MARLBOROUGH DISTRICT COUNCIL

Annual Air Quality Monitoring Report – Blenheim 2016

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Executive Summary

Particulate (PM_{10}) is main air pollutant of concern in urban areas of New Zealand. Air quality monitoring of PM_{10} in Blenheim has been carried out since 2000. In 2016 monitoring of PM_{10} was carried out in Redwoodtown and at the historical monitoring site in Middle Renwick Road (MRR). The main source of PM_{10} in Blenheim during the winter is solid fuel burning for domestic home heating.

Monitoring data for PM_{10} were compared to the National Environmental Standard for Air Quality (NES) of 50 µg m^{-3} (24-hour average) and to the Ministry for the Environment's air quality guidelines and indicator categories. Comparisons are made with historical data to determine the likelihood of trends in concentrations.

At the main air quality monitoring site in Redwoodtown PM_{10} concentrations exceeded 50 µg m^{-3} (24-hour average) on three occasions during 2016. The maximum measured concentration was 61 µg m^{-3}.

An evaluation of trends in PM_{10} concentrations in Blenheim previously showed a decrease from 2005-2009 followed by an increase in 2010 and 2011. From 2012 – 2016 average concentrations appear to have decreased to around pre 2010 but it is unclear whether the upper quartile/ peak concentrations have decreased to pre 2010 levels. The annual average PM_{10} concentration for the Bowling Club site was 18 µg m^{-3} and is consistent with previous years and less than the MfE guideline of 20 µg/m^3 (annual average).

The maximum PM_{10} concentration measured at the MRR site was 29 µg m^{-3} for 2016. The annual average concentration for this site was estimated to be 11 µg/m^3 for 2016 and compares with 13 µg/m^3 for 2013-2015. An evaluation of trends at the MRR site suggests a decrease in annual average PM_{10} concentrations at this site between 2000 and 2008 but no further reductions are evident since 2009.

An additional evaluation of Redwoodtown data was carried out to assess underlying changes in concentrations. An evaluation of variations in the temporal distribution of PM_{10} concentrations across a day was carried out. Results indicated peak hourly concentrations had decreased from 2010-2016 when compared with earlier years but that the duration of the elevated concentrations particularly during the overnight period had increased. Two possible causes of the increase in overnight concentrations are an increase in PM_{10} emissions over this period, most likely associated with the banking down of fires overnight or a sustained change in the meteorological conditions impacting on PM_{10} concentrations between the hours of 10pm and 6am. Banking down of fires and the tampering of NES compliant burners to enable banking down has significant implications for air quality management. Management measures to reduce PM_{10} concentrations to meet the NES included in the notified air plan are likely to be ineffective if burners are allowed to be tampered with.

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1. Introduction

Particulate has been the main air contaminant of concern in Blenheim and other urban areas of New Zealand for many decades. The main indicator of particulate used has been PM_{10}, particles in the air less than 10 microns in diameter and this size fraction forms the basis of the previous National Environmental Standard (NES). For the past decade, however, the scientific community has been of the view that the smaller of these particles, those less than 2.5 microns in diameter are a stronger indicator of health.

In 2004 the Ministry for the Environment introduced National Environmental Standards (NES) for ambient air quality (Ministry for Environment, 2004). Table 1.1 shows the contaminant, the concentration, averaging period and allowable exceedances as required by the NES. The NES for PM_{10} is set at 50 µg m^{-3} with one allowable exceedence per 12 month period. Compliance with this target is required by 2016 in Blenheim. All other areas in Marlborough must remain compliant with the NES.

The Ministry for the Environment are in the process of reviewing the NES for particulate, however, with a focus on the most appropriate form and averaging period. It is likely that the revised NES will be for the $PM_{2.5}$ size fraction and annual average concentrations. A likely implication is the need for $PM_{2.5}$ monitoring either in addition to or instead of PM_{10} monitoring. The implications for the current PM_{10} requirements are unclear at this stage.

This report summarises concentrations of PM_{10} that were measured at two sites in Blenheim during 2016. The main site for reporting PM_{10} relative to National Environmental Standards is at the Redwoodtown Bowling Club. A second-long term monitoring site in Blenheim is located at Middle Renwick Road (MRR).

Air quality monitoring in the Marlborough Region includes monitoring of PM_{10} at the MRR monitoring site, intermittent monitoring of PM_{10} at the Redwoodtown Bowling Club site, survey PM_{10} monitoring in Renwick during 2000 and 2002, monitoring for PM_{10} in Picton during 2008 and 2009, visibility surveys and passive sampling for nitrogen oxides and sulphur oxides. From 2007 to early 2008, PM_{10} concentrations were measured at the Croquet Club in Redwoodtown in addition to the main monitoring site at the Bowling Club. A site on Brooklyn Street in Redwoodtown was temporarily used to measure PM_{10} concentrations during 2004.

Air quality monitoring data in other urban areas of New Zealand indicates that it would seem unlikely that concentrations of NES contaminants other than PM_{10} would be in breach in Blenheim. Concentrations of other contaminants even in large urban areas are typically within the NES and guideline concentrations. Because emissions of other contaminants in Blenheim are far lower than large urban areas such as Christchurch, it would seem unlikely that concentrations of other key urban air pollutants would be in breach of the NES or air quality guidelines. The exception to this may be benzo(a)pyrene concentrations, which appear to occur well in excess of guideline concentrations in Christchurch.

The Ministry for the Environment also provides guidelines for ambient air quality (Ministry for Environment, 2002). Table 1.2 shows the ambient air quality guidelines and Table 1.3 details the air quality indicator categories to assist in the presentation and management of air quality in New Zealand. Air quality monitoring data in this report are presented relative to air quality guidelines and these indicator categories. These categories provide a useful perspective on the overall air quality and provide a valuable tool for evaluating trends in concentrations over time.

Table 1.1: National Environmental Standards for Ambient Air Quality (MfE, 2004)

Contaminant	NES values		
	Concentration	Averaging Period	Allowable exceedences / year
Particles (PM10)	50 µg m-3	24-hour	1
Nitrogen dioxide	200 µg m-3	1-hour	9
Sulphur dioxide	350 µg m-3	1-hour	9
Sulphur dioxide	570 µg m-3	1-hour	0
Ozone	150 µg m-3	1-hour	0

Table 1.2: Ambient air quality guidelines for New Zealand (MfE, 2002)

Contaminant	2002 guideline values	
	Concentration	Averaging Period
Carbon monoxide	30 mg m-3 10 mg m-3	1-hour 8-hour
Particles (PM10)	50 µg m-3 20 µg m-3	24-hour Annual
Nitrogen dioxide	200 µg m-3 100 µg m-3	1-hour 24-hour
Sulphur dioxide b	350 µg m-3 120 µg m-3	1-hour 24-hour
Ozone	150 µg m-3 100 µg m-3	1-hour 8-hour
Hydrogen sulphide c	7 µg m-3	1-hour
Lead d	0.2 µg m-3 (lead content of PM10)	3-month moving, calculated monthly
Benzene (year 2002) Benzene (year 2010)	10 µg m-3 3.6 µg m-3	Annual Annual
1,3-Butadiene	2.4 µg m-3	Annual
Formaldehyde	100 µg m-3	30-minutes
Acetaldehyde	30 µg m-3	Annual
Benzo(a)pyrene	0.0003 µg m-3	Annual
Mercury (inorganic) d Mercury (organic)	0.33 µg m-3 0.13 µg m-3	Annual Annual
Chromium VI d Chromium metal and chromium III	0.0011 µg m-3 0.11 µg m-3	Annual Annual
Arsenic (inorganic) d Arsine	0.0055 µg m-3 0.055 µg m-3	Annual Annual

Notes for Table 1.2:

[a] All values apply to the gas measured at standard conditions of temperature (0° C) and pressure (1 atmosphere).
[b] The sulphur dioxide guideline values do not apply to sulphur acid mist.
[c] The hydrogen sulphide value is based on odour nuisance and may be unsuitable for use in geothermal areas.
[d] The guideline values for metals are for inhalation exposure only; they do not include exposure from other routes such as ingestion. These other routes should be considered in assessments where appropriate.

Table 1.3: Environmental Performance Indicator categories for air quality (MfE, 2002)

Category	Value relative to guideline	Comment
Excellent	Less than 10% of the guideline	Of little concern: if maximum values are less than a tenth of the guideline, average values are likely to be much less
Good	Between 10% and 33% of the guideline	Peak measurements in this range are unlikely to affect air quality
Acceptable	Between 33% and 66% of the guideline	A broad category, where maximum values might be of concern in some sensitive locations but generally they are at a level which does not warrant urgent action
Alert	Between 66% and 100% of the guideline	This is a warning level, which can lead to exceedences if trends are not curbed
Action	More than 100% of the guideline	Exceedences of the guideline are a cause for concern and warrant action, particularly if they occur on a regular basis

In 2012 the emission inventory for Blenheim (Wilton, 2005) was updated to provide a more recent estimate of the sources of PM_{10} and other contaminant emissions (Wilton, 2012b). The results of the inventory indicated that domestic home heating was the main source of PM_{10} emissions, contributing to around 92% of the daily wintertime PM_{10} (Wilton, 2012). Motor vehicles contributed to 2% of PM_{10} emissions, outdoor burning contributed to 5% and industry contributed to 1% of total wintertime emissions.

2. Methodology

Air quality monitoring of PM_{10} in Blenheim during 2016 was carried out at the two historical monitoring sites (Redwoodtown and Middle Renwick Road (MRR)). At the Redwoodtown Bowling Club site in Blenheim, two 5014i beta attenuation monitors (BAM) were used as well as a high volume sampler. One sampler was located at the site for the whole year and the second from 28 April, when improvements were also made to the equipment enclosure. Originally the purpose of the second 5014i was to replace the existing sampler as data for 2015 had been problematic. However, with improvements to the enclosure the original BAM was found to improve its operation. Both monitors were used at the site to check the ongoing reliability of the original BAM. The purpose of the high volume sampler was to determine the relationship of the samplers to the high volume reference method.

At the MMR site a gravimetric high-volume sampler, a method compliant with the NES reference method specifications, was used. High-volume sampling was carried out on a one day in three sampling regime with samples collected over a 24-hour period from midnight to midnight. Although compliant in terms of the principles of operation, the high volume sampler is difficult to operate continuously because of the requirement for filter change at midnight. Consequently this method as used at the MMR site was not compliant with the NES. The site was historically classified as a residential neighbourhood monitoring site in accordance with the Ministry for the Environments Good Practice Guide for Air Quality Monitoring (Ministry for the Environment, 2009) but has been revised to traffic peak owing to its proximity to the road.

Prior to 2016, meteorological data, including wind speed, wind direction were obtained from a NIWA site on the outskirts of Blenheim. Ambient temperature data was collected at the Bowling Club site in Redwoodtown. All meteorological data (wind speed, temperature and wind direction) are now monitored at the Redwoodtown monitoring site.

2.1. Air quality monitoring sites

Figure 2.1 shows the MRR site, which provides a historical record of PM_{10} in Blenheim and is located to the north-west of Blenheim, the Redwoodtown Bowling Club site which has been operational since 2002, and the NIWA metrological monitoring site, which was used for meteorological data prior to 2016.

In 2007 a site at the Croquet Club was established for the purposes of evaluating the relationship between Brooklyn Street area PM_{10} and PM_{10} concentrations measured at the Bowling Club. This was considered important because PM_{10} concentrations of the magnitude measured during 2004 at Brooklyn Street had not been measured at the Bowling Club and because the reductions required in PM_{10} concentrations in Blenheim had been dependent on the Brooklyn Street results. The results from work undertaken in 2007 and reported in the '2007 Air Quality Monitoring Report' (Wilton, 2008) indicated that the Brooklyn Street site was likely to be affected by localised sources of PM_{10} and should not be used for air quality management purposes. Details of the Croquet Club site are outlined in '2008 Air Quality Monitoring Report' (Wilton & Baynes, 2009).

Figure 2.1: Location of air quality sites and NIWA metrological site in Blenheim

2.1.1. Middle Renwick Road (MRR) monitoring site

The MRR air quality monitoring site was established in 2000 at the back yard area of a Council site at 106 Middle Renwick Road. An aerial picture of the MMR site and its surrounds are shown in Figure 2.2, and Figure 2.3 shows the high volume sampler located at the MRR monitoring site. Table 2.1 provides site details for the site.

Figure 2.2: Aerial photo of the MRR air quality monitoring site (red arrow points to monitoring location).

Figure 2.3: PM_{10} monitor at the MRR air monitoring site

Table 2.1: Site summary details for the MRR air quality monitoring site.

Site name	Blenheim – 106 Middle Renwick Road
Site contact details	Marlborough District Council
Description of site	Grass lawn near to roadside. Mixed use area with proximity to industrial, residential and high traffic count road.
Site category	Traffic peak
Purpose of site and sources	To measure ambient air concentrations of PM_{10} at the historical air quality monitoring site in Blenheim. Main source during the winter months is solid fuel burning for domestic heating.
Proposed duration of monitoring	Ongoing
Contaminants monitored	PM_{10}
Site co-ordinates	E1678182 N5404327
Date of site installation	January 2000
Meteorological characteristics of area	Low wind speeds occur regularly during the winter months. Temperature inversions are likely.
Sample frequency	One day in three from May 2005 One day in six prior to this during the summer and one day in three during the winter.
Inlet height	1.5 metres
Averaging period	24-hour

2.1.2. Redwoodtown - Bowling Club Monitoring Site

In 2010 air quality monitoring took place at the main air quality monitoring site at the Blenheim Bowling Club on Weld Street in Redwoodtown. Figures 2.4 and 2.5 show the surrounding area and the location of the monitoring site within the Bowling Club grounds. Summary site details are given in Table 2.2.

Figure 2.4: Aerial photo of the Redwoodtown - Bowling Club air quality monitoring site (note: blue arrow depicts monitoring site).

Figure 2.5: PM_{10} monitor at the Redwoodtown - Bowling Club air quality monitoring site.

Table 2.2: Site summary details for the Redwoodtown - Bowling Club air quality monitoring site.

Site name	Redwoodtown – Bowling Club
Site contact details	Marlborough District Council
Description of site	The site is located at the Blenheim Bowling Club, which is to the south-east of central Blenheim. The surrounding area includes a bowling green, gravel petanque area and paved areas.
Site category	Residential neighbourhood
Purpose of site and sources	To measure worst-case ambient air concentrations of PM_{10} in Blenheim. The main source during the winter months is solid fuel burning for domestic heating. The site is downwind of a large residential area for meteorological conditions conducive to poor air quality.
Proposed duration of monitoring	Ongoing
Contaminants monitored	PM_{10}
Site co-ordinates	E1679764 N5402328
Date of site installation	Monitoring from 2000-2003. Permanent site since 2005.
Meteorological characteristics of area	Low wind speeds occur regularly during the winter months. Temperature inversions are likely.
Sample frequency	Continuous
Inlet height	3.5 metres
Averaging period	24-hour and hourly

2.2. Quality assurance

Marlborough District Council staff operated the high volume PM_{10} samplers, including filter changing.

Flow calibrations were carried out every month, normally during the morning. Filters were couriered to Hill Laboratories, who undertook filter weighing in accordance with the New Zealand and Australia standard for high volume sampling. Hill Laboratories hold IANZ accreditation, for high volume PM_{10} sampling.

Transportation of filters occurs at the end of each month, with filters stored and transported in snaplock bags at ambient temperature. Quality assurance methods include the analysis of one field blank per site per month. Field blanks outside of the “acceptable” range (± 8 mg per filter) are noted in a report from Hills Laboratory.

Operation of the BAM is also carried out by MDC staff. Ten minute data is recorded by the instrument and logged by an iQuest iRIS 350 datalogger. The BAM filter spot is moved on every eight hours. Results are telemetered hourly to MDC and stored in the hilltop database. Annual calibrations are carried out by Lear Siegler.

3. Air quality monitoring in Blenheim

3.1. PM_{10} concentrations at the MRR site

Daily average PM_{10} concentrations measured at the MRR site during 2016 are shown in Figure 3.1. The maximum measured 24-hour average PM_{10} concentration was 29 µg m^{-3} and was measured on 9 June 2016. The corresponding concentration at Redwoodtown was 61 µg m^{-3}.

Figure 3.2 shows a reasonable correlation between gravimetric PM_{10} concentrations measured at MRR during 2016 with those in Redwoodtown with the latter measuring less than half of the concentrations at Redwoodtown. The correlation is similar to that observed for 2015.

Concentrations of PM_{10} at MRR have exceeded 50 µg m^{-3} on only a few years. In 2008 the maximum concentration recorded was 51 µg m^{-3}. The only other years that concentrations above 50 µg m^{-3} have been recorded at this site are 2000 (56 µg m^{-3}), 2003 (75 µg m^{-3}) and 2008 (51µg m^{-3}).

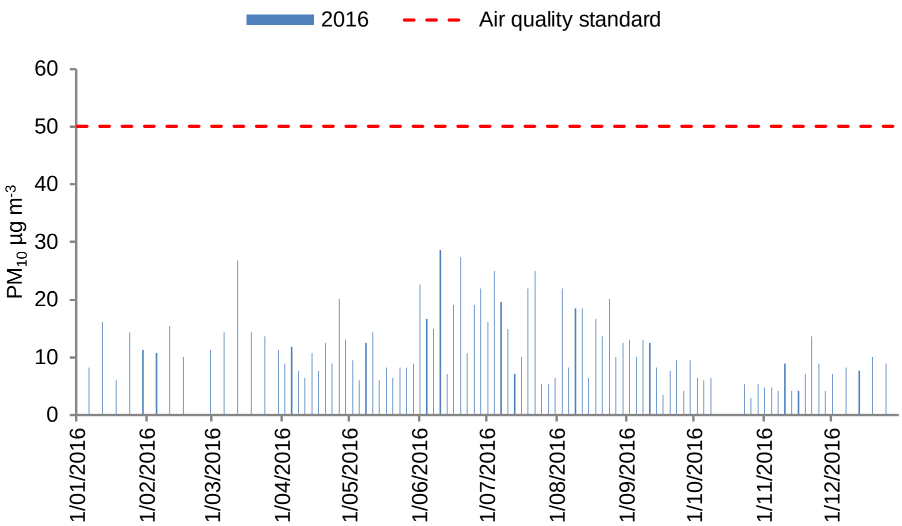

Figure 3.1: Daily winter PM_{10} concentrations measured at the MRR site during 2016.

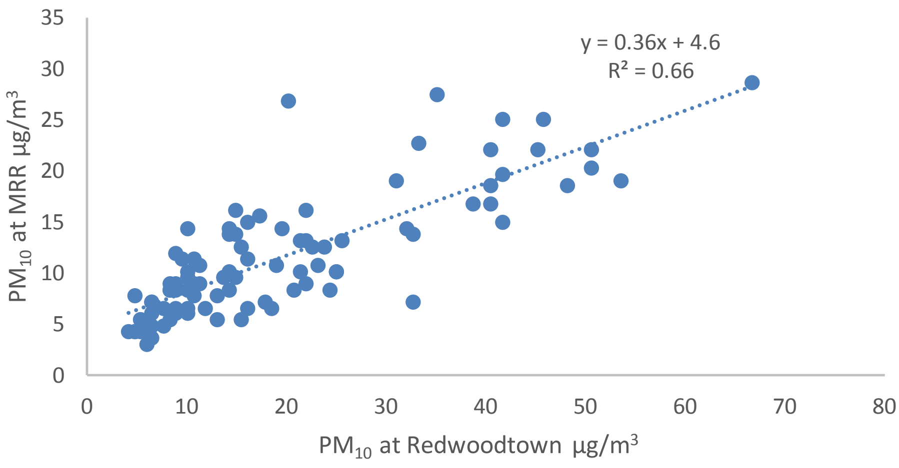

Figure 3.2: Relations between daily winter PM_{10} concentrations at the MRR site and at Redwoodtown during 2016.

Figure 3.3 shows changes in PM_{10} concentrations relative to MfE air quality indicator categories (shown in Table 1.3) at the MRR site from 2000 to 2016. Data indicate improving PM_{10} concentrations at the MRR monitoring site between 2000 and 2011 with no further improvement evident after this time. Data for 2016 are similar to those for 2010 with less than 20% of the concentrations above 16.5 µg/m^3 (33% of the NES).

Monthly variations in PM_{10} concentrations compared to air quality indicators for 2016 are shown in Figure 3.4. Figure 3.5 shows the number of days when the NES was exceeded, the maximum concentration and the second highest concentration for 2016 and for previous years.

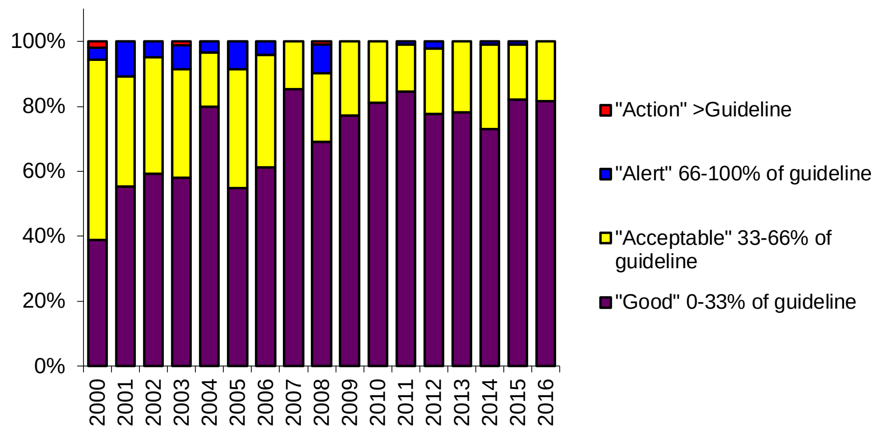

Figure 3.3: Comparison of PM_{10} concentrations measured at the MRR site from 2000 to 2016 to air quality indicator categories.

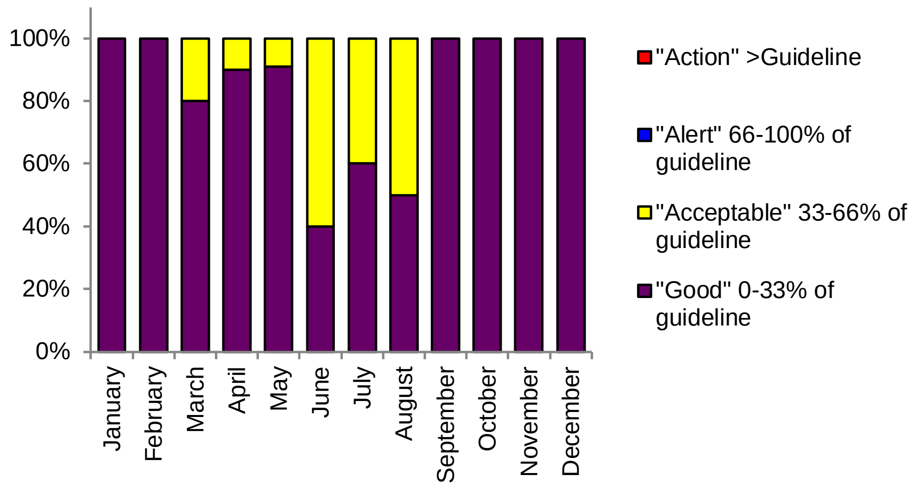

Figure 3.4: Comparison of daily PM_{10} concentrations each month during 2016 to air quality indicator categories at the MRR site.

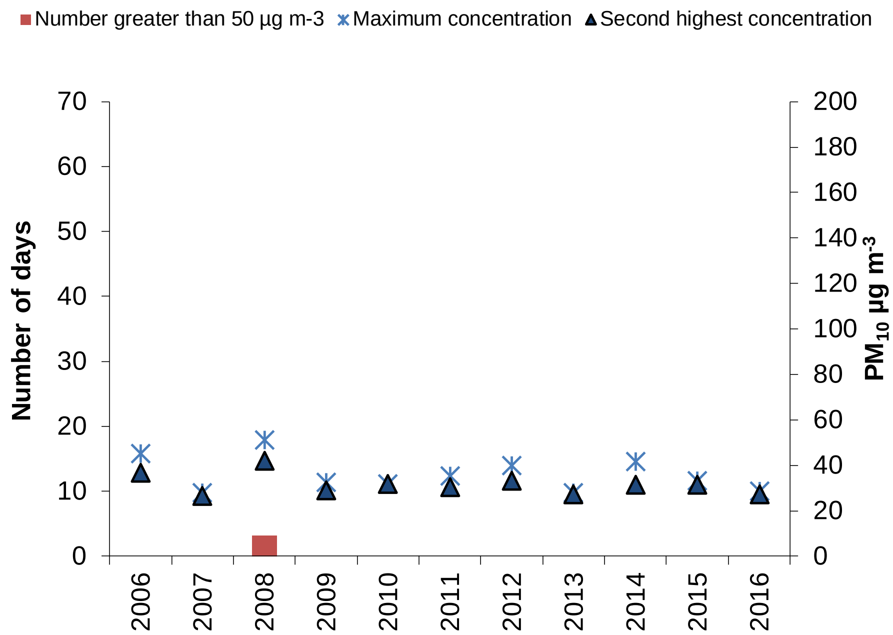

Figure 3.5: Number of days when the NES was exceeded, the maximum concentration and the second highest concentration from 2006 to 2016 at the MRR site.

The estimated annual average PM_{10} concentration for the MRR site for 2016 is 11 µg $m^{-3,}$ compared with around 13 µg/m^3 for 2013-2015. Figure 3.6 shows a downward trend in annual average PM_{10} concentrations at MRR since 2000. However, trends between 2000 and 2008 dominate this with data suggesting negligible changes in annual average PM_{10} since 2009. The Ministry for the Environments annual average PM_{10} guideline is 20 µg m^{-3}. There is currently no NES for annual average PM_{10} concentrations.

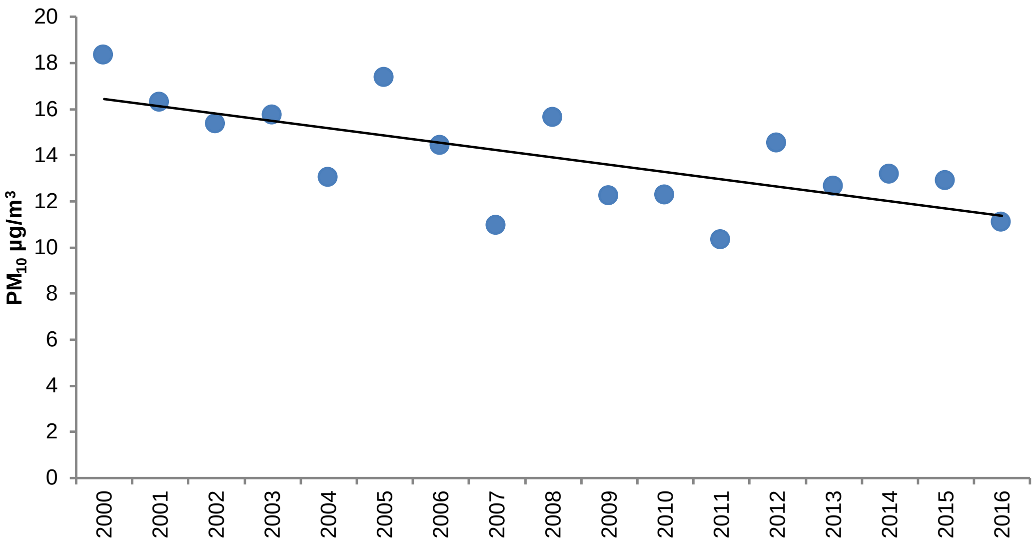

Figure 3.6: Annual average PM_{10} concentration from 2000 to 2016 at the MRR site.

Table 3.1: Summary of PM_{10} concentrations measured at the MRR monitoring site from 2000 to 2016

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
"Good" 0-33% of guideline	39%	55%	59%	58%	80%	55%	61%	85%	69%	77%	81%	84%	78%	76%	73%	82%	82%
"Acceptable" 33-66% of guideline	56%	34%	36%	33%	17%	37%	35%	15%	21%	23%	19%	15%	20%	21%	26%	17%	18%
"Alert" 66-100% of guideline	4%	11%	5%	7%	3%	9%	4%	0%	8%	0%	0%	1%	2%	0%	1%	1%	0%
"Action" >Guideline	2%	0%	0%	1%	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%	0%	0%	0%
Percentage of valid data	15%	20%	22%	22%	16%	25%	33%	32%	31%	32%	29%	32%	26%	32%	30%	28%	27%
Annual average (µg m^{-3})	18	16	15	16	13	17	14	11	16	12	12	10	15	13	13	13	11
Measured PM_{10} concentrations above 50 µg m^{-3}	1	-	-	1	-	-			1						0	0	0
Extrapolated PM_{10} concentrations above 50 µg m^{-3}									3						0	0	0
99.7 %ile concentration (µg m^{-3})	53	46	40	67	46	47	42	27	48	31	32	34	38	28	38	33	28
Annual maximum (µg m^{-3})	56	48	41	75	49	49	45	28	51	32	32	35	40	28	42	33	29
Number of records	54	74	81	81	60	93	121	116	113	118	106	116	97	115	111	101	98

3.2. PM_{10} concentrations at Redwoodtown – Bowling Club

Concentrations of PM_{10} exceeded the 50 µg/m³ limit on three occasions at the Redwoodtown air quality monitoring site during 2016 (Figure 3.7). The NES allows one exceedence of 50 µg m^{-3} per year before a breach occurs. Thus the NES was breached on two occasions at Redwoodtown during 2016.

The maximum measured PM_{10} concentration for 2016 was 61 µg/m³ and occurred on 9 June. The second and third highest PM_{10} concentrations were 53 µg/m³ and as recorded on 27 May and 52 µg/m³ on 18 July. Previous recent maximum concentrations at Redwoodtown have ranged from 59 - 82 µg m^{-3}.

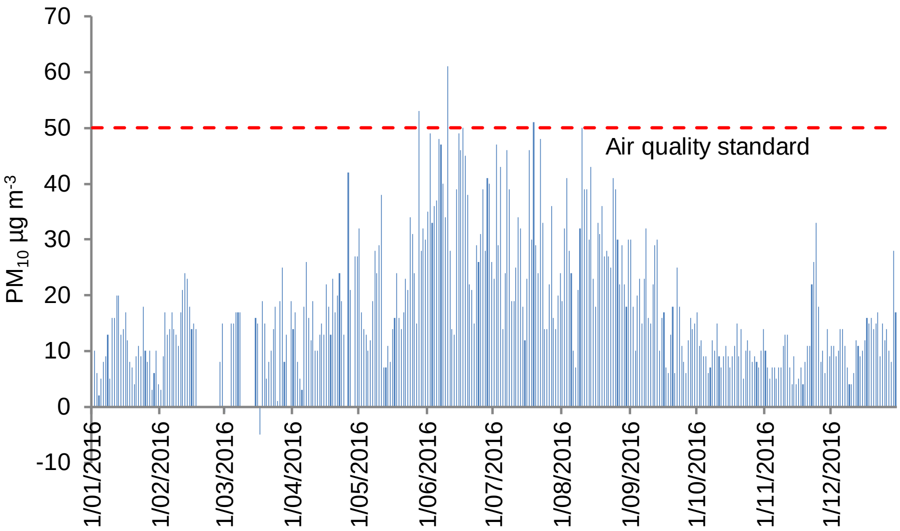

Figure 3.7: 24-hour average PM_{10} concentrations measured at the Redwoodtown - Bowling Club site during 2016.

Daily PM_{10} concentrations measured from 2006 to 2016 relative to the MfE air quality indicator categories (shown in Table 1.3) are illustrated in Figure 3.8. Similarly, monthly variations in the distribution of PM_{10} concentrations for 2016 are shown in Figure 3.9. The distribution of PM_{10} concentrations by season are similar to other years with the winter months showing the greatest proportion of days in the "acceptable", "alert" and "action" categories and fewer days in the "good" category.

Figure 3.10 compares the number of days when the NES was exceeded in 2016 to previous years along with the maximum concentration and the second highest concentration. It is important to note, that comparisons between years does not take into account year to year variations in the impact of meteorology. This issue is examined further in section 4 of this report.

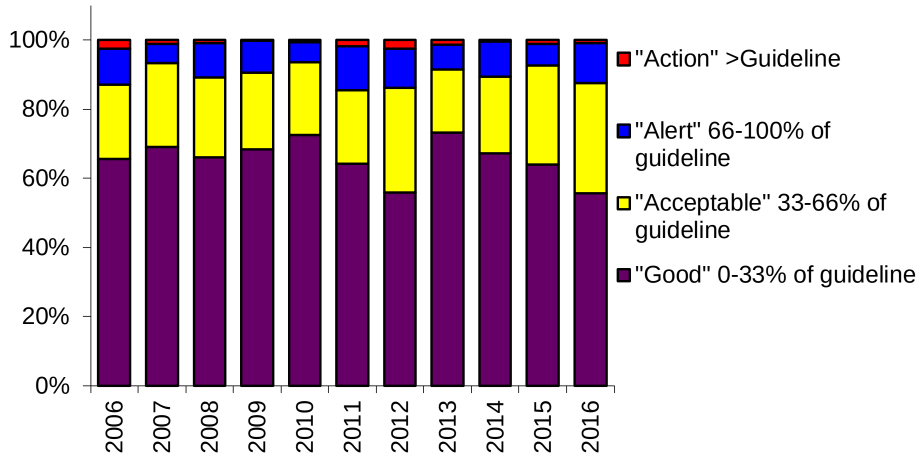

Figure 3.8: Comparison of PM_{10} concentrations measured at Redwoodtown - Bowling Club site during 2006 to 2016 to air quality indicator categories.

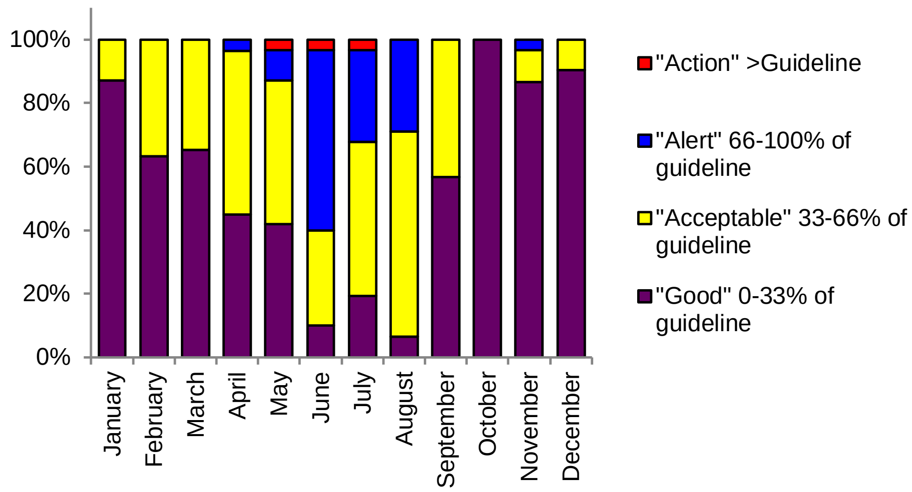

Figure 3.9: Comparison of daily PM_{10} concentrations each month during 2016 to air quality indicator categories.

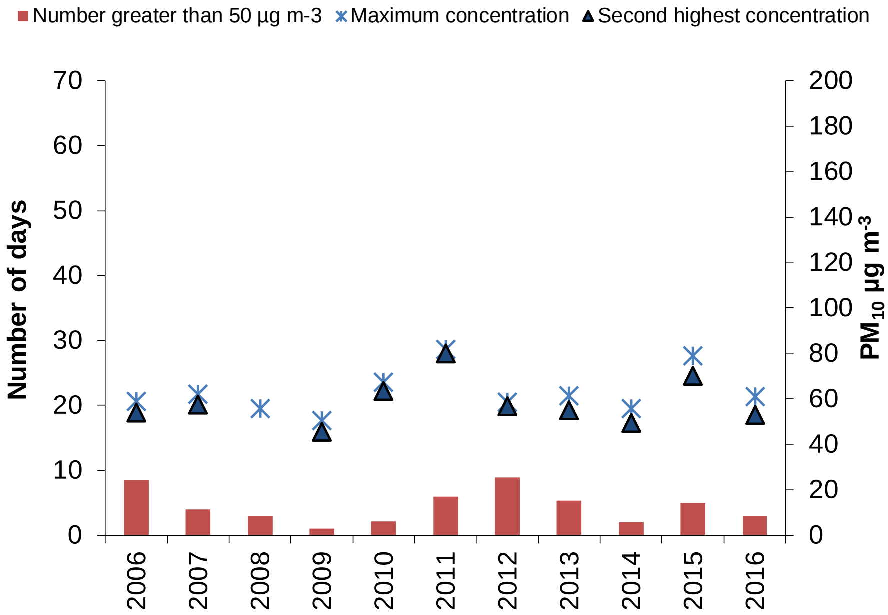

Figure 3.10: Number of days when 50 µg m^{-3} was exceeded, the maximum concentration and the second highest concentration from 2006 to 2016.

The annual average PM_{10} concentration for 2016 was 18 µg m^{-3}. This is within the normal range for this monitoring site (14-19 µg/m^3). The Ministry for the Environment specifies an annual average guideline for PM_{10} of 20 µg m^{-3}. The NES does not currently include an annual average concentration for PM_{10}.

Summary statistics for PM_{10} monitoring results from the Redwoodtown Bowling Club site from 2002 to 2016 are provided in Table 3.2. Data for 2016 has been adjusted for gravimetric equivalency. From 2005 monitoring was conducted from January to December and in 2004 air quality monitoring took place at a site in Brooklyn Street.

Table 3.2: Summary of PM_{10} concentrations measured at Redwoodtown - Bowling Club site from 2002-2016

	2002	2003	2004	2005	2006*	2007*	2008*	2009*	2010*	2011*	2012*	2013*	2014*	2015*	2016**
Monitoring method	Hi-vol	Hi-vol	Hi-vol	Hi-vol	BAM	BAM	BAM	BAM	BAM	BAM	BAM/Hi-vol	BAM	BAM/Hi-vol	BAM/Hi-vol	BAM
"Good" 0-33% of guideline	18%	22%	46%	63%	66%	69%	66%	68%	72%	64%	56%	72%	67%	64%	56%
"Acceptable" 33-66% of guideline	62%	30%	22%	17%	21%	24%	23%	22%	21%	21%	31%	18%	22%	29%	32%
"Alert" 66-100% of guideline	10%	26%	20%	17%	10%	6%	10%	9%	6%	13%	11%	7%	10%	6%	12%
"Action" >Guideline	10%	22%	12%	3%	3%	1%	1%	0%	1%	2%	2%	1%	0%	1%	1%
Percentage of valid data	14%	7%	22%	32%	68%	99%	99%	98%	96%	87%	91%	98%	70%	91%	95%
Annual average (µg m^{-3})	-	-	22	18	17	15	17	15	14	16	19	14	16	17	18
Measured PM_{10} concentrations above 50 µg m^{-3}	5	6	10	3	6	5	3	1	2	6	8	5	1	4	3
Extrapolated PM_{10} concentrations above 50 µg m^{-3}	16	34	31	9	10	4	3	1	2	6	9	5	2	5	3
Second highest PM_{10} concentration (µg m^{-3})					54	58	56	46	64	80	57	55	51	70	53
Annual maximum (µg m^{-3})	58	60	81	58	59	62	56	46	67	82	59	61	56	79	61
Number of records	50	27	82	115	247	360	363	357	352	319	331	351	254	331	346

*not adjusted for gravimetric equivalency

**adjusted for gravimetric equivalency

3.3.

3.4. PM_{10} and meteorology in Blenheim

Figure 3.11 shows variations in PM_{10} concentrations and meteorological conditions on the 9 June, 27 May and 18 July 2016 when the 24-hour average PM_{10} concentrations exceeded 50 µg m^{-3} at the Redwoodtown air quality monitoring site. Data are generally consistent with historical high pollution days although the morning peak duration on 9 June is slightly longer than typical, possibly because of very low wind speeds. The key meteorological conditions associated with the elevated concentrations are low wind speeds and south-westerly wind direction.

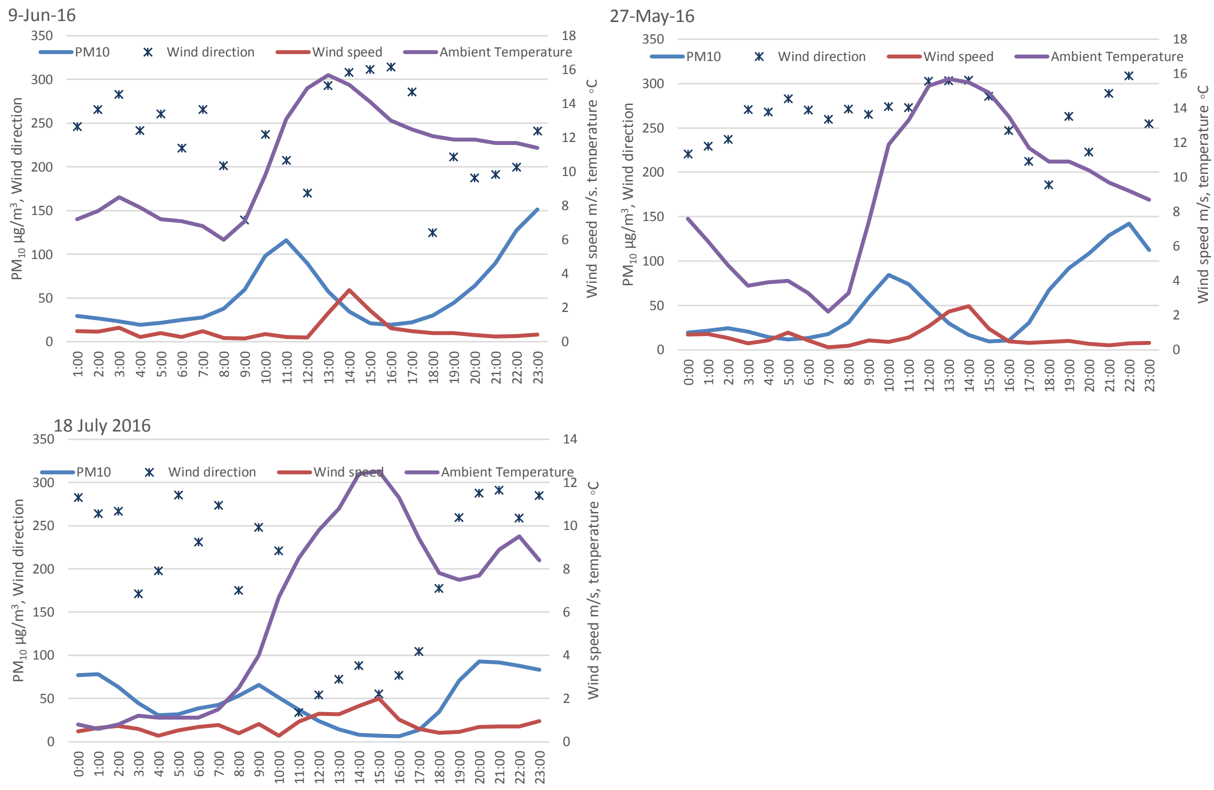

Figure 3.11: Hourly average PM_{10}, wind direction and temperature on 9 June, 27 May and 18 July 2016 when PM_{10} concentrations exceeded 50 µg m^{-3} (24 hour average) at Redwoodtown.

3.5. Comparison of PM_{10} from two BAM samplers

In April 2016 an additional BAM sampler (BAM2) was located at the Bowling Club Site. The sampler was initially intended to replace the existing BAM which had been problematic. At the same time the site enclosure was upgraded. As a result of the enclosure improvements the performance of the initial BAM improved significantly. Figure 3.12 compares the BAM to the BAM2 (neither samplers adjusted for gravimetric equivalency) for daily average PM_{10} concentrations for 2016. Results show a strong correlation (r^2= 0.99) with the BAM2 recording slightly higher PM_{10} concentrations overall. The relationship between the two instruments using reduced major axis (RMA) regression was BAM2 = 1.04BAM +0.1.

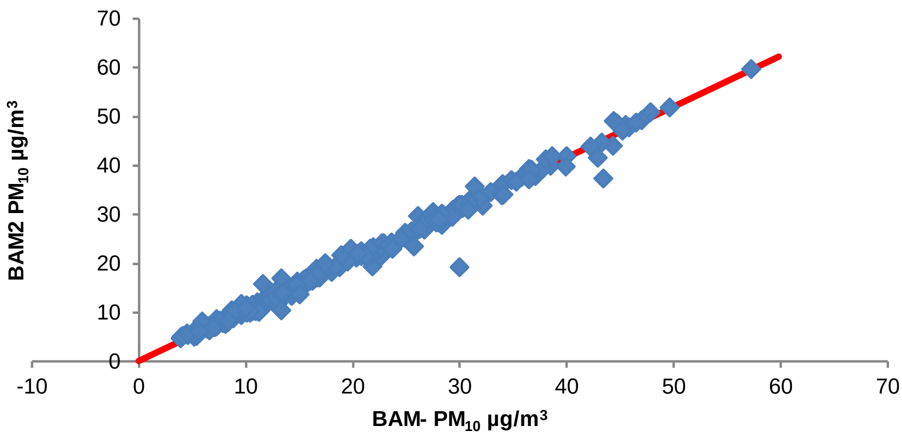

Figure 3.12: Comparison of daily average PM_{10} concentrations from the two BAMs located at the Redwoodtown monitoring site during 2016.

As a result of the improved operation the original BAM was retained at the site measuring PM_{10} concentrations and a $PM_{2.5}$ inlet was attached to the BAM2 to enable measurement of $PM_{2.5}$.

4. Trends in PM_{10} concentrations in Blenheim

Additional analysis of data was carried out for the 2016 air quality monitoring report to further examine changes in concentrations over the 10-year period from 2006 to 2016. It aims to understand observed changes, potential reasons, and any implications for air quality management. For the purposes of assessing trends BAM data has not been adjusted for gravimetric equivalency to be consistent with historical data.

4.1. Annual and winter average

Figure 4.1 compares the annual average, median and winter average PM_{10} concentrations at Redwoodtown from 2006 to 2016. Data suggests no improvement in PM_{10} concentrations over the 10 year period with the lowest winter average concentrations occurring between 2007 and 2010. The highest winter average PM_{10} concentrations occurred during 2011 and 2012. Year to year variations in concentrations can be influenced by variability in meteorological conditions, particularly the prevalence and severity of those giving rise to elevated concentrations.

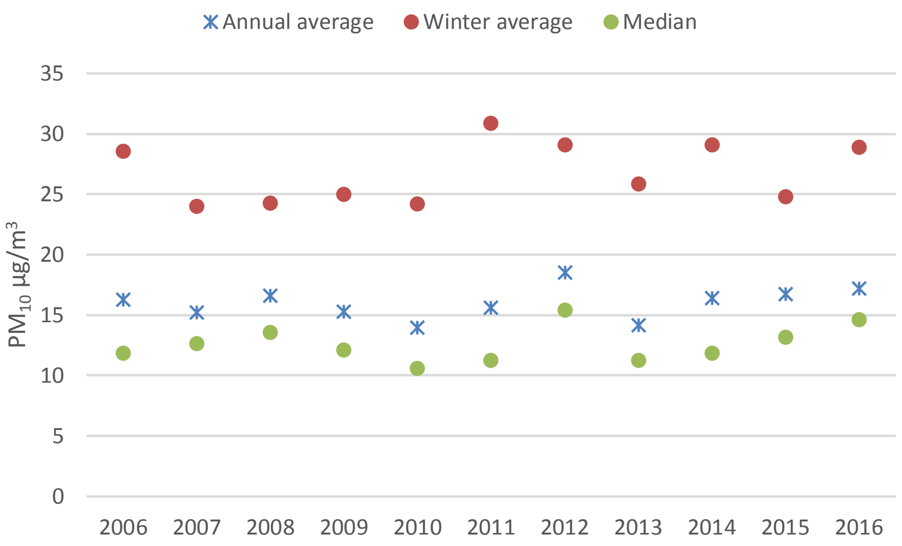

Figure 4.1: Annual average, median and winter average PM_{10} concentrations at Redwoodtown

4.2. Monthly average concentrations

Figure 4.2 shows variations in the monthly average PM_{10} concentrations from 2007 to 2016. These data are sensitive to variability in meteorological conditions but can be useful in assessing changes in emissions over the shoulder months, that is sustained trends in seasonal fire use behaviours. Data for 2006 were excluded because monthly data availability during winter did not past the 75% valid data required.

Data indicates September concentrations were higher during 2014 and 2015 than for earlier years suggesting people may have been using burners for longer during these years. However, 2016 data for September was similar to earlier years. Overall no trends are apparent from the monthly average data.

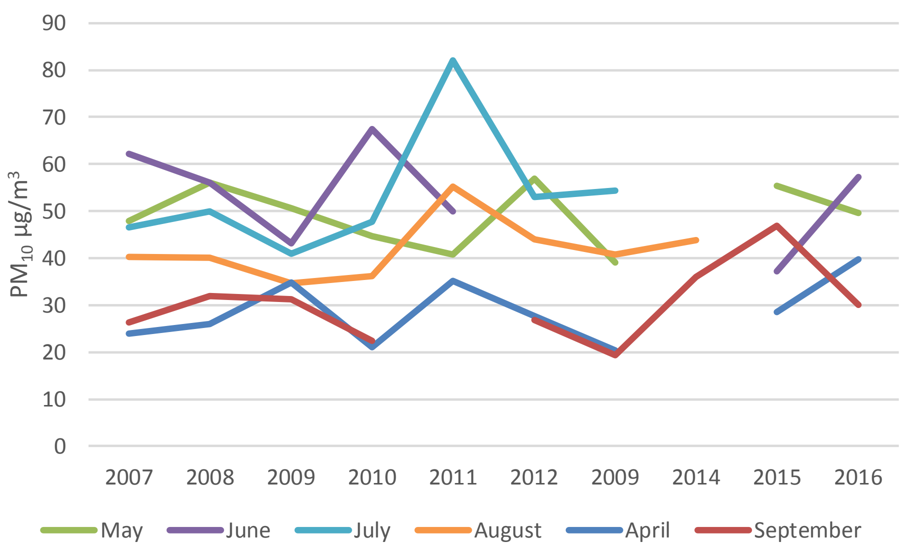

Figure 4.2: Monthly average PM_{10} concentrations at Redwoodtown from 2007 - 2016

4.3. Exceedences

Figure 4.3 shows the averaged number of exceedences over a five year period using a rolling average from 2006 to 2016. Using a five year average helps minimise some of the impact of year to year variability in meteorological conditions in assessing trends. Data support previous suggestions from earlier monitoring reports of an increase in emissions followed by possible improvements over the last few years. Using this indicator, the 2012-2016 average is the first year where any improvement is indicated.

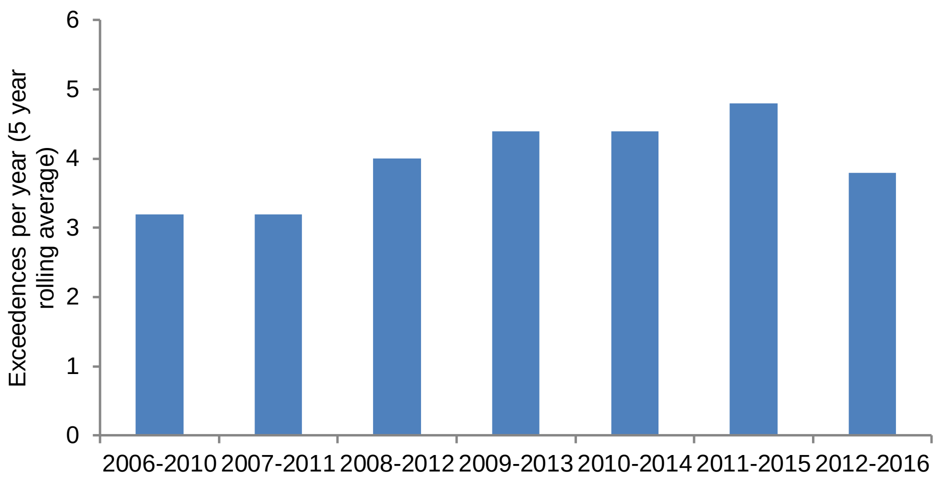

Figure 4.3: Number of exceedences per year (5 year rolling average) from 2006 to 2016

4.4. Normalised data

To quantify the impact of meteorological conditions and therefore further assess the likelihood of changes in PM_{10} concentrations since 2005, a trends assessment was updated in 2012 (Wilton, 2012a). The objective of that work was to identify meteorological conditions giving rise to concentrations of PM_{10} in excess of the NES and to provide a tool for comparing year to year PM_{10} concentrations whilst minimising the impact of variability in meteorological conditions. The trends assessment provided a tool for updating the trends analysis with time. Figure 4.4 shows trends in PM_{10} concentrations updated with the 2016 PM_{10} data adjusted for the impact of meteorological conditions.

Results suggest a decrease in concentrations between 2006 and 2009 followed by increasing concentrations for 2010 and 2011 (Figure 4.4). Since then PM_{10} concentrations appear to have decreased slightly across most of the concentration ranges, although it is unclear whether peaks concentrations have decreased to below 2010 levels. It is uncertain whether the higher peak concentrations (95th percentile) for 2015 occur because of changes in emissions, the spatial distribution of emissions or meteorological conditions not quantified in the trends assessment.

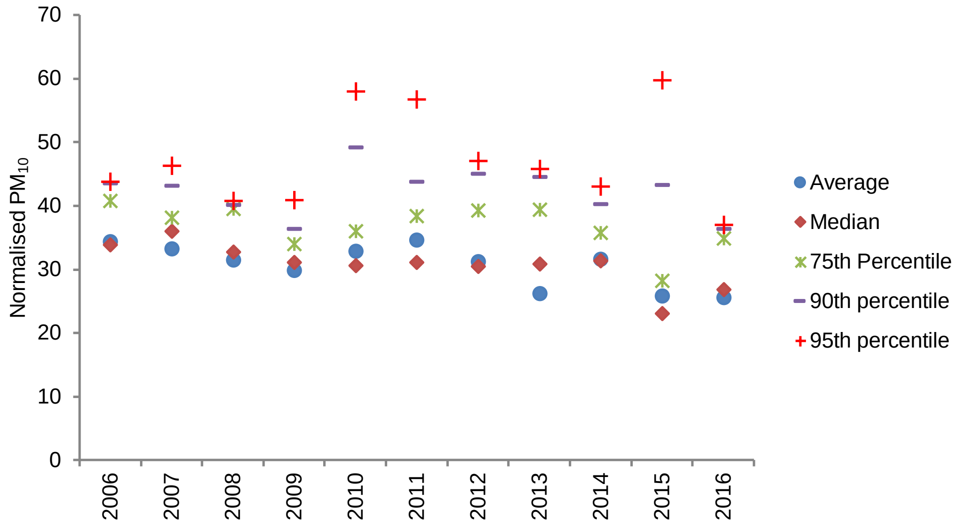

Figure 4.4: Trends in PM_{10} concentrations after adjusting for meteorological conditions

4.5. Analysis of trends in hourly PM_{10} data

The purpose of this evaluation is to examine whether there have been changes in the distribution of the daily PM_{10} concentrations that may help explain the trends observed, particularly the higher PM_{10} concentrations, and possible increase in emissions observed around 2009- 2010. In theory, emissions should have been reducing during this time as older more polluting wood burners were replaced with NES compliant burners.

Anecdotal evidence suggests that some installers of new wood burners in Blenheim have been assisting households to achieve an overnight burn in their NES complaint burners by adjusting the oxygen setting i.e., tampering with the burners to enable shutting down of the air supply. This practice results in increased emissions, particularly during the overnight period as the fire smoulders without adequate oxygen supply.

An evaluation of the hourly average PM_{10} concentrations from 2006 – 2009 compared with 2010 – 2016 is shown in Figure 4.5. The 2010-2016 evaluation excludes data from 2014 and 2015 because of data quality issues. The analysis suggests that concentrations are remaining higher during the overnight period with average concentrations around 12% higher from 8pm to 6am from 2010-2016 compared with 2006-2009. Table 4.1 shows that for other times of the day PM_{10} concentrations have either stayed the same (12pm – 4pm) or have decreased. The greatest reduction in concentrations appears in the peak (4pm – 8pm) time period (10%).

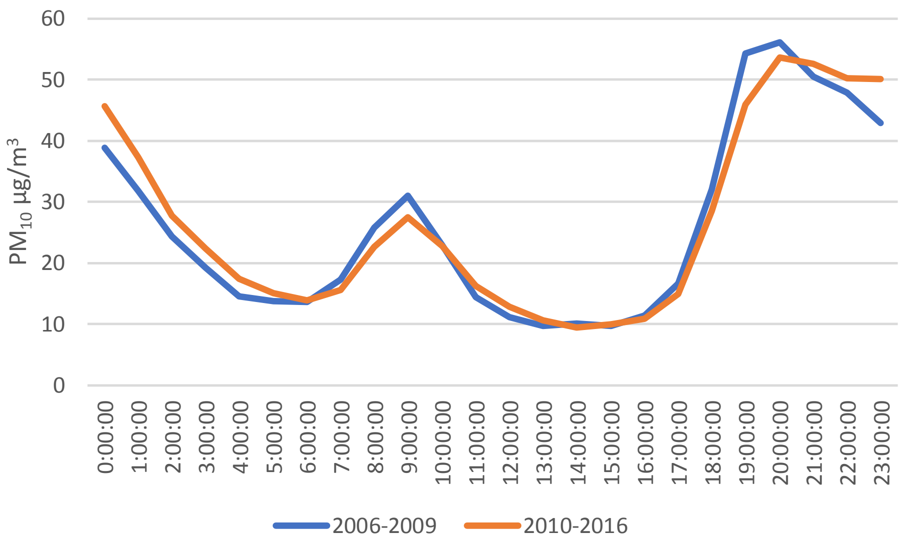

Figure 4.5: Comparison of hourly average PM_{10} concentrations 2006-2009 and 2010-2016

The time of day trend analysis is indicative of either an increase in emissions during the overnight period or a sustained change in the meteorological conditions overnight. The former scenario would be expected if more households were damping down wood burners overnight, or if the impact of dampening down was more significant. In addition, the tampering of burners required to achieve an overnight burn is likely to result in higher emissions at other times including the evening 4pm – 8 pm period that has observed an overall decrease in PM_{10} over time. An emission inventory conducted for Blenheim (Wilton, 2012b), indicates an expected reduction in PM_{10} emissions of around 26% between 2005 and 2012. As the observed reduction in concentrations over the peak evening period (10%) is less than predicted (26% until 2012) it is possible that tampering of burners has reduced improvements in peak concentrations as well as increasing PM_{10} emissions during the overnight period. The policy implications, if tampering of burners is occurring, are significant as the impact of measures proposed in the notified Air Plan for Marlborough will not be realised.

Table 4.1: Evaluation of changes in the distribution of PM_{10}

Time period	Average 2006-2009	Average 2010-2016	Difference %
Morning - 6am-12 pm	20.4	19.6	-4%
Afternoon - 12pm-4pm	10.2	10.3	0%
Evening - 4pm-8pm	39.7	35.8	-10%
Overnight - 8pm-6am	29.7	33.3	12%

5. Summary

Concentrations of PM_{10} measured at the main air quality monitoring site in Redwoodtown recorded three exceedences of 50 µg/m^3 and two breaches of the NES for PM_{10} during 2016. The highest concentration was measured on 9 June and reached 61 µg/m^3 (24-hour average). This is a similar magnitude to concentrations measured in other years but lower than the 2015 maximum concentration of 79 µg/m^3. The annual average concentrations for Redwoodtown for 2016 was 18 µg/m^3.

Concentrations of PM_{10} were also measured at the historical Middle Renwick Road monitoring site. There have been no exceedences of 50 µg/m^3 for PM_{10} at this site since 2008. The maximum daily PM_{10} concentration for 2016 was 29 µg/m^3. An evaluation of annual average concentrations measured at this site since 2000 has previously indicated a downward trend in concentrations. The trend appears to have tapered since 2009. Concentrations at this site are less than half those measured at Redwoodtown on average.

A comparison of the two 5014i BAMs for 2016 indicated good precision with instruments typically recording similar concentrations. Improved instrument housing appears to have fixed earlier problems with the original BAM.

The NES for PM_{10} was reviewed by the Ministry for the Environment in 2011. A new date of September 2016 was given for compliance with 50 µg m^{-3} (24-hour average, one allowable exceedence) for areas with fewer than 10 breaches. Blenheim is required to meet this target date which means Blenheim is unable to breach the NES for PM_{10} from winter 2017. Prior to 2010 PM_{10} concentrations appeared to be reducing. However, increases in the frequency of exceedences and the magnitude of concentrations were observed around 2009 and 2010. While more recent data suggests some decreases in concentrations since 2011 concentrations do not appear to have reduced below the pre 2009 levels.

An additional evaluation of data suggests that while peak concentrations have reduced by around 10% concentrations of PM_{10} have increased during the overnight period, when comparing pre 2010 data to that from 2010 onwards. Two possible causes of the increase in overnight concentrations are an increase in PM_{10} emissions over this period, most likely associated with the banking down of fires overnight or a sustained change in the meteorological conditions impacting on PM_{10} concentrations between the hours of 10pm and 6am.

There are significant implications for air quality management if the cause relates to an increase in overnight banking, particularly as a result of the tampering of NES compliant burners. Management measures to reduce PM_{10} concentrations to meet the NES have been included in the notified air plan. However, these are likely to be ineffective if burners are allowed to be tampered with. Irrespective, it is unlikely that Blenheim will meet the required timeframe for compliance with the NES.

References

Ministry for Environment. (2002). Ambient Air Quality Guidelines – 2002. Ministry for Environment.

Ministry for Environment. (2004). Resource Management (National Environmental Standards for Air Quality) Regulations 2004. New Zealand Government. Retrieved from http://www.legislation.govt.nz/regulation/public/2004/0309/latest/DLM286835.html?search=ts_regulation_air+quality_resel&p=1&sr=1

Ministry for the Environment. (2009). *Good practice guide for air quality monitoring and data management 2009*. Wellington, N.Z.: Ministry for the Environment. Retrieved from http://www.mfe.govt.nz/publications/air/good-practice-guide-air-quality-2009/good-practice-guide-for-air-quality.pdf

Wilton, E. (2005). Blenheim Air Emission Inventory 2005. Marlborough District Council Report.

Wilton, E. (2008). Annual air quality monitoring report 2007. Marlborough District Council Report.

Wilton, E. (2012a). Assessing trends in PM10 concentrations in Blenheim - 2011. Marlborough District Council Report.

Wilton, E. (2012b). Blenheim Emission Inventory - 2012. Marlborough District Council Report.

Wilton, E., & Baynes, M. (2009). Annaul air quality monitoring report for Blenheim and Picton - 2008. Marlborough District Council Report.