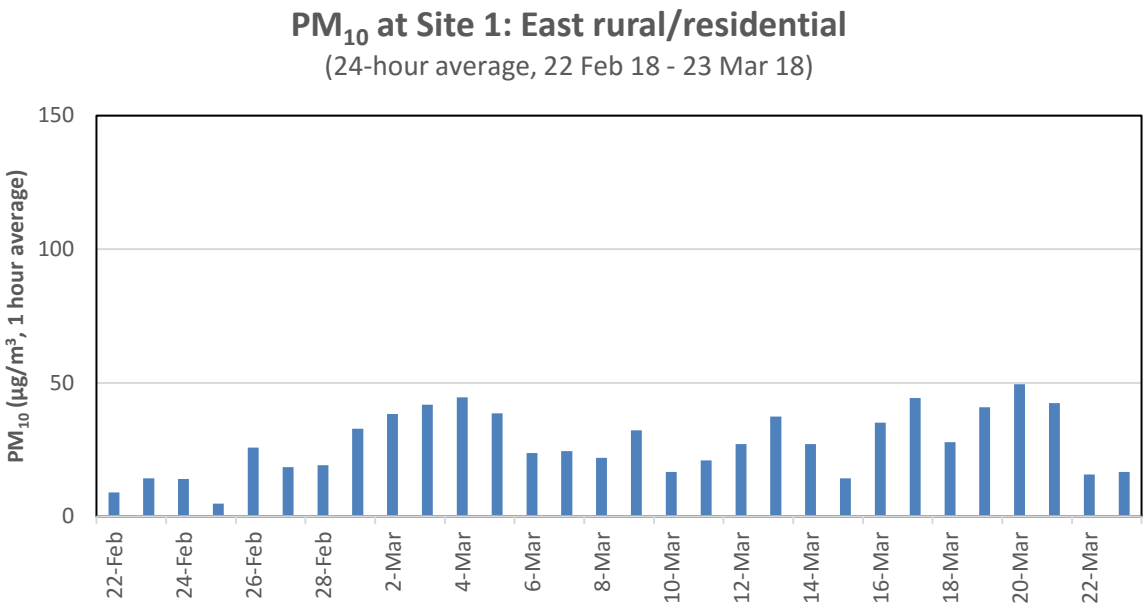

Figure 6 Daily PM_{10} (nephelometer) at Site 1: East rural/residential for period 22 Feb - 23 Mar 2018

2.2 Site 2: North (east) rural/residential

PM_{10} and $PM_{2.5}$

We installed and commissioned two nephelometers (PM_{10} and $PM_{2.5}$) monitors at Site 2 on 15 December. These were fully operational from 16 December 2017.

We installed and commissioned a beta attenuation monitor (BAM) reference method PM_{10} monitor at Site 2 on 20 December 2017. This was fully operational from 21 December 2017.

Elevated concentrations were observed between 2pm and 4pm on 8 March. An investigation revealed that there was a fire on a neighbouring property around this time and it is likely that the north-easterly winds transported the smoke to Site 2 resulting in elevated hourly concentrations of both PM_{10} and $PM_{2.5}$ during this period.

Figure 7 presents hourly PM_{10} from the nephelometer (blue) and BAM (pink) for the period when both were monitoring side by side from 22 February - 23 March 2018. Elevated hourly PM_{10} concentrations were observed by the nephelometer between 2pm and 4pm on 8 March. An investigation revealed that there was a fire on a neighbouring property around this time and it is likely that the north-easterly winds transported the smoke to Site 2 resulting in elevated concentrations of both PM_{10} and $PM_{2.5}$ during this period. A peak PM10 concentration of 183 $\mu g/m^3$ occurred between 2pm and 3pm on 8 March.

Figure 8 presents wind speed and wind direction data during the exceedance on 8 March 2018.

Figure 9 presents one-minute PM_{10} during the exceedance on 8 March 2018.

Figure 10. presents daily PM_{10} measured by the nephelometer and the BAM (reference method) between 22 February - 23 March 2018. There were no exceedances of the NES for PM_{10} measured by the BAM during this period at Site 2. However, **Figure 10** shows that the daily average concentrations of PM_{10} at Site 2 were elevated compared with levels reported in the previous two monthly reports.

Figure 11. presents PM_{10} measured by BAM as a function of PM_{10} measured by nephelometer for available validated days of data at Site 2. This correlation suggests the nephelometer is over-reading actual PM_{10} levels when compared with the reference method.

Figure 12. presents hourly $PM_{2.5}$ measured by nephelometer at Site 2 for the period of operation (22 February - 23 March 2018).

Figure 13. presents daily $PM_{2.5}$ at Site 2 for this same period and shows that daily levels of $PM_{2.5}$ were elevated compared with the previous two monthly reports.

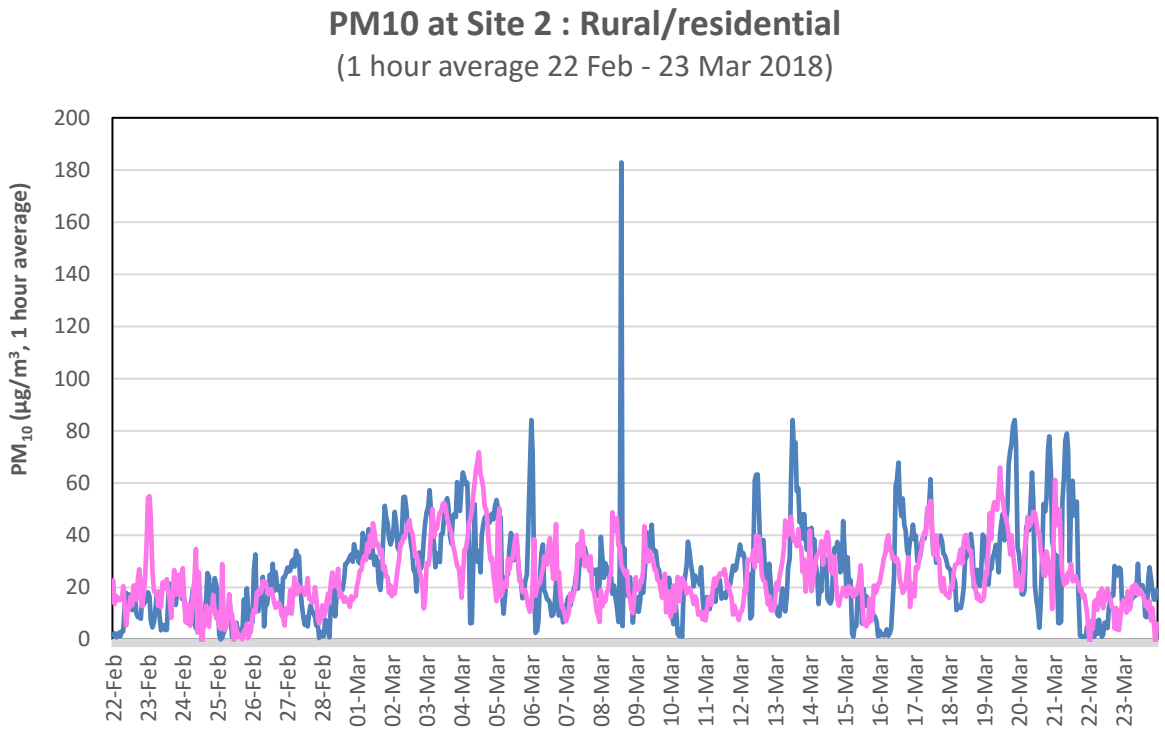

Figure 7 Hourly PM_{10} nephelometer (thin blue) and BAM (pink) at Site 2: North (east) rural/residential for period 22 Feb - 23 Mar 2018

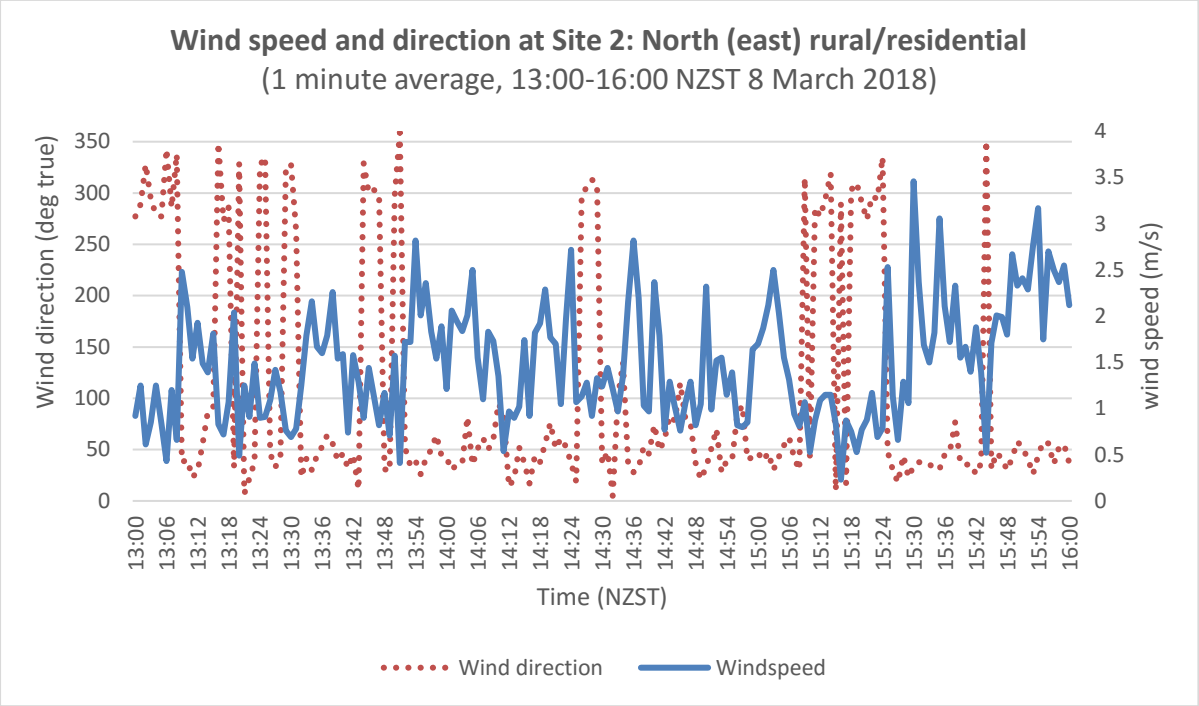

Figure 8 One minute wind speed and wind direction at Site 2: North (east) rural/residential on 8 March 2018 during an exceedance event.

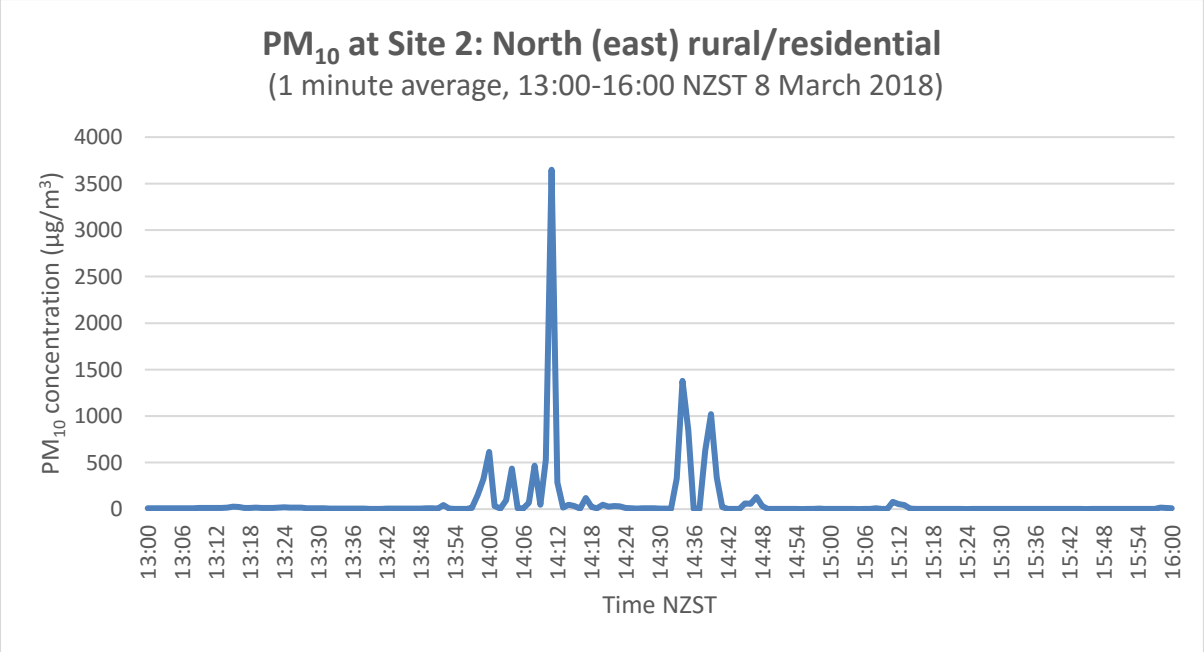

Figure 9 One minute PM_{10} at Site 2: South (east) rural/residential on 15 March 2018 during an exceedance event.

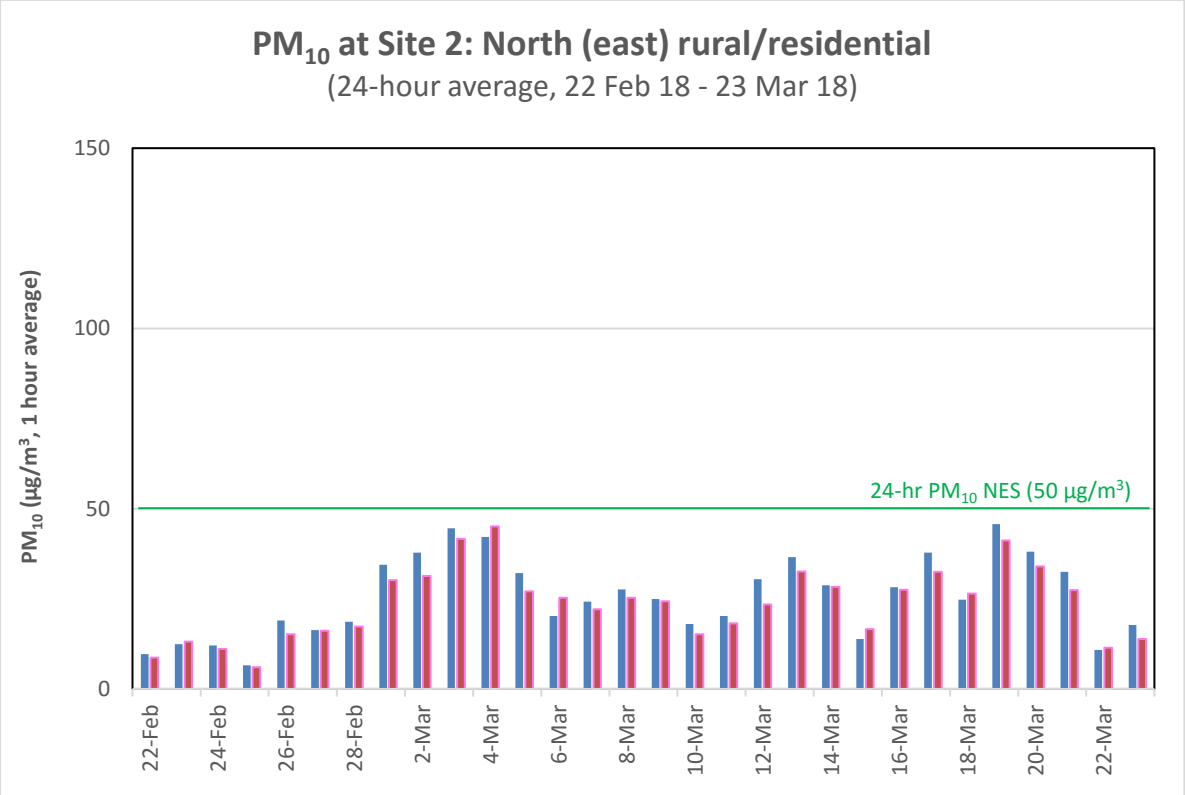

Figure 10 Daily PM_{10} nephelometer (blue) and BAM (pink) at Site 2: North (east) rural/residential for period 22 Feb - 23 Mar 2018

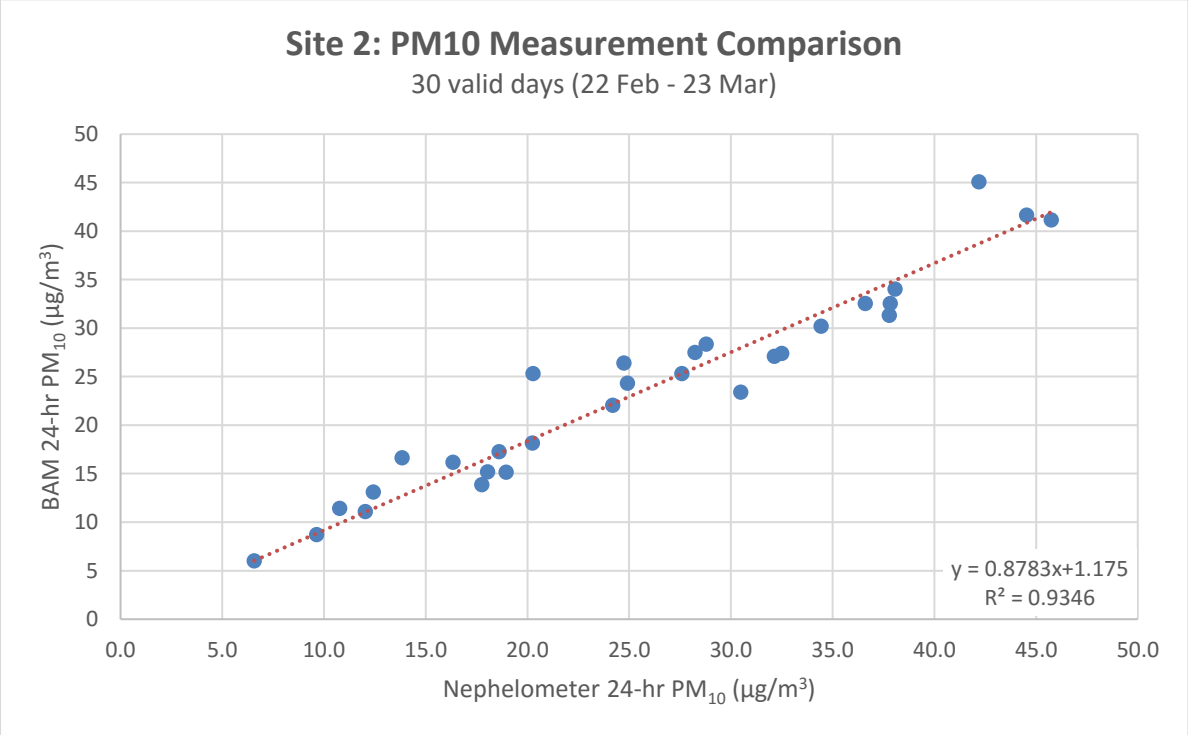

Figure 11 Daily PM_{10} measured by nephelometer as a function of daily PM_{10} measured by BAM at Site 2: North (east) rural/residential for (validated data) period 22 Feb - 23 Mar 2018

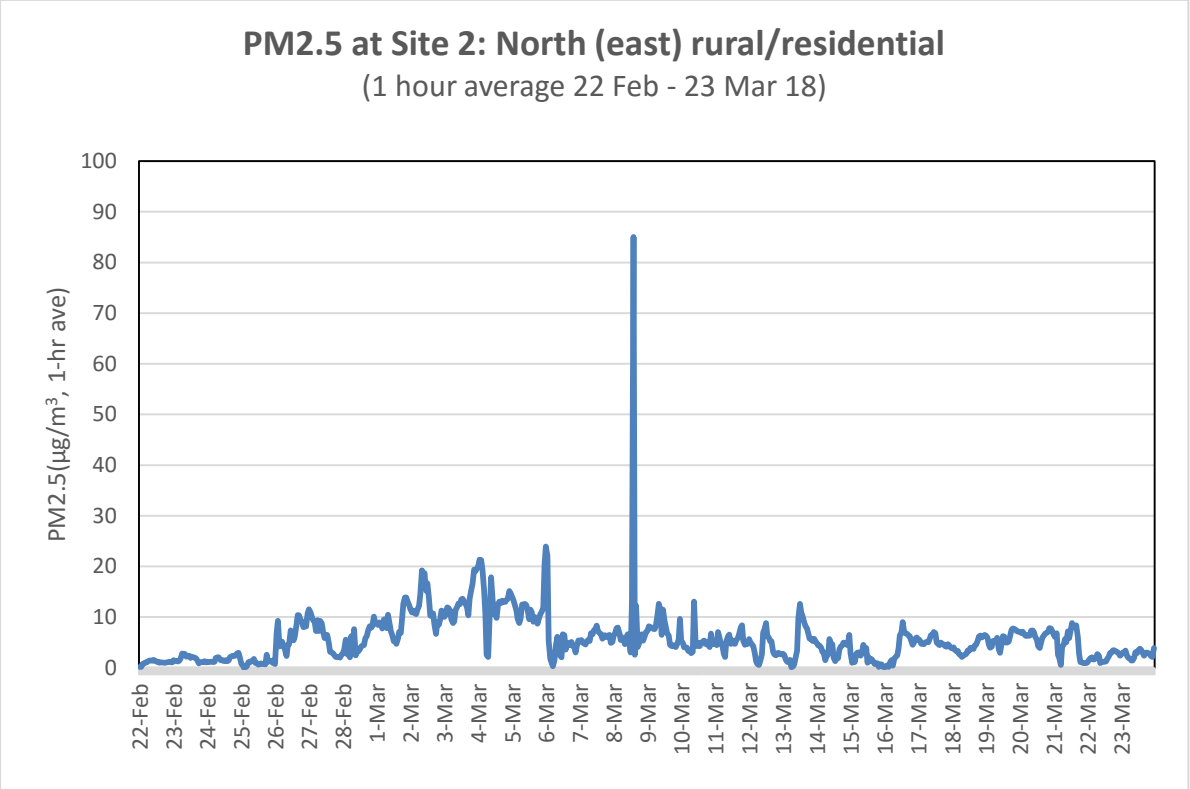

Figure 12 Hourly $PM_{2.5}$ nephelometer at Site 2: North (east) rural/residential 22 Feb - 23 Mar 2018

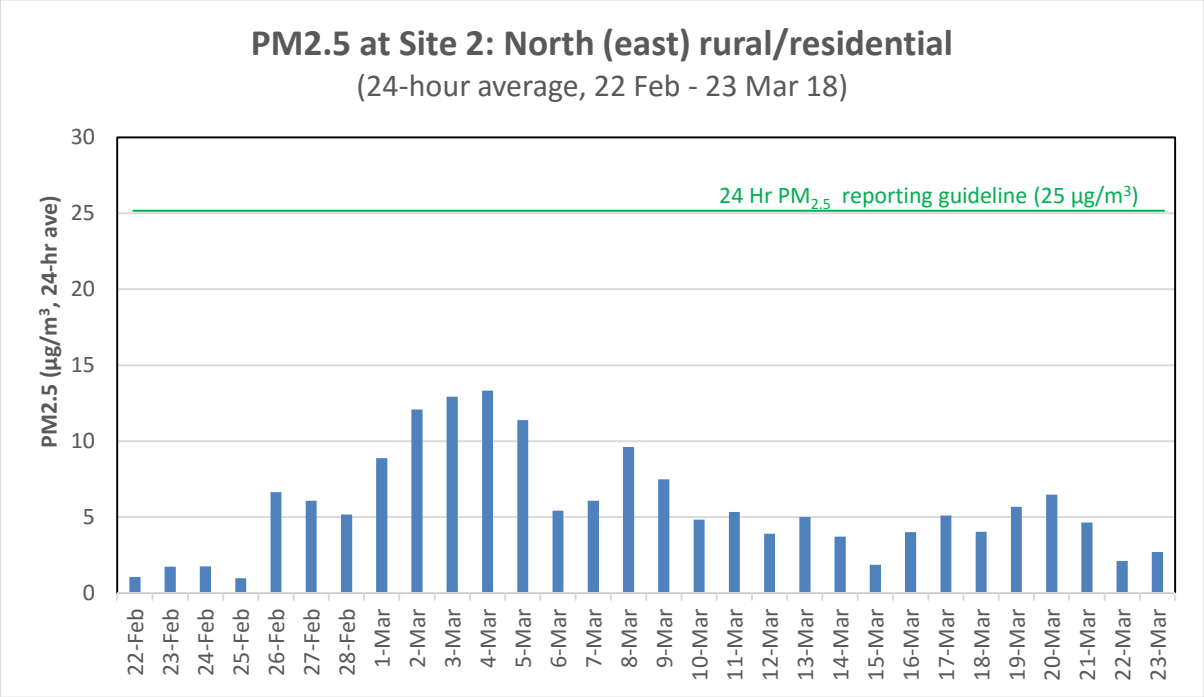

Figure 13 Daily $PM_{2.5}$ nephelometer at Site 2: North (east) rural/residential 22 Feb - 23 Mar 2018

Meteorology

We installed and commissioned a meteorological monitoring station at Site 2 on 21 December 2018. This was fully operational from 22 December 2017.

There was no rainfall recorded at this site between 22 February and 23 March 2018.

Figure 14. presents wind direction and wind speed measured at Site 2 for the period 22 February - 23 March 2018.

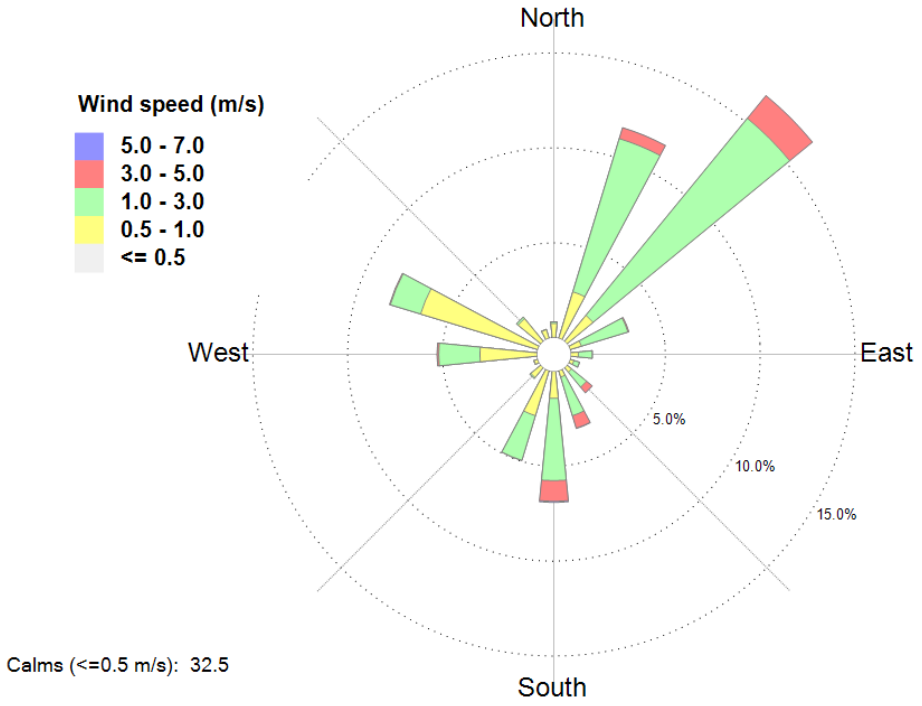

Figure 8 Wind direction and wind speed measured at Site 2: North (east) rural/residential for period 22 Feb - 23 Mar 2018

2.3 Site 3: South (east) rural

PM_{10} and $PM_{2.5}$

We installed and commissioned a PM_{10} nephelometer monitor at Site 3 on 15 December and it was fully operational from 16 December 2017. We installed and commissioned a $PM_{2.5}$ nephelometer on 21 December and it was fully operational from 22 December 2017.

Figure 15 presents hourly PM_{10}. There was one exceedance (167 µg/m^3) of the 1-hour suggested trigger threshold (150 µg/m^3) between 7 am and 8 am on 15 March 2018. This exceedance coincided with an exceedance at Site 5 (South west rural).

A light north-westerly was recorded during the period of the exceedance. The instrument was in power-save mode at the time the exceedance occurred by collecting data but not transmitting it in

order to conserve power. As a consequence of this, the exceedance was not evident in the real-time data available on the web-site.

Figure 16 presents one-minute PM_{10} and wind direction data during the exceedance on 15 March 2018.

Figure 17 presents daily PM_{10} measured by the nephelometer between 22 February and 23 March 2018.

NB: As noted above, daily PM_{10} measured by a nephelometer cannot be directly compared with the national environmental standard for PM_{10}. However, **Figure 16** shows that the daily average concentrations of PM_{10} at Site 3 were elevated compared with levels reported in the previous two monthly reports.

Figure 18 and **Figure 19** present hourly and daily $PM_{2.5}$ measured at Site 3 for the monitoring period 22 February to 23 March 2018.

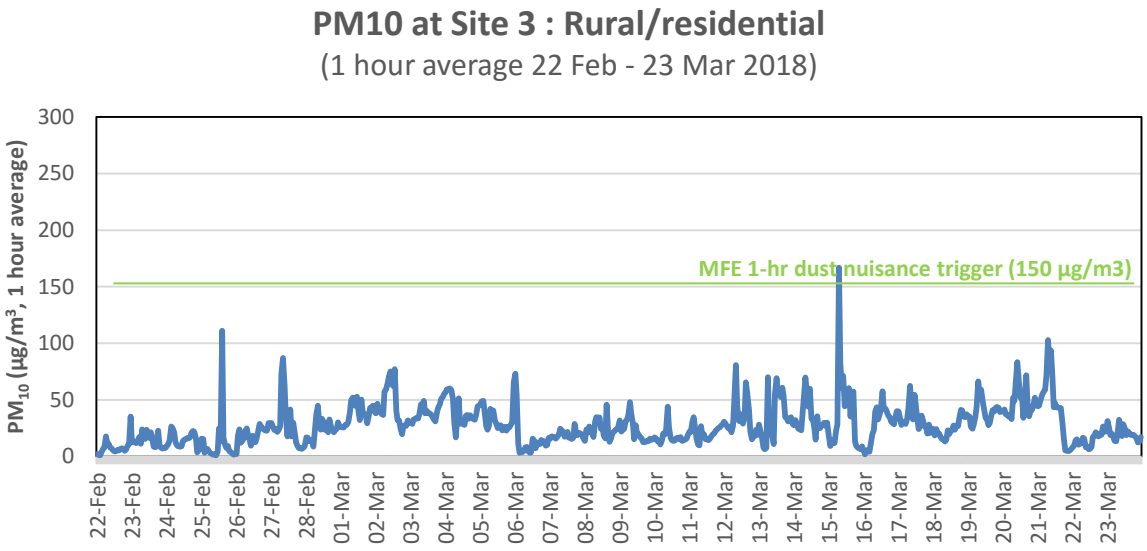

Figure 9 Hourly PM_{10} (nephelometer) at Site 3: South (east) rural for period 22 Feb - 23 Mar 2018

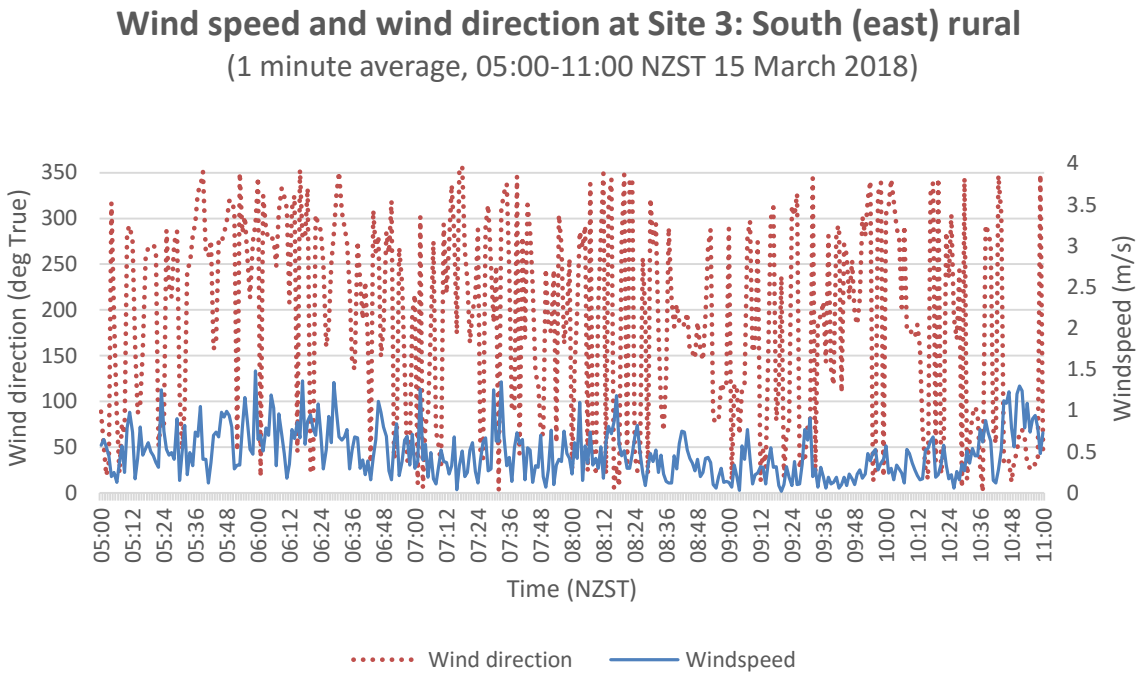

Figure 16 One minute wind speed and wind direction at Site 3: South (east) rural on 15 March 2018 during an exceedance event.

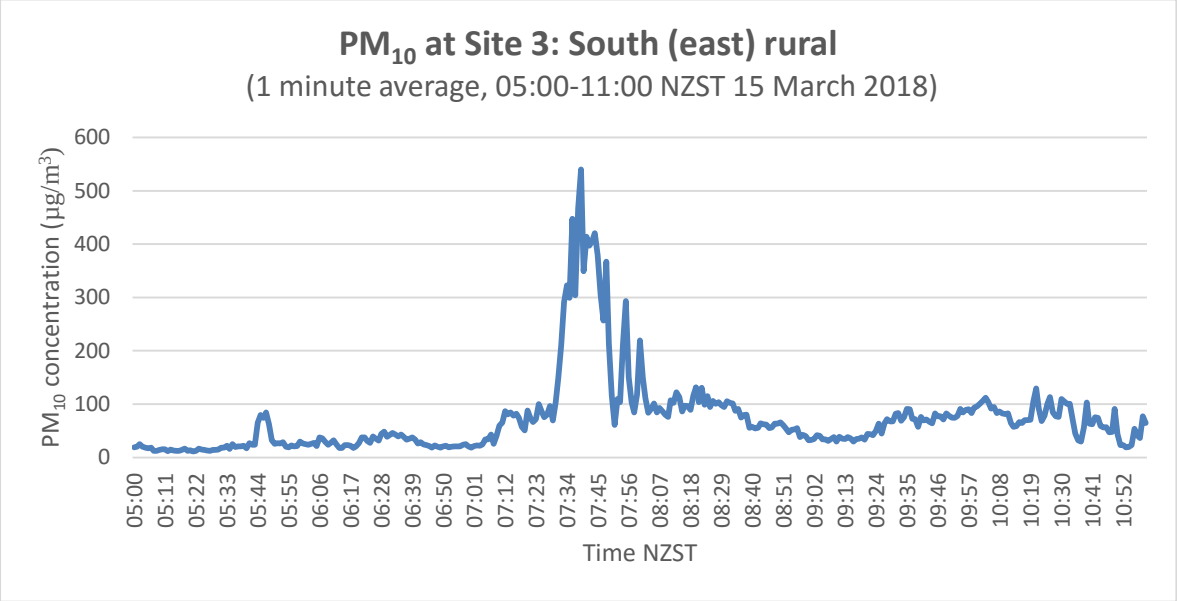

Figure 17 One minute PM_{10} at Site 3: South (east) rural on 15 March 2018 during an exceedance event.

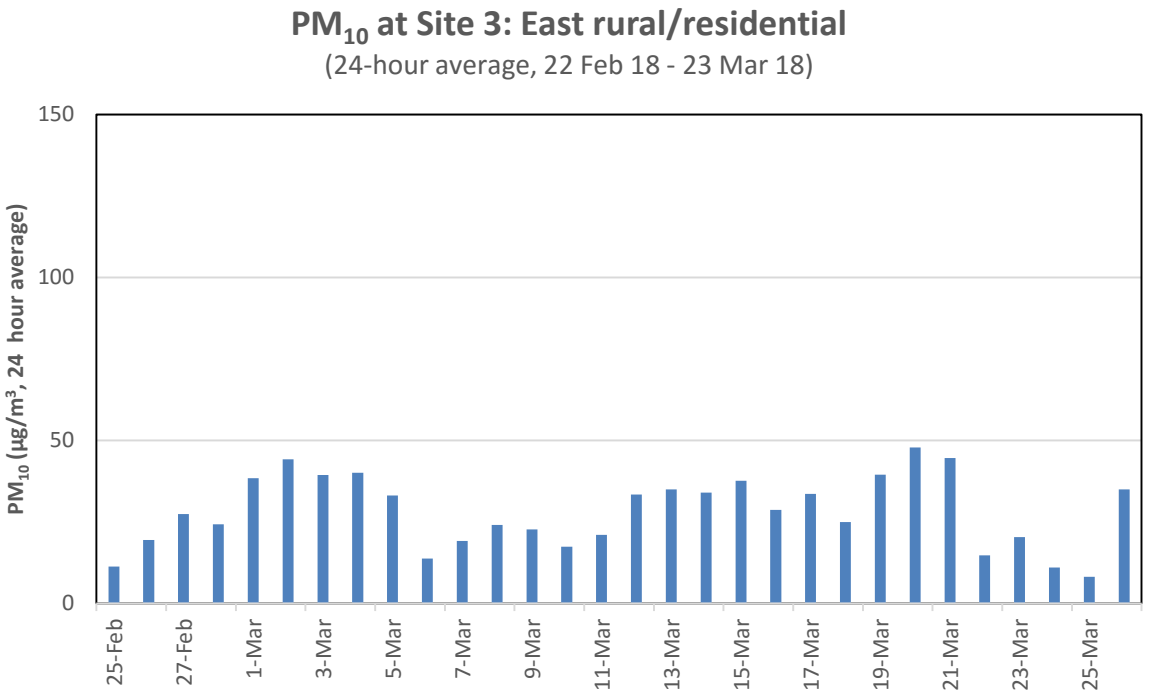

Figure 10 Daily PM_{10} (nephelometer) at Site 3: South (east) rural for period 22 Feb - 23 Mar 2018.

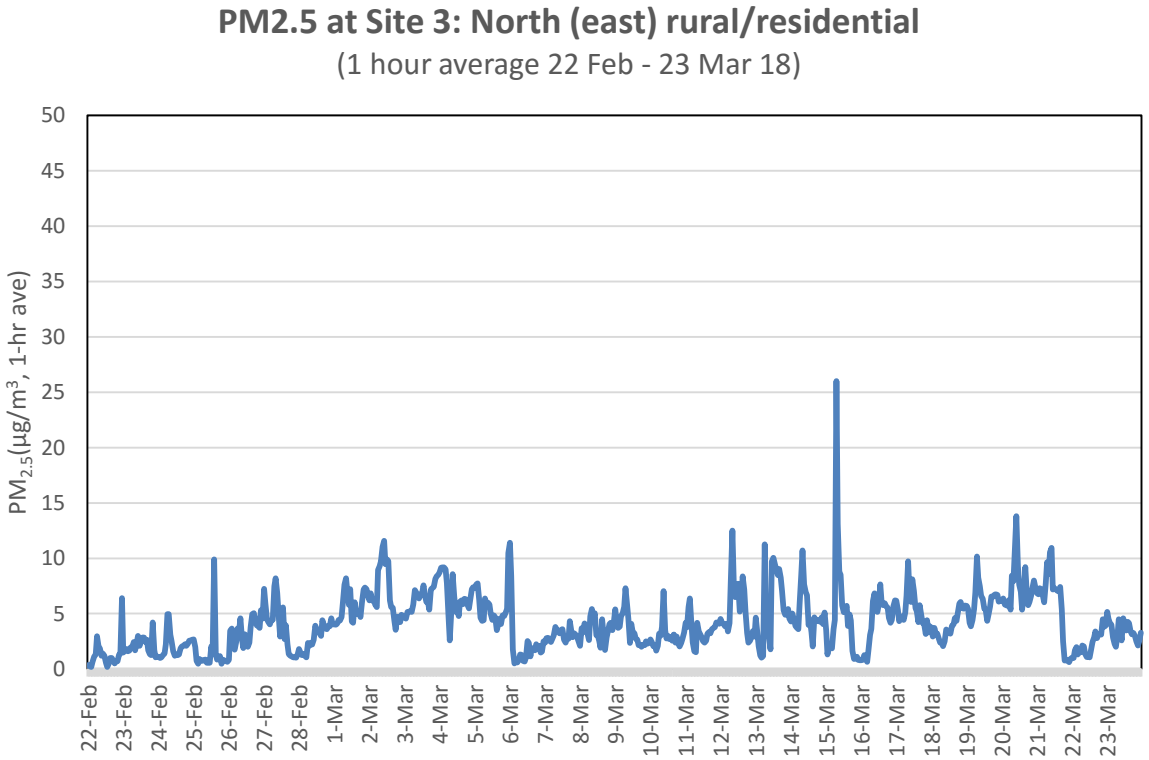

Figure 11 Hourly $PM_{2.5}$ (nephelometer) at Site 3: South (east) rural for period 22 Feb - 23 Mar 2018

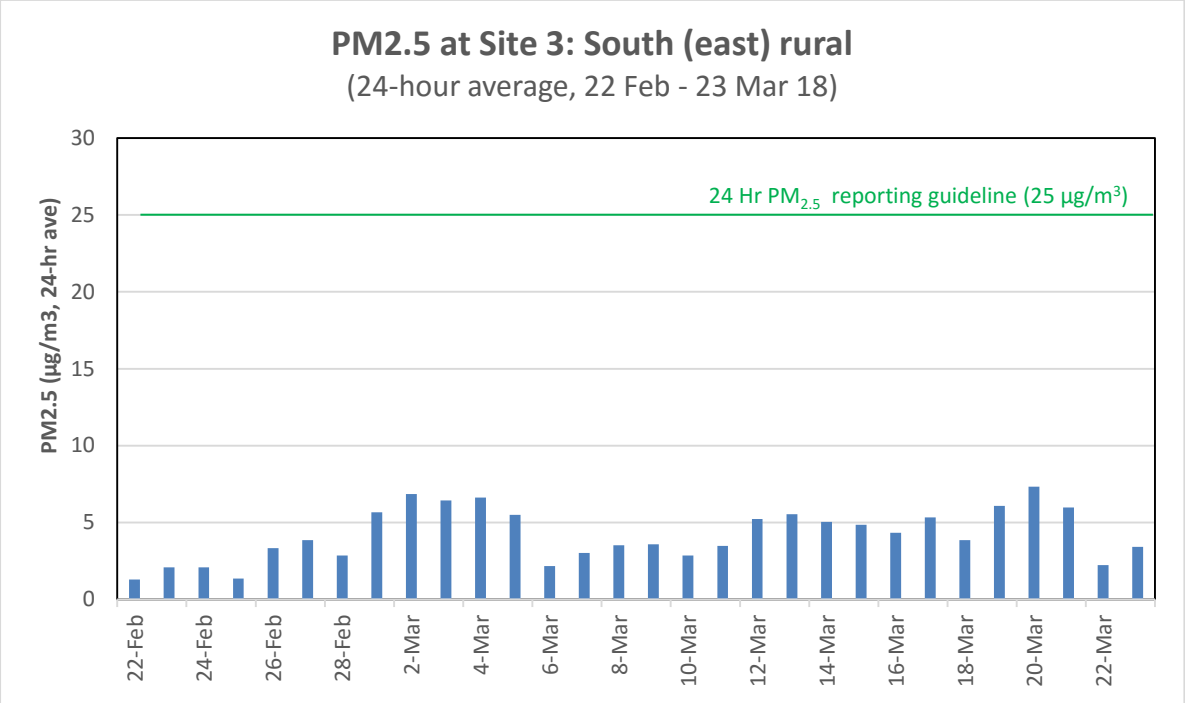

Figure 20 Daily $PM_{2.5}$ (nephelometer) at Site 3: South (east) rural for period 22 Feb - 23 Mar 2018

2.4 Site 4: Background rural/residential

PM_{10} and $PM_{2.5}$

We installed and commissioned a nephelometer (PM_{10}) monitor and BAM at Site 4 on 14 December 2017. These were fully operational from 15 December 2017.

Figure 21 presents hourly PM_{10} from the nephelometer (blue) and BAM (pink) for the period 22 February 2018 and 23 March 2018. There were no exceedances of the 1-hour suggested trigger threshold (150 µg/m^3) during this monitoring period at Site 4.

Figure 22 presents daily PM_{10} measured by the nephelometer and the BAM (reference method) between 22 February 2018 and 23 March 2018. There were no exceedances of the NES for PM_{10} measured by the BAM during this period at Site 4.

Figure 23 presents PM_{10} measured by BAM as a function of PM_{10} measured by nephelometer for available validated (30) days of data at Site 4. This correlation suggests the nephelometer is over-reading actual PM_{10} levels when compared with the reference method.

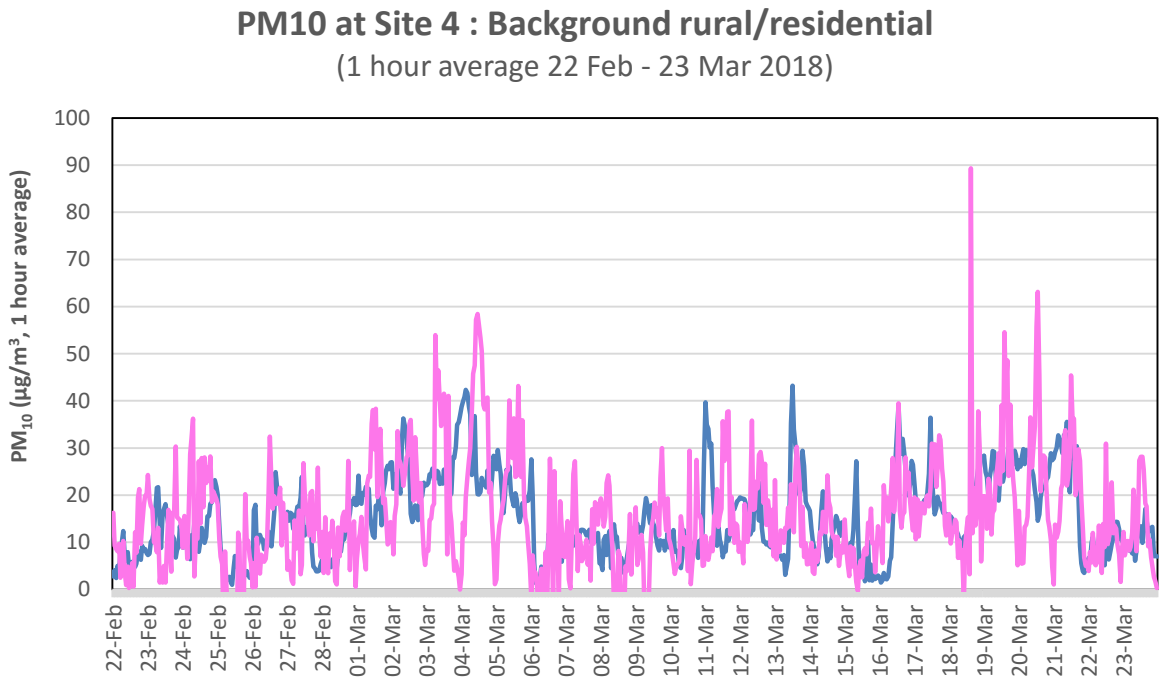

Figure 21 Hourly PM_{10} nephelometer (thin blue) and BAM (pink) at Site 4: Background rural for period 22 Feb - 23 Mar 2018

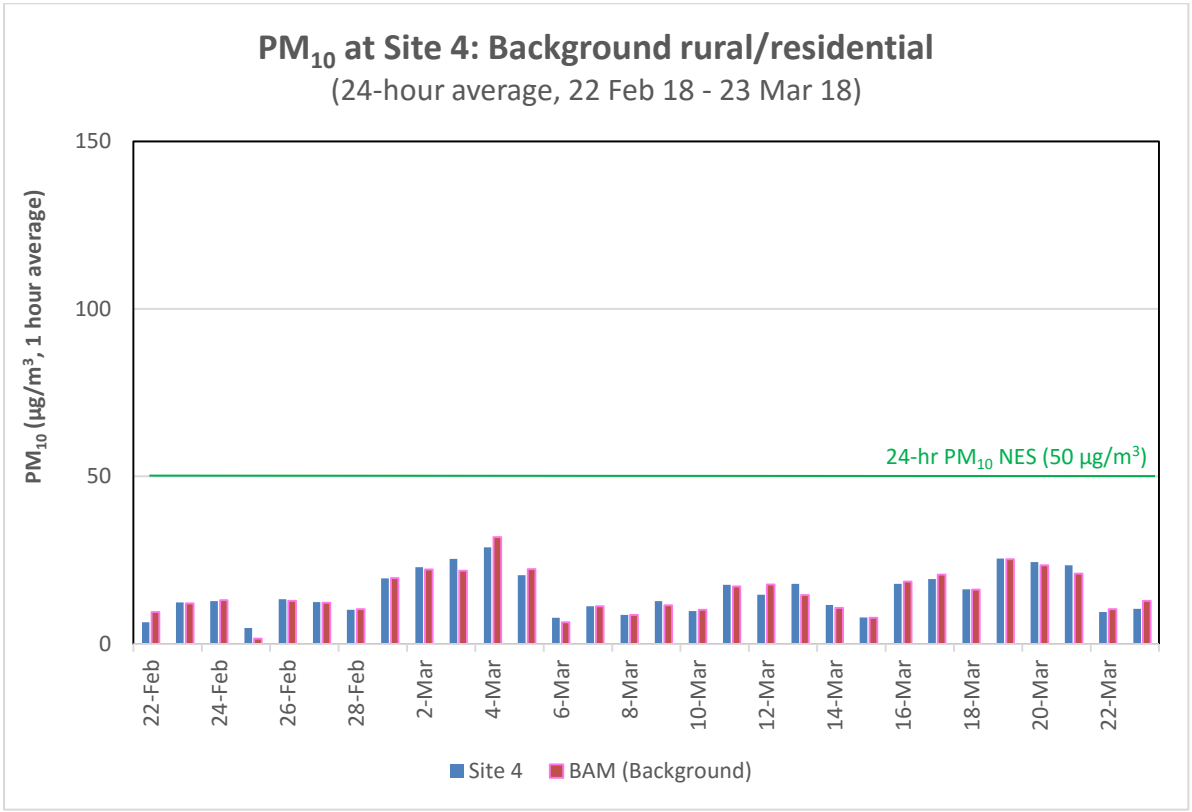

Figure 22 Daily PM_{10} nephelometer (thin blue) and BAM (pink) at Site 4: Background rural for period 22 Feb - 23 March 2018

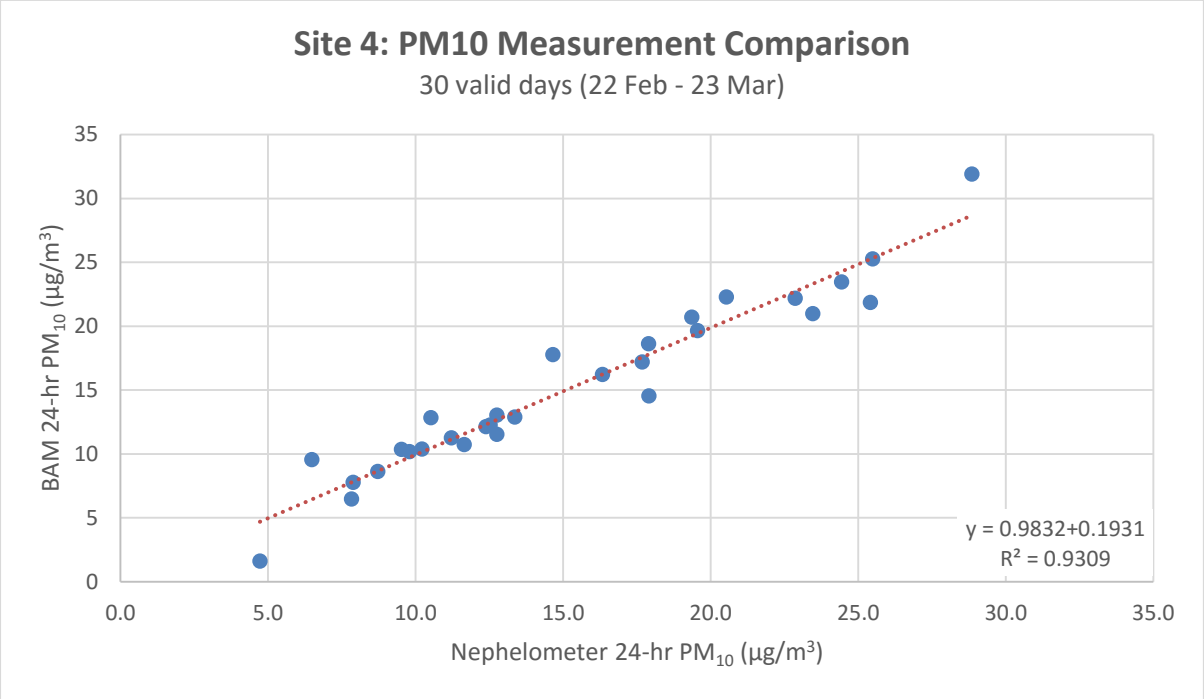

Figure 23 Daily PM_{10} measured by nephelometer as a function of daily PM_{10} measured by BAM at Site 4: Background rural/residential for (validated data) period 22 Feb - 23 Mar 2018

Figure 24 presents hourly $PM_{2.5}$ measured by nephelometer at Site 4 for the period of operation (22 Feb - 23 Mar 2018)

Figure 25 presents daily $PM_{2.5}$ measured by nephelometer at Site 4 for the period of operation (22 Feb - 23 Mar 2018)

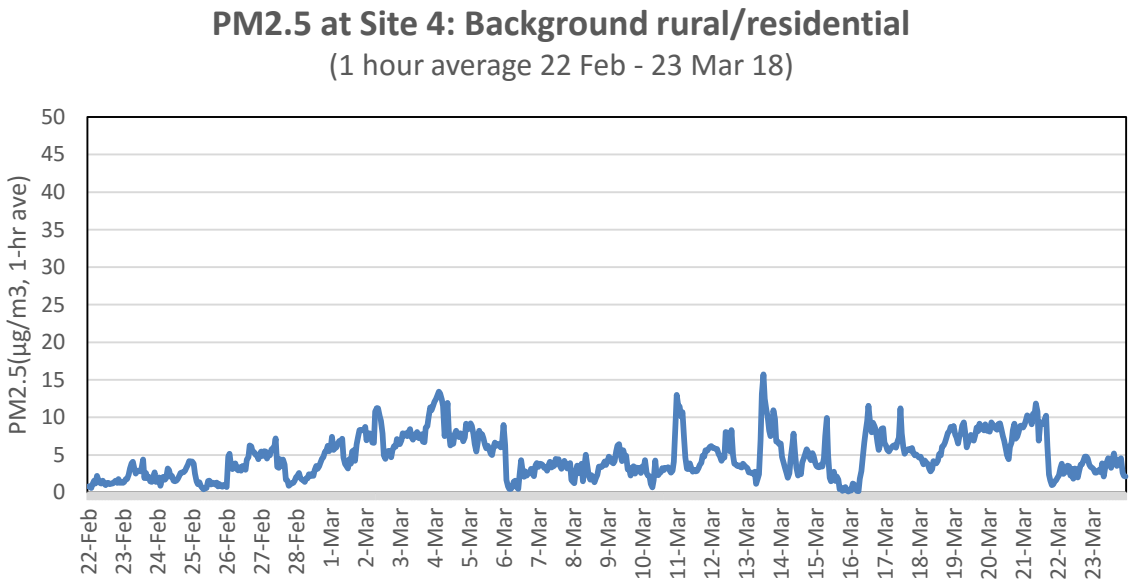

Figure 24 Hourly $PM_{2.5}$ nephelometer at Site 4: Background rural/residential for period 22 Feb - 23 Mar 2018

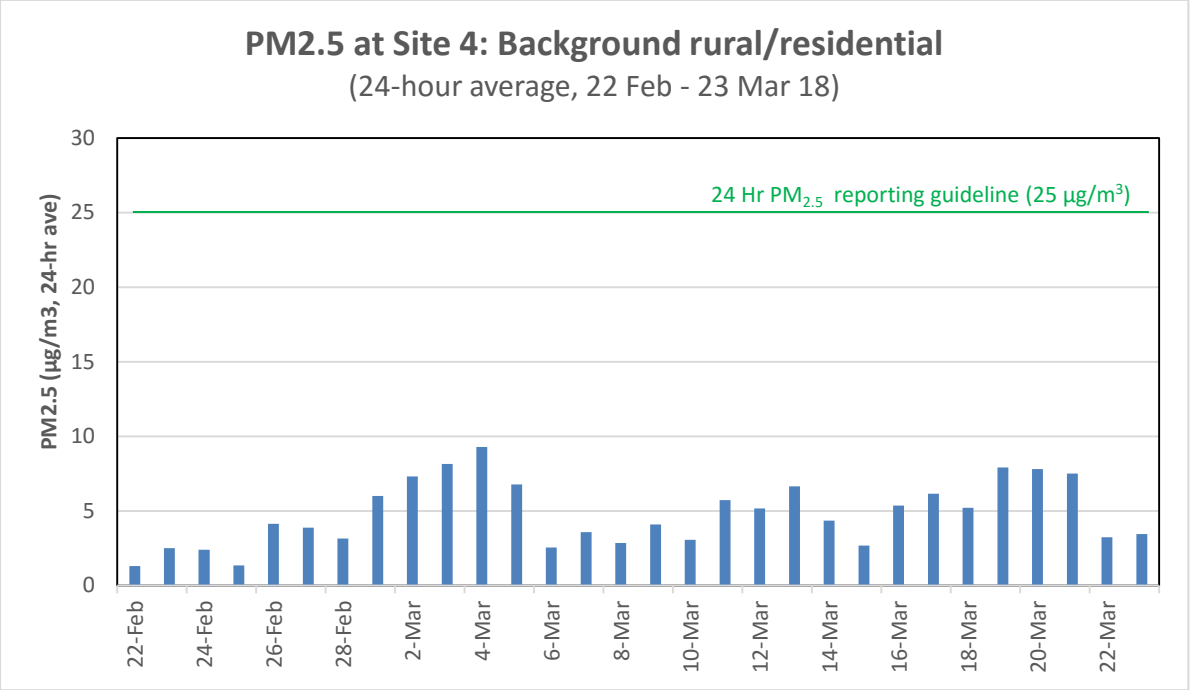

Figure 25 Daily $PM_{2.5}$ nephelometer at Site 4: Background rural/residential for period 22 Feb - 23 Mar 2018

2.5 Site 5: South (west) rural

We installed and commissioned a PM_{10} nephelometer monitor at Site 5 on 15 December and it was fully operational from 16 December 2017.

Figure 26 presents hourly PM_{10}. There was one exceedances (198 µg/m^3) of the 1-hour suggested trigger threshold (150 µg/m^3) between 7:00 and 8am on 15 March 2018. This was the same day and time that an exceedance of the suggested trigger threshold was also measured at Site 3. The reasons for the exceedance are unclear. Winds were light and variable at the time of the exceedance.

Figure 27 presents wind speed and wind direction data during the exceedances on 15 March 2018.

Figure 28 presents one minute PM10 data during the exceedances on 15 March 2018.

Figure 29 presents daily PM_{10} measured by the nephelometer between 22 February and 23 March 2018.

NB: As noted above, daily PM_{10} measured by a nephelometer cannot be directly compared with the national environmental standard for PM_{10}. However, **Figure 27** shows that the daily average concentrations of PM_{10} at Site 5 were elevated compared with the levels reported in the previous two monthly reports.

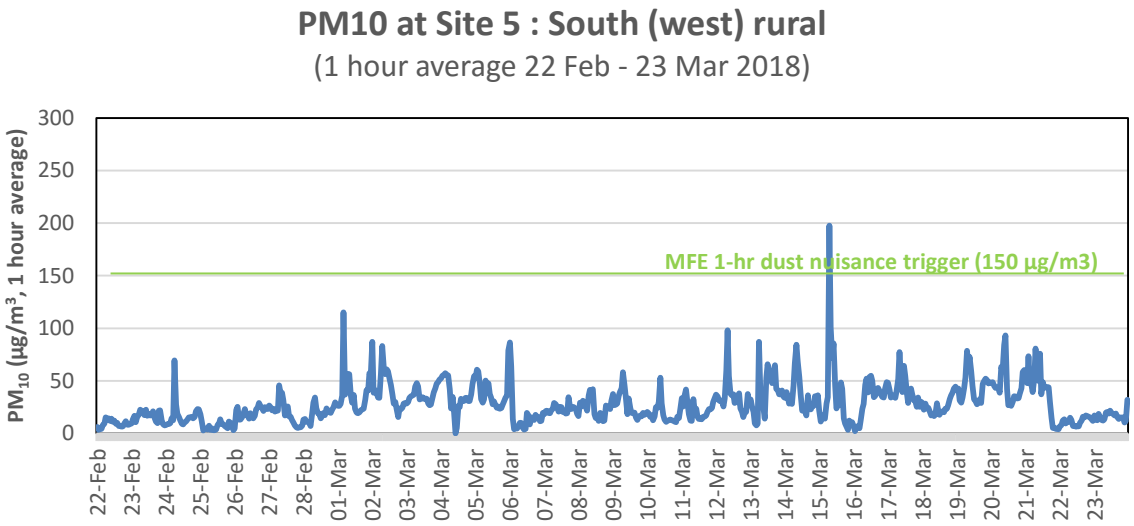

Figure 26 Hourly PM_{10} (nephelometer) at Site 5: South (west) rural for period 22 Feb - 23 Mar 2018

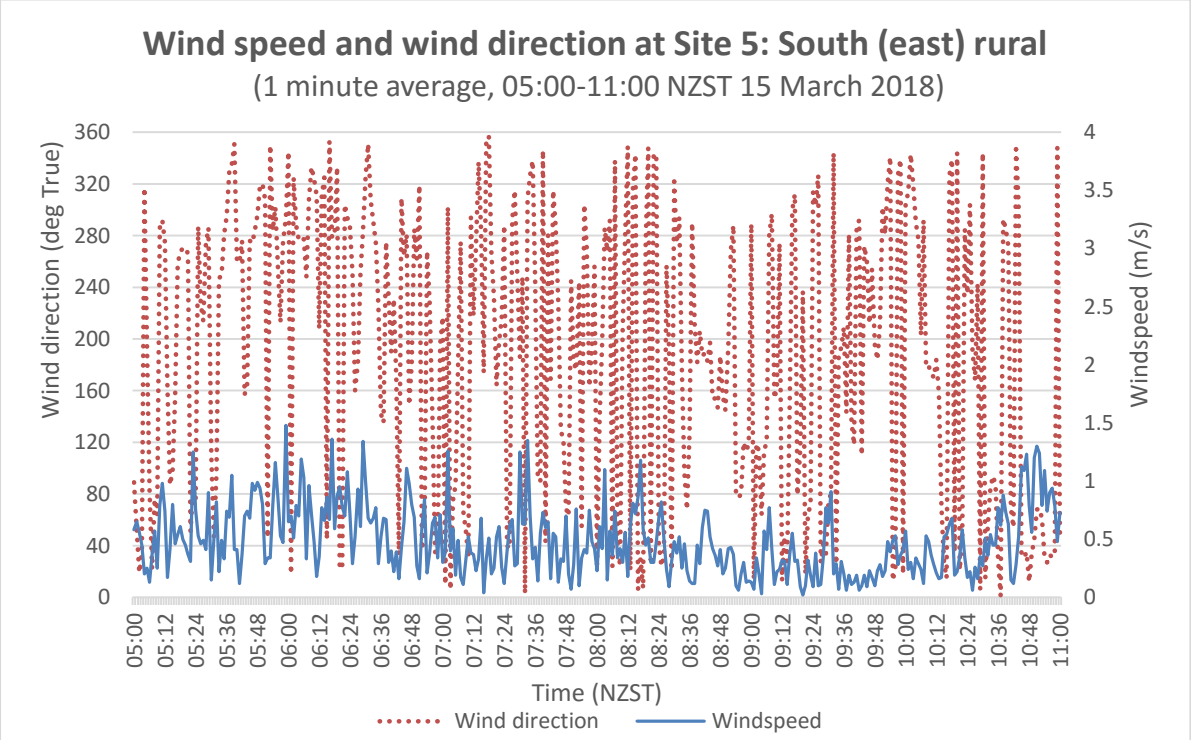

Figure 27 One minute wind speed and wind direction at Site 5: South (west) rural on 15 March 2018 during an exceedance event.

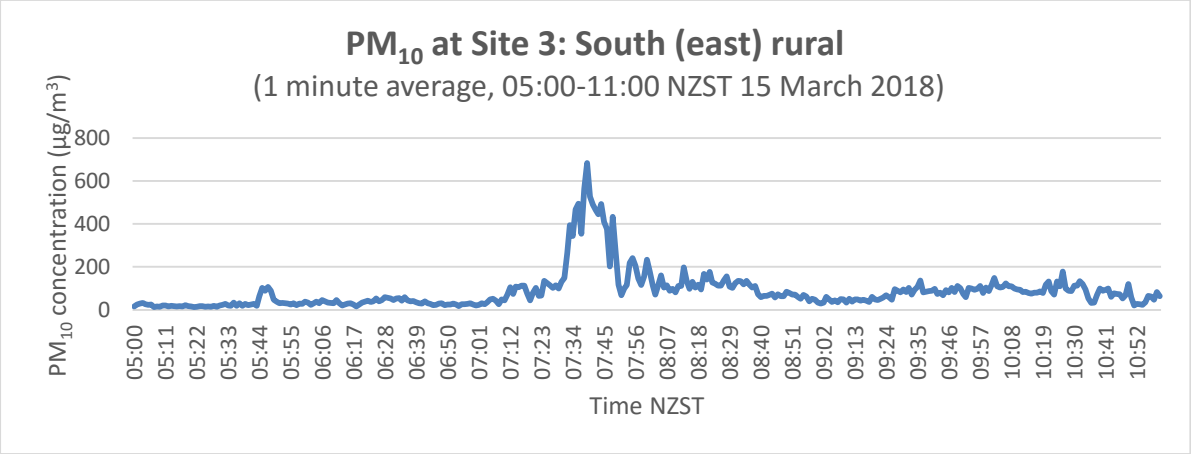

Figure 28 One minute PM10 (nephelometer) at Site 5: South (west) rural on 15 March 2018 during an exceedance event.

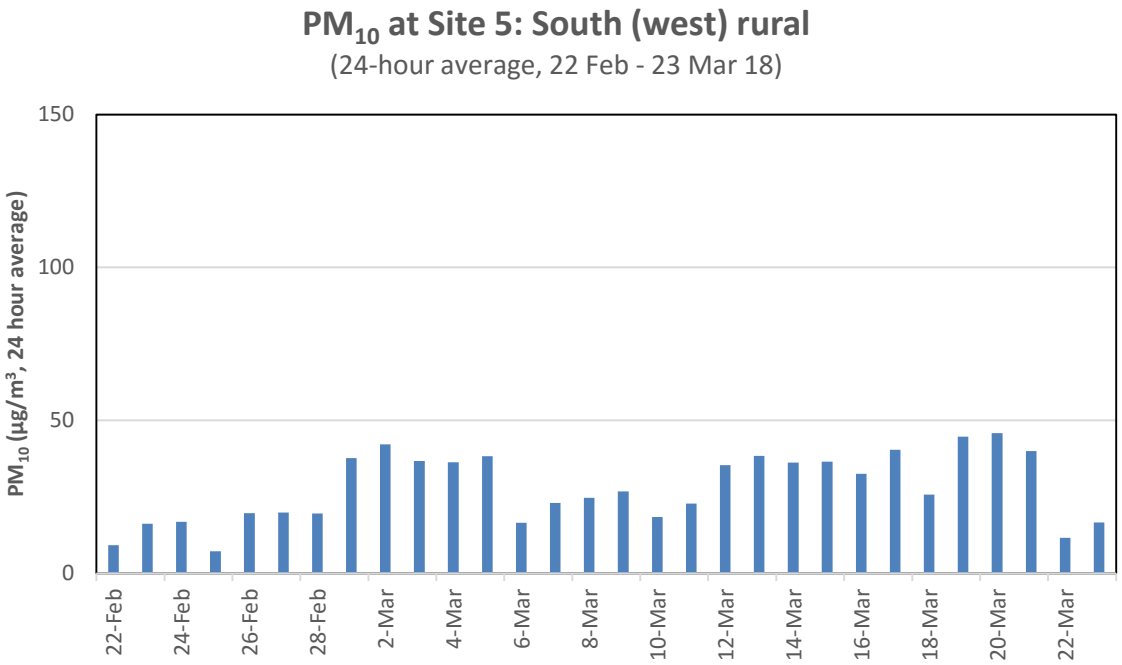

Figure 12 Daily PM_{10} (nephelometer) at Site 5: South (west) rural for period 22 Feb - 23 Mar 2018

2.6 Site 6: North (west) rural/residential

We installed and commissioned a PM_{10} nephelometer at Site 6 on 22 December 2017. Due to communication problems, we shifted this site a small distance (<100 metres) in January 2018 as reported in the second monthly report.

Figure 30 presents hourly PM_{10} for Site 6. There were no exceedances of the 1-hour suggested trigger threshold (150 µg/m^3) between 22 February and 23 March 2018.

Figure 31 presents daily PM_{10} measured by the nephelometer at Site 6 for this period.

NB: As noted above, daily PM_{10} measured by a nephelometer cannot be directly compared with the national environmental standard for PM_{10}. However, **Figure 30** shows that the daily average concentrations of PM_{10} at Site 6 were elevated compared with levels reported in the previous two monthly reports.

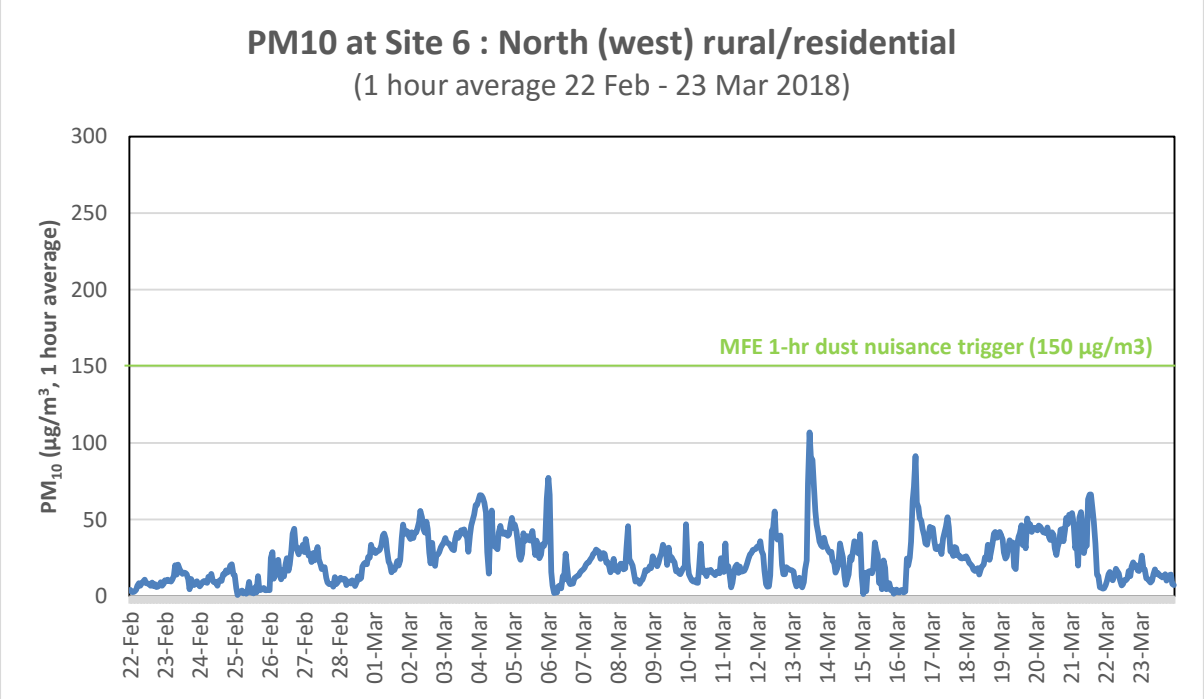

Figure 30 Hourly PM_{10} (nephelometer) at Site 6: North (west) rural/residential for period 22 Feb - 23 Mar 2018

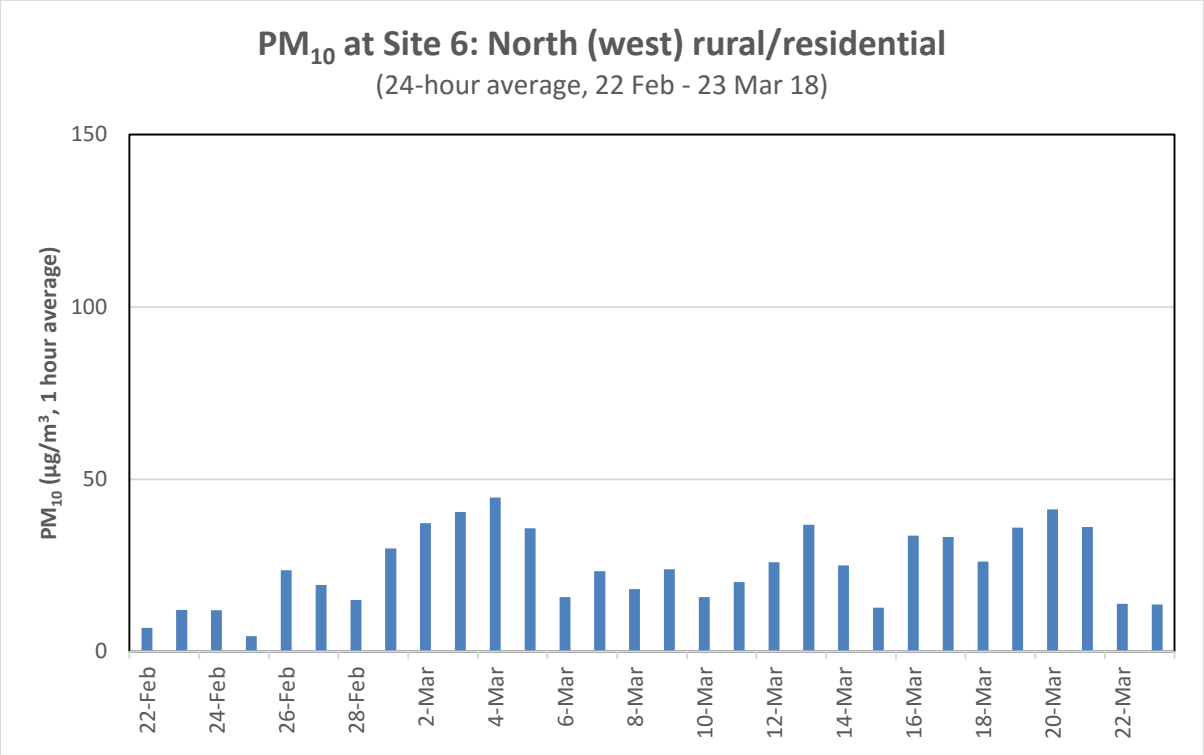

Figure 31 Daily PM_{10} (nephelometer) at Site 6: North (west) rural/residential for period 22 Feb – 23 Mar 2018

2.7 Transect monitors

A series of PM_{10} nephelometers were deployed to the south-east of the Site 3 monitor as shown in Table 3.

Table 3 Location and site details of transect monitors

Location	Installation date	Distance from quarries
Site 3	16 December 2017	50m
Transect 1	9 February 2018	250m
Transect 2	9 February 2018	500m
Transect 3	9 February 2018	650m

A combined plot displaying the hourly average PM_{10} at each of the transect sites is shown below in **Figure 32**.

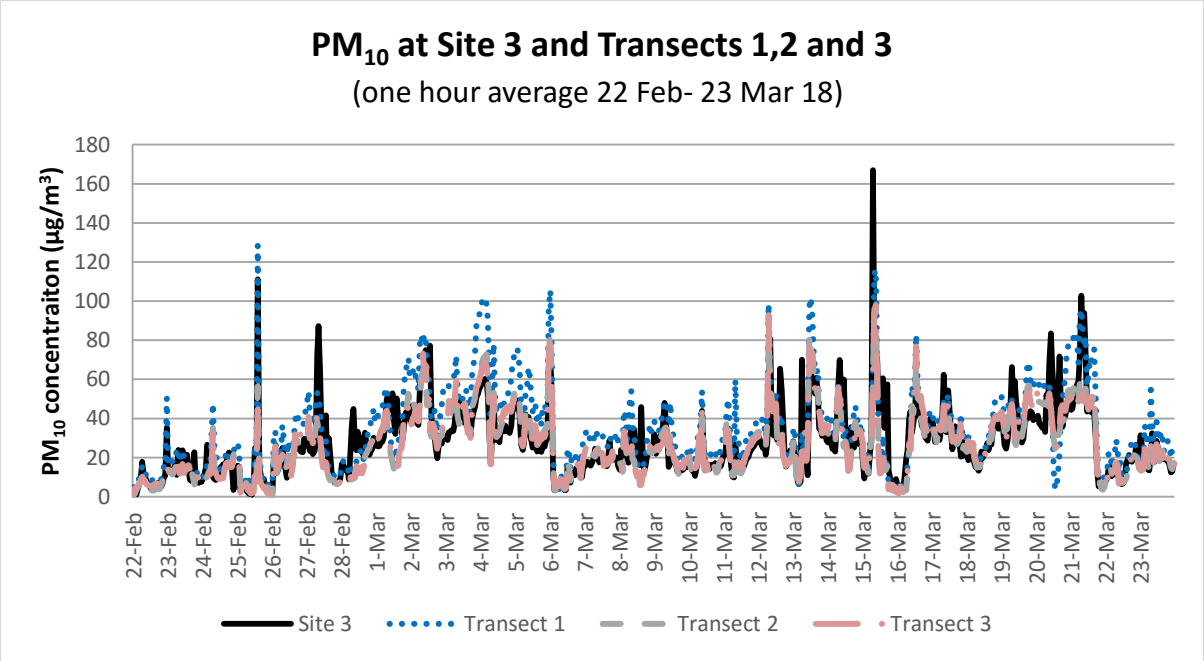

Figure 32 Hourly PM_{10} (nephelometer) at the transects south of the quarries for period 22 Feb - 23 Mar 2018

There were no strong north-westerly wind events during this reporting period. However there was one period of moderate north-westerly winds (peak speeds of 7.1 m/s or 25 kilometres per hour) and this occurred between 1 pm on 25 February and 1:15 am on 26 February. The peak wind gust of just over 7 metres per second coincided with an increase in PM10 concentrations downwind as shown in Figure 32 below.

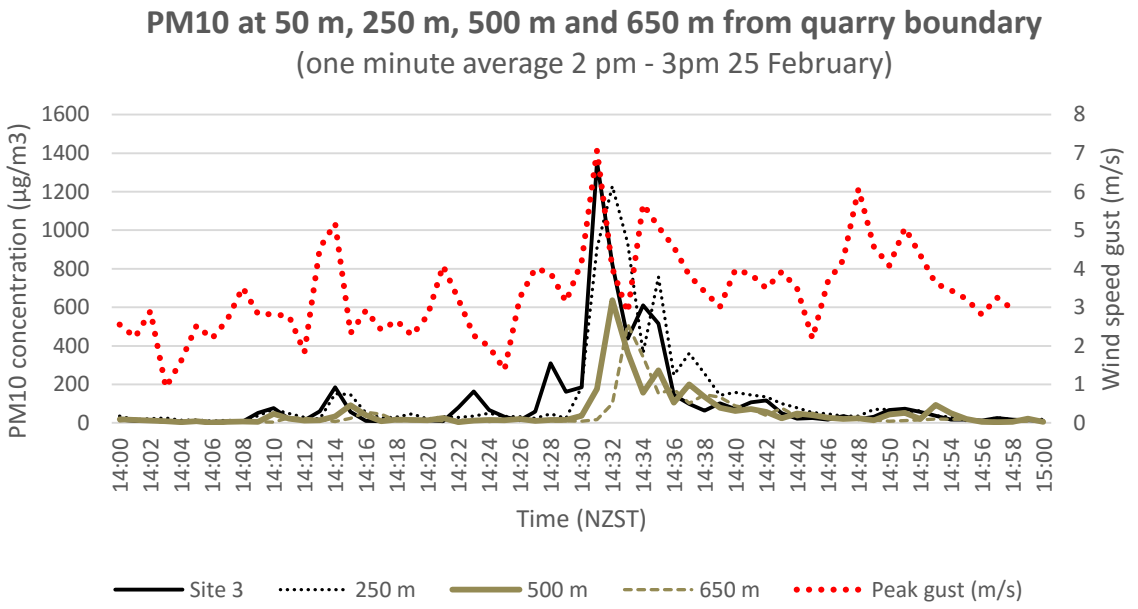

Figure 33 One minute PM_{10} (nephelometer) at various distances downwind of the quarry boundary during a moderate north-westerly wind on 25 February 2018.

During this event, the peak (1-minute) concentration at Site 3 (50 metres from the quarry boundary) reduced by approximately 9% at a distance of 250 metres. At a distance of 500 metres the peak concentration was reduced by approximately 54%. There was a further reduction in PM10 concentration of 62% at a distance of 650 metres from the quarry boundary.

This increase in PM10 coinciding with a north-westerly wind was over quickly and the 1 hour average at Site 3 (111 µg/m^3) did not exceed the suggested dust nuisance trigger level of 150 µg/m^3. It should be noted that wind speed was recorded at a different site (Site 2). We have therefore, adjusted the wind speed times in Figure 33 by approximately 2 minutes to account for the different location.

2.8 Summary

There were three exceedances of the suggested PM_{10} trigger threshold for dust nuisance measured at three locations between 22 February and 23 March 2018.

These events occurred at sites 2, 3 and 5. Site 2 is situated to the north of the quarries, while Sites 3 and 5 are situated to the south of the quarries. The exceedance at Site 2 occurred during a north-easterly event when the wind was blowing from the site towards the quarries and was most likely associated with a fire on a neighbouring property.

The exceedances at Sites 3 and 5 both occurred on the same day during light north-westerly winds. Details of the exceedances are summarised in Table 4 below.

Table 4 Summary Elevated Particulate Levels 22 Feb - 23 Mar 2018

Site	Location	Date / Time[1]	Conc ($\mu g/m^3$)	Wind Dir	Wind Speed (km/hr)	Comment
Suggested PM_{10} trigger threshold for dust nuisance = 150 $\mu g/m^3$ as a 1-hour average						
2	North (east)	8 Mar 14:00-15:00	183	North-easterly	1.5	Fire on neighbouring property
3	South (east)	15 Mar 07:00-08:00	167	Variable	0.4	
5	South (west)	15 Mar 07:00-08:00	198	Variable	0.4	

Notes

[1] New Zealand standard time (NZST) – add one hour to get to New Zealand daylight savings time

2.9 Quarry Operations

At our meeting with the quarries on 7 November 2017 we requested monitoring and operational data to inform the Yaldhurst monitoring programme. The quarry representatives responded positively to this request.

However, we have been unable to obtain operational data from the quarries to date.

2.10 Complaints data

Table 6 presents Environment Canterbury's record of dust complaints during the monitoring period.

The complaint at 08:00am (07:00 NZST) on 16 March coincided with a wind change from the north to the southwest. While the PM10 concentration at downwind sites on Old West Road did increase slightly following the wind change, the increase was relatively modest and well-below the suggested dust nuisance trigger threshold of 150 $\mu g/m^3$ as a 1 hour average.

Table 6 Dust complaints received by Environment Canterbury 22 Feb -23 Mar 2018

Complaint Received Date	Incident Start Date	Incident Start Time	Description of Incident	No. Complaints	General Location Description
20/03/2018	16/03/2018	08:00	16/03/2018 - Excess dust from Winston's quarry on Friday March 16 after forecast southerly wind change duration of dust pollution 1 hr. This is not in compliance with consent restrictions.	1	Winston's quarry 233 Old West Coast Road
21/03/2018	20/03/2018	16:57	Email received 20/03/18 4:57pm: Massive dust cloud around fulton hogan/kbs quarries. Residents live near these quarries. **2nd Report** - [Dust - Miners Road/Fulton Hogan Quarry] - 21/03/2018 2:44pm - Caller reports seeing and breathing "intense amounts of dust" while driving down Miners Road [McLeans Island - Templeton] today at 11:30am near the Fulton Hogan Quarry (which is at 24 Miners Rd, Templeton).	2	Miners Road, Yaldhurst, Christchurch

3.0 Conclusions

Six ambient air quality monitoring sites and three transect monitoring sites were operated for a period of one month between 22 February 2018 – 23 March 2018. Three additional transect monitors were deployed to the south-east of the quarries from 9 February 2018.

Three exceedances of the hourly suggested trigger threshold for dust nuisance (150 µg/m^3, MfE 2016) were recorded at two monitoring locations on the same day (15 March 2018):

- Site 2 (North-east) 3 pm (183 µg/m^3)
- Site 3 (South-east) 8 am (167 µg/m^3)
- Site 5 (South-west) 8 am (198 µg/m^3)

The exceedances at Site 2 occurred during a north-easterly wind and was likely related to a fire on a neighbouring property. The exceedances at Sites 3 and 5 coincided with winds from the quarries towards the monitoring site locations.

There were no exceedances of the national environmental standard for PM_{10} recorded by the reference method monitors at Site 2 (North rural/residential) or Site 4 (Background rural/residential) during this period. However, daily PM_{10} concentrations measured by nephelometer were elevated at all monitoring sites in the vicinity of the quarries (Sites 1, 2, 3, 5 and 6) compared with previous monthly reports.

Co-located monitoring for PM_{10} using nephelometers and beta attenuation monitors (BAM) at two monitoring locations (Site 2 and Site 4) has provided good correlations between the methods. The data to date suggest the nephelometers are over-reading actual PM_{10} levels when compared with the reference method.

Co-located monitoring for $PM_{2.5}$ using nephelometers also appears to be providing robust, realistic ambient data.

4.0 References

MfE, 2009. *Good Practice Guide for Air Quality Monitoring and Data Management 2009*. Wellington. April. Available at www.mfe.govt.nz

MfE, 2016. *Good Practice Guide for Assessing and Managing Dust*. Wellington. November. Available at: www.mfe.govt.nz.