Annual air quality monitoring report for the Wellington region, 2008

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1. Introduction

Greater Wellington Regional Council (Greater Wellington) monitors ambient air quality at seven permanent monitoring stations in the Wellington region. Ambient air is outdoor air where people live, work and play (i.e., does not include air indoors or inside tunnels and vehicles). Air quality depends not only on the amount and types of pollutants discharged to air from human activities, but also on whether meteorological conditions are favourable for dispersion of those pollutants.

This report summarises ambient air quality monitoring data for the Wellington region measured during the 2008 calendar year. Monitoring results are compared against national standards and guidelines for air quality that are designed to protect human health and the environment.

2. Ambient air quality monitoring programme

2.1 Objectives

The objectives of Greater Wellington's ambient air quality monitoring programme are to:

- Provide scientifically robust information about air quality in the Wellington region on which to base sound resource management and policy decisions; and
- Use standard monitoring methods that allow monitoring data to be compared against national guidelines[1] and standards[2].

2.2 Regional airsheds

The Wellington region is divided into eight airsheds, constrained by valleys between steep hills or mountains (Figure 2.1). These airsheds are Wellington City, Karori, Porirua Basin (including Tawa valley and Pauatahanui Inlet), Lower Hutt Valley, Wainuiomata, Upper Hutt Valley, Wairarapa Valley and Kapiti Coast. Each airshed has a distinct microclimate, meteorological conditions and air quality pressures.

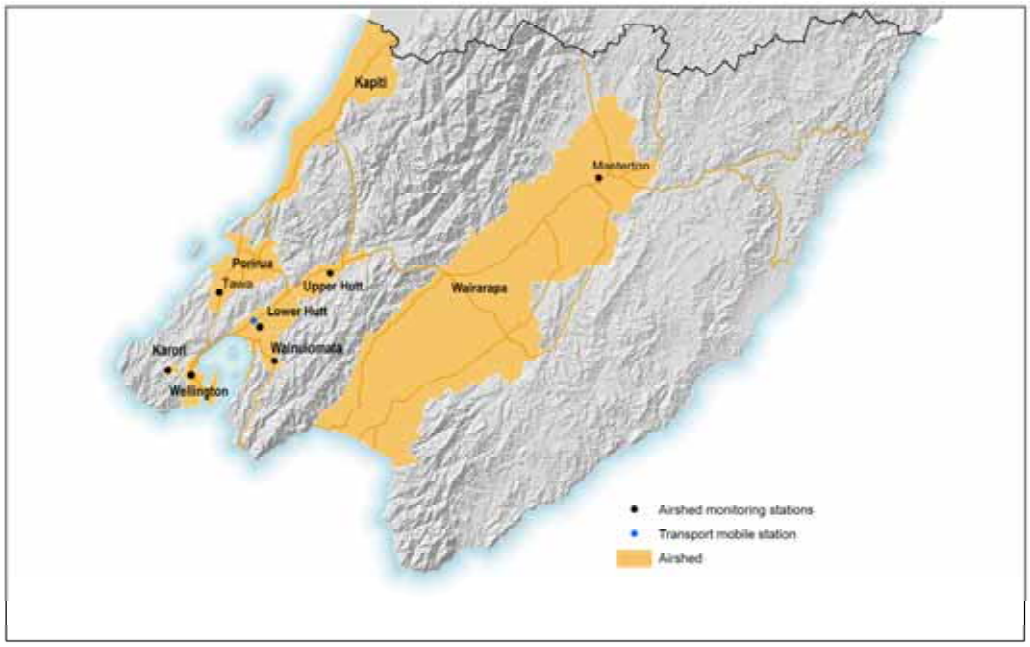


Figure 2.1: Location of air quality monitoring stations within airsheds in the Wellington region

[1] Ambient air quality guidelines 2002 update. Air quality report no. 32. Ministry for the Environment, May 2002.

[2] Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins, and Other Toxics) Regulations 2004.

2.3 Monitoring sites

Permanent monitoring stations are required to assess trends in air quality and to determine compliance with national standards and guidelines. Air quality information is also used for resource management purposes, such as assessing the impact of resource consent proposals. At least three years of continuous data are needed before any trends become evident and useful comparisons can be made between sites. In 2008, Greater Wellington operated seven permanent monitoring sites employing continuous monitoring instruments (Table 2.1).

Meteorological instruments for recording parameters such as wind speed, wind direction and temperature are co-located at each monitoring site to assist with the interpretation of air quality data. Wind roses showing wind speeds and wind direction during the monitoring period at each monitoring site are presented in Appendix 1.

Table 2.1: Permanent air quality monitoring sites operated in 2008 calendar year

Site	Station	Airshed	Location	Pollutants monitored	Site established
Wellington central	Corner V	Wellington City	Corner Victoria & Vivian Streets	PM_{10}, CO, NOx	2004
Lower Hutt	Birch Lane	Lower Hutt Valley	Phil Evans Reserve	PM_{10}, CO, NOx	2001
Wainuiomata	Wainuiomata Bowling Club	Wainuiomata	Moohan Street	PM_{10}	2006
Upper Hutt	Savage Park	Upper Hutt Valley	Savage Crescent	PM_{10}, CO, NOx	2005
Masterton	Wairarapa College	Wairarapa Valley	Cornwell Street	PM_{10}, CO, NOx	2002
Tawa	Duncan Park	Porirua	Linden Street	PM_{10}, CO, NOx	2007
Karori	Terawhiti Bowling Club	Karori	Karori Park	PM_{10}, CO, NOx	2007

2.4 Air pollutants monitored

The pollutants currently monitored in the Wellington region are particulate matter (PM_{10}), carbon monoxide (CO) and nitrogen oxides (NOx) which include nitrogen dioxide (NO_2) and nitric oxide (NO). These are the contaminants emitted in the greatest amounts throughout the region and all have known adverse human health effects when concentrations in air are elevated. The two other pollutants regulated by the national standards, sulphur dioxide (SO_2) and ozone (O_3), are not presently monitored in the region. Meteorological conditions in the region are not usually conducive to the formation of ozone and there are no major point source emissions of sulphur dioxide. Information on how monitored pollutants are reported is presented in Appendix 2.

2.5 National environmental standards and guidelines for air quality

National ambient air quality guidelines (national guidelines) were established by the Ministry for the Environment (MfE) in 1994 and were revised in 2002. Some of these guideline values were adopted as national environmental standards in 2004. The national environmental standards for air quality specify minimum requirements for outdoor air quality that provide a consistent level of protection for human health and the environment.

The relevant national environmental standards and national guidelines for pollutants measured in the region are provided in sections 3 to 6 of this report.

2.6 Air quality reporting categories

A useful way to illustrate the significance of ambient air quality monitoring results is to show the percentage of time that monitoring results fall into different categories (Table 2.2). This method is described by MfE (1997).

Table 2.2: Air quality categories for reporting monitoring results

Category	Measured values	Comment
Action	Exceed guideline/standard	Completely unacceptable by national and international standards.
Alert	Between 66% and 100% of the guideline/standard	A warning level which can lead to guidelines being exceeded if trends are not curbed.
Acceptable	Between 33% and 66% of the guideline/standard	A broad category, where maximum values might be of concern in some sensitive locations, but are generally at a level that does not warrant dramatic action.
Good	Between 10% and 33% of the guideline/standard	Peak measurements in this range are unlikely to affect air quality.
Excellent	Less than 10% of the guideline/standard	Of little concern.

3. Particulate matter (PM_{10})

3.1 Sources and health effects

Particulate matter (PM) is a mixture of solid particles and liquid droplets that are dispersed in air. PM_{10} is that portion of particulate matter with an equivalent aerodynamic cross-section less than 10 micrometres. This size fraction is small enough to be inhaled into the respiratory system.

Particulate matter arises from human activities and from natural sources. Sources of PM_{10} in the Wellington region include:

- Domestic solid fuel heating (e.g., wood burners)
- Motor vehicles, particularly from diesel-fuelled vehicles
- Industrial combustion processes
- Quarrying activities
- Natural sources such as sea salt and wind-blown soil particles

Epidemiological studies show adverse health effects from both short-term and long-term exposure to PM_{10}. However, a threshold below which there are no observed adverse effects has not been reliably established to date.

The adverse health effects associated with exposure to PM_{10} range from increases in the number of restricted activity days to increases in hospital admissions and premature deaths for people with existing lung and heart disease.

3.2 Monitoring method

PM_{10} is monitored by Rupprech & Patashnick TEOM series 1400AB Ambient Particulate Monitors at Masterton, Tawa and Lower Hutt; and by ThermoElectron Corp FH62 C14 beta attenuation monitors at the remainder of the stations. Both of these instruments are designated as automated methods equivalent to the United States Code of Federal Regulations (Title 40 – Protection of the Environment, Volume 2, Part 50, Appendix J: Reference Method for the Determination of Particulate Matter as PM_{10} in the Atmosphere) and therefore comply with the monitoring method specified by the national standard.

3.3 National standards and guidelines

The short-term daily average limit set by the national standard and the long term annual average national guideline value are both designed to minimise (not eliminate) adverse health effects associated with PM_{10} exposure. Table 3.1 presents the national standard and guideline values for PM_{10}.

Table 3.1: National standard and guideline values for PM_{10}

PM_{10}	Threshold concentration	Averaging period	Permissible exceedences per year
Standard	50 µg/m^3	24-hour mean	One 24-hour period
Guideline	20 µg/m^3	Annual	-

3.4 Monitoring results

3.4.1 National standard (24-hour average)

Ambient 24-hour PM_{10} concentrations recorded at the various air quality monitoring sites within the Wellington region are shown in Table 3.2. There was one exceedence of the national standard at Wellington central and three exceedences at Masterton during 2008.

Table 3.2: Annual statistics PM_{10} (24-hour average) for the 2008 calendar year

PM_{10} µg/m^3	Wellington Central	Lower Hutt	Wainuiomata	Upper Hutt	Masterton	Tawa	Karori
Maximum	60	31	41	31	59	32	28
2nd highest value	32	26	40	29	52	30	28
95th percentile	23	22	25	21	33	25	20
Mean	14	14	11	11	15	16	12
Median	14	13	10	10	12	15	11
Interquartile range	11 – 16	11-16	8-14	8-14	9-17	12-19	9-14
Valid data	98.6%	98.9%	99.7%	98.6%	100%	99.7%	98.1%

3.4.2 National guideline (annual average)

All annual averages were below the national guideline (Figure 3.1)

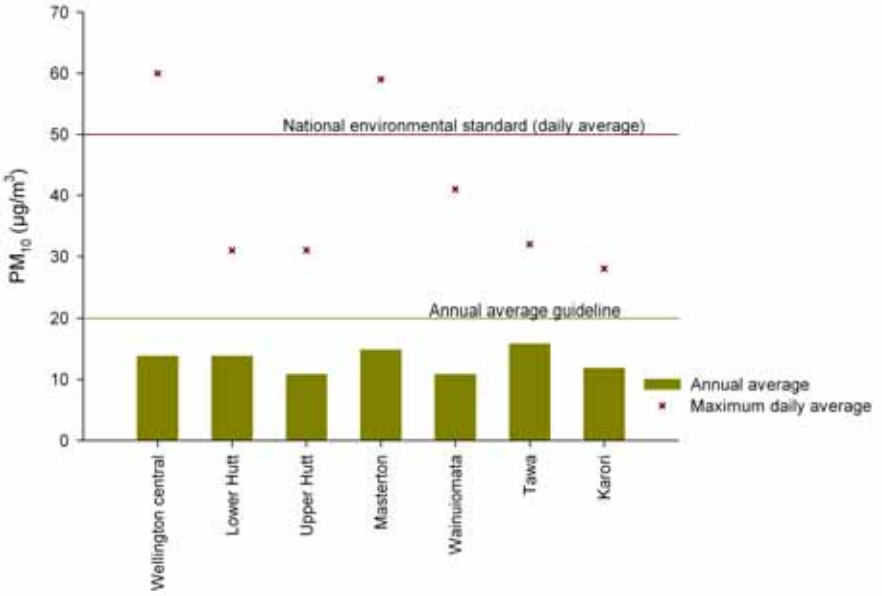


Figure 3.1: PM_{10} annual average concentrations and maximum daily concentration for the 2008 calendar year

3.4.3 Air quality reporting categories (24-hour average)

Ambient PM_{10} daily averages are reported as the percentage of days per year in each air quality category described in Section 1.6 (Figure 3.2). A breakdown of the actual number of days in 2008 by air quality category is given in Appendix 3 (Table A3.1). There were seven days in Wainuiomata and fifteen days in Masterton where the 'alert' level was reached. There were three days in Masterton and one day in Wellington Central where the 'action' level (equivalent to exceeding the national standard) was reached.

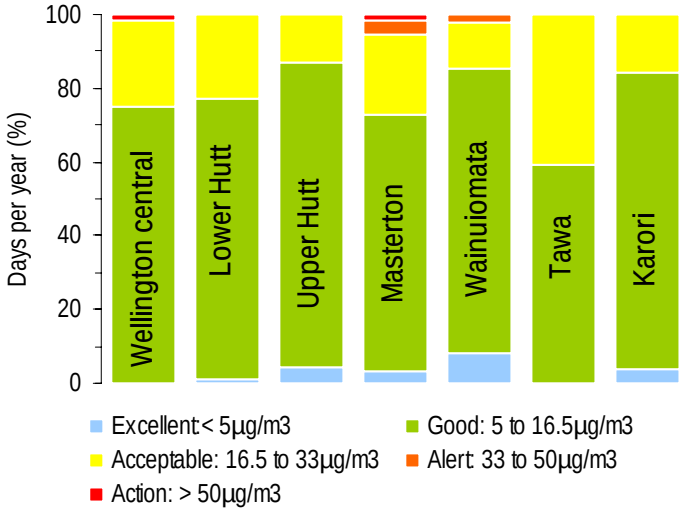


Figure 3.2: PM_{10} (24-hour average) by air quality reporting category for the 2008 calendar year

3.5 PM_{10} exceedence days

During the reporting period the threshold concentration for PM_{10} was exceeded in Masterton on 13 June 2008 (59 µg/m^3), 14 July 2008 (52 µg/m^3) and on

6 August 2008 (51 µg/m^3). The Wairarapa airshed did not comply with the national standard in 2008 as the standard allows only one 24-hour period per 12-month period to exceed the 50 µg/m^3 threshold concentration. The two breaches of the Wairarapa airshed were publicly notified in accordance with the requirements of the national environmental standard. The public notices issued for these breaches are presented in Appendix 4.

PM_{10} exceedences are very dependent on winter meteorological conditions. Typically on cold, clear and still nights, dispersion of PM_{10} emitted by domestic fires is inhibited. Figure 3.3 shows the PM_{10} exceedence recorded at Masterton on 14 July 2008. The peak hourly PM_{10} concentration measured at 9 pm coincided with low temperatures and low wind speed.

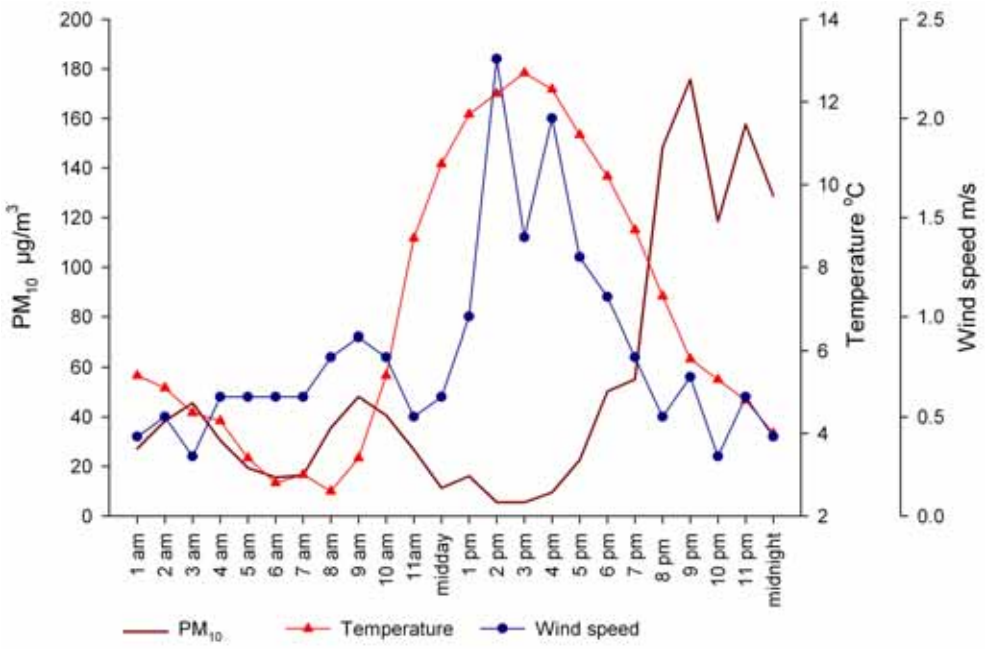


Figure 3.3: PM_{10} exceedence of 52 µg/m^3 measured at Masterton on 14 July 2008

The exceedence recorded at Wellington Central on 28 June 2008 (60 µg/m^3) is atypical as the highest concentrations of PM_{10} were recorded in the middle of the day - outside normal computer rush hour. It is likely that the elevated PM_{10} was due to a local source, other than traffic.

3.6 Air quality management for particulate matter (PM_{10})

The national standard mandates regional councils to demonstrate that they will meet the standard for PM_{10} in their nominated airsheds by 2013 or face restrictions on the granting of resource consents to discharge particulate matter in non-complying airsheds. The Wairarapa Valley and Wainuiomata Valley experience occasional exceedences and Greater Wellington must be assured that, given an unfavourable winter, the emissions in these airsheds will be low enough that the national standard is not breached in the years following 2013. Variations in air quality is driven by meteorology as well as by levels of domestic woodburner emissions. Peak PM_{10} concentrations in Wairarapa and Wainuiomata are close to the threshold limit - therefore these airsheds have the

potential to dip in and out of compliance from year to year, depending of the type of winter experienced.

Regional councils are required to develop emission reduction strategies to ensure an incremental year-on-year improvement in air quality until the standard is met by 2013. The national standard refers to this predicted annual improvement in air quality as the 'straight line path'.

Straight line paths for Masterton and Wainuiomata are shown in Figures 3.4 and 3.5 respectively. The starting points for the straight line paths are based on the second highest maximum concentration recorded in the airshed. Wainuiomata's start point is based on high volume monitoring data and Masterton is based on TEOM data that have been adjusted upwards for FH62 equivalency. The straight line paths show the predicted percentage reduction in emissions necessary to ensure there will be no more than one allowable exceedence per year by 2013.

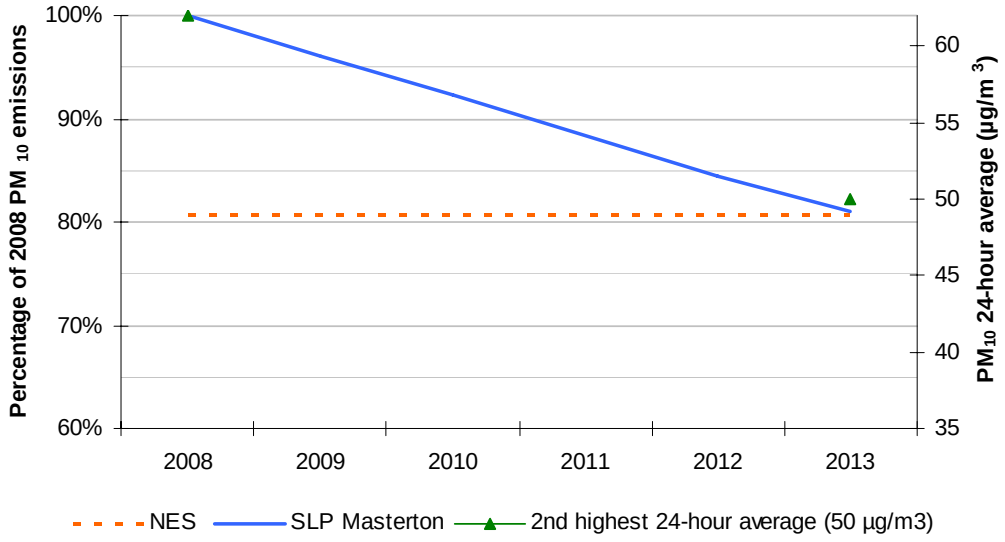


Figure 3.4: Masterton straight line path started at 62 µg/m^3 in 2008

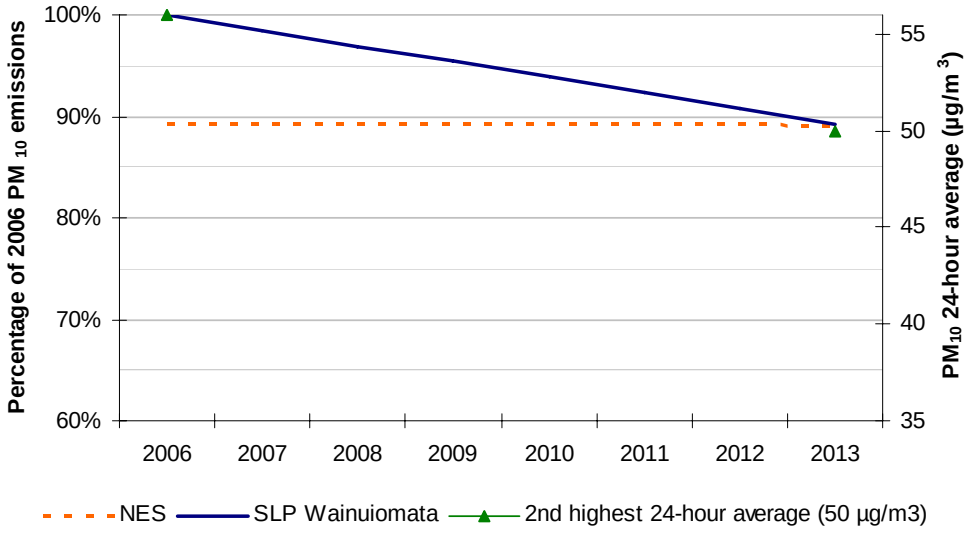


Figure 3.5 Wainuiomata straight line path started at 56 µg/m^3 in 2006

Wainuiomata is likely to comply with the national standard by 2013 as households replace their old woodburners at the end of their working life with modern low emission models (Wilton 2008). The Masterton urban area is predicted to require an eight per cent decrease in domestic emissions from 2008 levels to ensure that national standard is not breached after 2013.

4. Carbon monoxide

4.1 Sources and health effects

Carbon monoxide (CO) is a colourless and odourless gas produced by the incomplete combustion of carbon-containing fuels such as petrol and diesel used by motor vehicles or wood and coal used by domestic appliances or industrial boilers. Motor vehicles are the main source of carbon monoxide in urban areas.

When inhaled, carbon monoxide reduces the oxygen carrying capacity of the blood and, depending on its concentration, causes a range of adverse health effects.

4.2 Monitoring method

Carbon monoxide is monitored using CO Gas Filter Correlation Infrared Analysers in accordance with AS3580.7.1:1992. API 300 series analysers are employed at all stations apart from Tawa where an Ecotech ML 9830 instrument is used.

4.3 National standards and guidelines

The national standards and guidelines for carbon monoxide are set at a level to protect susceptible people, such as those with existing heart disease, children and developing foetuses. Table 4.1 presents the national standard and guideline values for carbon monoxide.

Table 4.1: National standard and guideline values for carbon monoxide

Carbon monoxide	Threshold concentration	Averaging period	Permissible exceedences per year
Standard	10 mg/m^3	8-hour moving average	One 8-hour period
Guideline	30 mg/m^3	1-hour average	-

4.4 Monitoring results

4.4.1 National standard (8-hour moving average)

Ambient concentrations of carbon monoxide measured at the various sites in the region are shown in Table 4.2. All concentrations were well within the national standard for carbon monoxide during the reporting period.

Average levels of carbon monoxide in air are low and reflect the national trend for lower vehicle emissions due to improvements in emissions control technology brought about by modernisation of New Zealand's vehicle fleet.

Table 4.2: Annual statistics carbon monoxide (8-hour moving average) for the 2008 calendar year

Carbon monoxide mg/m^3	Wellington Central	Lower Hutt	Upper Hutt	Masterton	Tawa	Karori
Maximum	3.1	1.8	1.9	3.7	2.2	1.7
95th percentile	1.6	0.7	1.0	1.2	0.9	0.6
Mean	0.6	0.2	0.3	0.3	0.2	0.1
Median	0.5	0.2	0.2	0.2	0	0
Interquartile range	0.3 - 0.9	0 - 0.3	0.1 - 0.4	0 - 0.3	0 - 0.2	0 - 0.1
Valid data	98.9%	96.8%	96.9%	98.6%	99.2	98.8%

4.4.2 National guideline (1-hour average)

All hourly average carbon monoxide concentrations were well within the national guideline of 30 mg/m^3 (1-hour average). Hourly concentrations of carbon monoxide measured at Wellington Central show distinct peaks at the time of rush-hour traffic (Figure 4.1). Concentrations measured at the other sites (less so at Lower Hutt) exhibit a lower peak later in the evening due to the influence of domestic fires in winter.

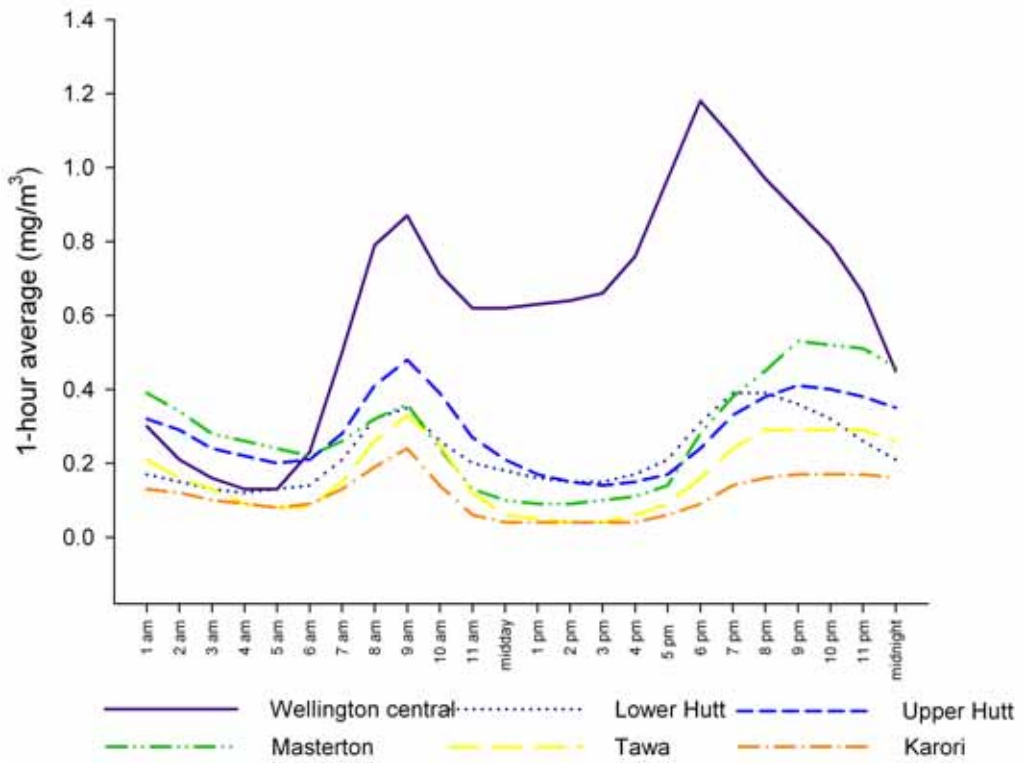


Figure 4.1: Ensemble of 1-hour average carbon monoxide for the 2008 calendar year

4.4.3 Air quality reporting categories

The concentrations of carbon monoxide in air are reported as a percentage of the number of 8-hour moving averages per year in each air quality category (Figure 4.2). At all monitoring sites concentrations of carbon monoxide were mostly 'excellent'. A breakdown of the number of hours in each category is given in Appendix 3 (Table A3.2).

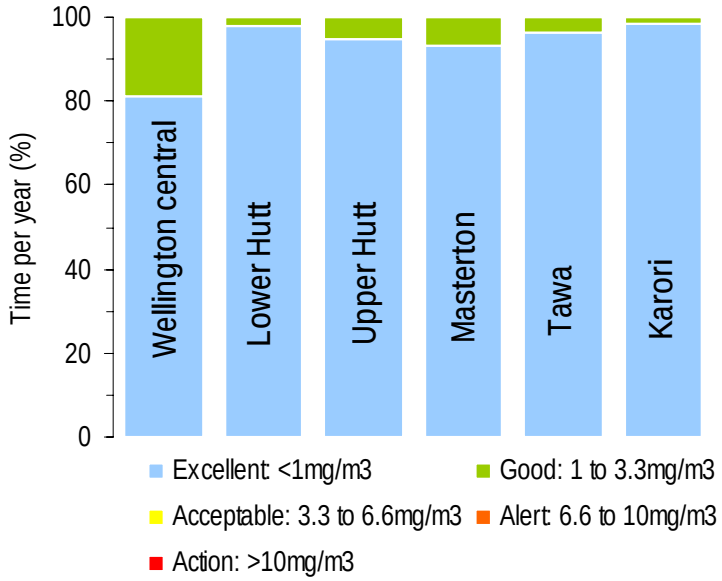


Figure 4.2: Carbon monoxide (8-hour moving average) by air quality category for the 2008 calendar year

5. Nitrogen dioxide

5.1 Sources and health effects

Nitrogen dioxide (NO_2) arises from combustion processes, with vehicle emissions being the main source in urban areas. Vehicle exhausts contain a mixture of nitrogen dioxide and nitric oxide (NO), collectively known as oxides of nitrogen (NOx). Most of the NOx discharged from vehicle exhausts is in the form of nitric oxide which is subsequently converted to nitrogen dioxide by oxidation.

Nitrogen dioxide appears as a brown and acidic gas in the atmosphere and can be seen as a haze over some cities during periods of calm weather and heavy traffic congestion. As well as contributing to poor visibility, nitrogen dioxide has adverse health effects such as lung inflammation and eye, nose and throat irritation.

5.2 Monitoring method

Nitrogen dioxide is monitored using NOx Chemiluminscence Analysers in accordance with AS3580.5.1:1993. API 200 series analysers are used at all air quality monitoring stations apart from Tawa where an Ecotech ML 9841B instrument is used.

5.3 National standards and guidelines

The national standard and national guideline concentration thresholds are designed to protect children, asthmatics and adults with chronic respiratory and cardiac conditions. Table 5.1 shows the applicable national standard and guideline values.

Table 5.1: National standard and guideline values for nitrogen dioxide

Nitrogen dioxide	Threshold concentration	Averaging period	Permissible exceedences per year
Standard	200 µg/m^3	1-hour average	9 hours
Guideline	100 µg/m^3	24-hour average	-

5.4 Monitoring results

5.4.1 National standard (1-hour average)

A summary of 1-hour average concentrations of nitrogen dioxide measured throughout the region is presented in Table 5.2. The national standard was not exceeded at any time during the reporting period.

Table 5.2: Annual statistics nitrogen dioxide (1-hour average) for the 2008 calendar year

Nitrogen dioxide µg/m^3	Wellington Central	Lower Hutt	Upper Hutt	Masterton	Tawa	Karori
Maximum	100.7	58.5	53.5	57.7	52.5	45.7
95th percentile	67.7	32.9	27.9	23.1	27.6	16.0
Mean	35.8	11.7	9.3	6.6	9.9	3.7
Median	33.3	8.4	6.1	3.7	7.0	1.7
Interquartile range	22.6 – 47.3	4.8 – 15.6	3.4 – 12.6	2.0 – 8.0	4.2 – 13.2	0.7 – 3.9
Valid data	96.2%	96.9%	96.1%	96.3%	97.5%	97.2%

Nitrogen dioxide concentrations recorded at the Lower Hutt, Upper Hutt, Masterton and, to a lesser extent, Karori monitoring sites show daily peaks coinciding with commuter traffic times. As expected, the Wellington Central site experiences the highest nitrogen dioxide concentrations due to larger traffic volumes (Figure 5.1).

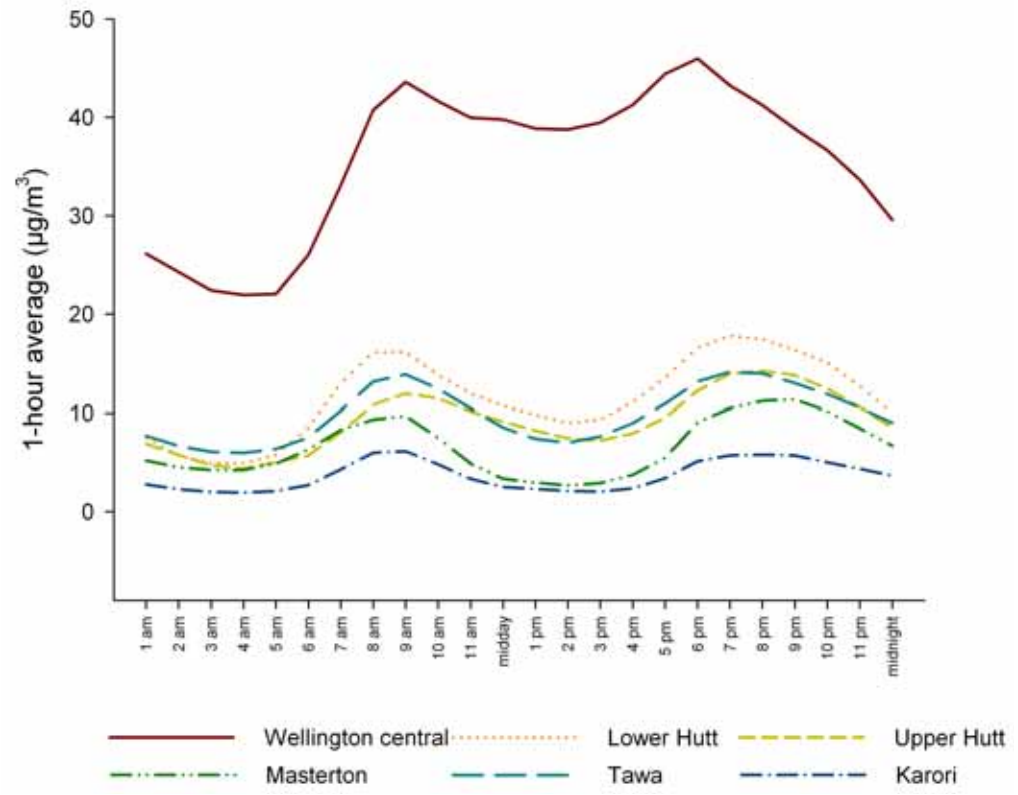


Figure 5.1: Ensemble of 1-hour average nitrogen dioxide for the 2008 calendar year

5.4.2 National guideline (24-hour average)

A summary of 24-hour concentrations of nitrogen dioxide measured during 2008 is presented in Table 5.3. Air quality was well within the national guideline at all times during the reporting period.

Table 5.3: Annual statistics nitrogen dioxide (24-hour average) for the 2008 calendar year

Nitrogen dioxide µg/m^3	Wellington Central	Lower Hutt	Upper Hutt	Masterton	Tawa	Karori
Maximum	66.1	33.0	27.6	24.0	26.3	19.5
95th percentile	53.8	22.0	19.2	16.9	21.0	10.8
Mean	35.6	11.6	9.3	6.6	9.8	3.7
Median	35.7	10.6	8.0	5.1	8.7	2.6
Interquartile range	26.2 – 45.6	6.6 – 16.1	4.8 – 13.0	3.5 – 8.2	5.7 – 13.0	1.2 – 4.9
Valid data	97.8%	97.5%	98.1%	97.0%	96.7%	98.6%

5.4.3 Air quality reporting categories

The concentrations of nitrogen dioxide in air are reported as a percentage of the number of hours per year in each air quality category (Figure 5.2). At all monitoring sites except Wellington Central, concentrations of nitrogen dioxide were mostly ‘excellent’. A breakdown of the number of hours in each category is given in Appendix 3 (Table A3.3).

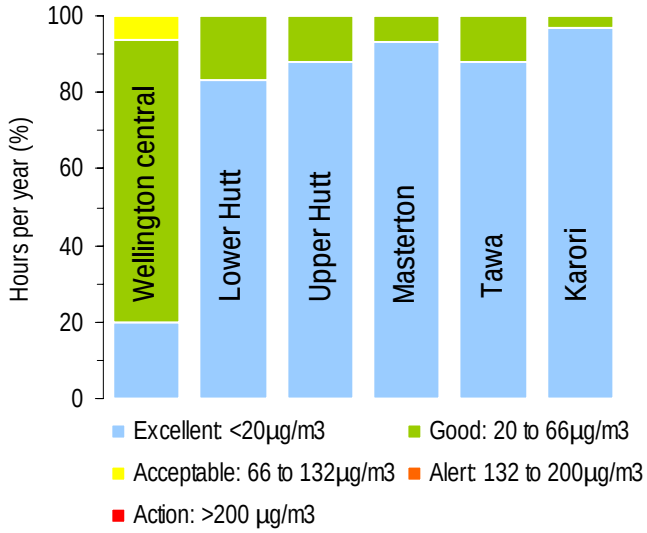


Figure 5.2: Nitrogen dioxide (1-hour average) by air quality category for the 2008 calendar year

6. Air quality investigations

6.1 Roadside air quality

In conjunction with Greater Wellington's Transport Strategy Development Department and in addition to the permanent monitoring station in central Wellington, mobile air quality stations are used to monitor air quality near busy roads to assess the impact of traffic emissions on local air quality. Two locations were monitored during 2008, the Ngauranga Gorge (Centennial Highway, Wellington) and the Melling bridge intersection (SH 2, Lower Hutt). Only the results of air quality monitoring at Melling are presented as the mobile station located at Ngauranga Gorge was removed on 30 June 2008.

The results of air quality monitoring undertaken at Melling station in 2008 are presented as pie charts in Figure 6.1. Using the air quality reporting categories described in Section 2.6, air quality at Melling was 'acceptable' or better during 2008.

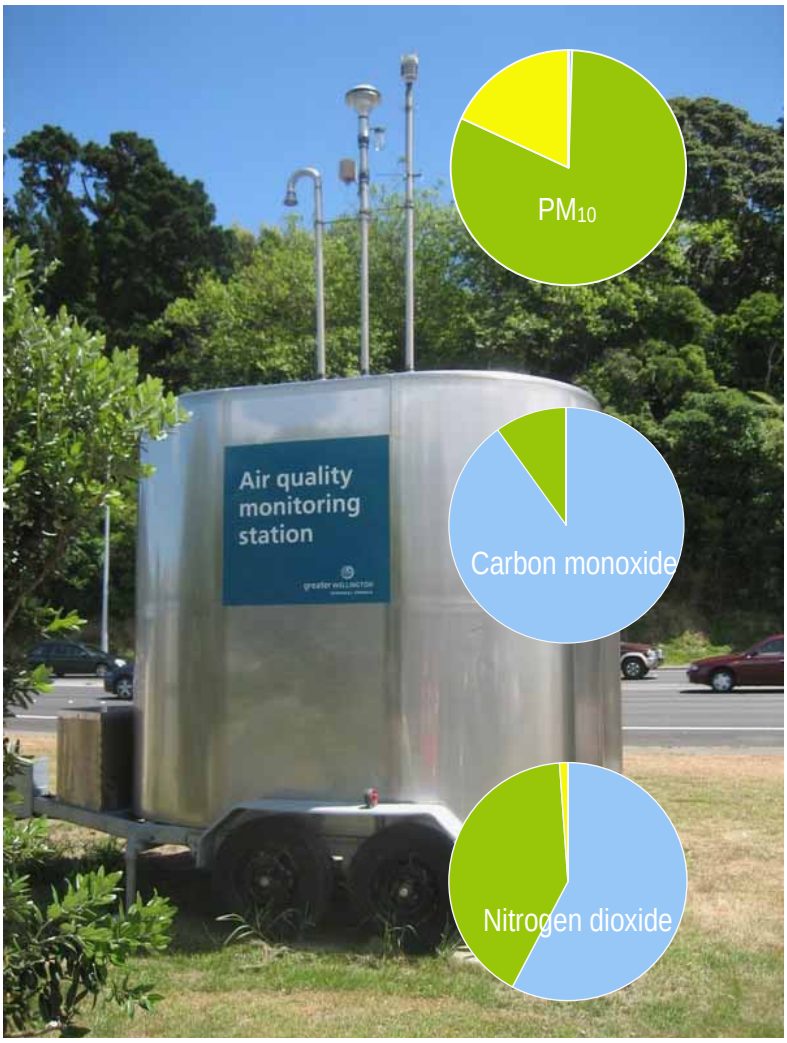


Figure 6.1: Air quality mobile monitoring station at Melling intersection (Lower Hutt) and monitoring results by air quality reporting category for 2008 calendar year

6.2 Sources of air pollution in Wainuiomata

In collaboration with GNS Science, a source apportionment study using receptor modelling was undertaken to identify the sources of particulate pollution in Wainuiomata (Davy et al. 2009). Samples of PM_{10} were collected as two size fractions - fine particulate matter ($PM_{2.5}$) and coarse particulate matter ($PM_{2.5-10}$) - from September 2006 to September 2008 at the air quality monitoring station in Moonhan Road, Wainuiomata. Elemental fingerprints of the air particulate samples were then used to determine the different sources of the fine and coarse particulate matter measured in air.

$PM_{2.5}$ is produced by combustion and contains inorganic ions, carbon, organic aerosols and metals. In Wainuiomata, the major sources of $PM_{2.5}$ were found to be local emissions from domestic fires and vehicles, and secondary sulphate from sources outside the airshed. $PM_{2.5}$ causes the most harm to people's health because smaller particles can penetrate deeper into the lungs.

Coarse particles ($PM_{2.5-10}$) arise when rocks and soils are crushed by mechanical processes, such as earthworks or quarrying. Sea spray and wind-blown soils are common natural sources of coarse particulate. In Wainuiomata, the principal source of coarse particulate is sea-salt, followed by road dust and soil. Road dust, produced as cars drive over the road surface, contains copper and zinc from wear of brake linings and pads.

For much of the year natural sources make up most of the PM_{10} in Wainuiomata's air. However, $PM_{2.5}$ produced by domestic fires makes up most of the PM_{10} measured on high pollution days in winter. Meteorology also plays an important role in pollution episodes. PM_{10} concentrations are more likely to be high on days where the average temperature is less than $10^{o}C$ and average wind speed is less than 2 m/s.

Figure 6.2 shows the relative source contributions to the concentrations of fine and coarse particulate for days when PM_{10} concentrations were elevated. Note these monitoring results cannot be directly compared to the national environmental standard as a non-standard monitoring method was used.

Domestic fires were also found to be a source of arsenic in air, most likely arising from the burning of timber treated with copper-chrome-arsenic preservative. During winter, on average, organic carbon made up about 20 % of PM_{10}. Most of the organic carbon arises from wood smoke and was found to contain toxic compounds such as polycyclic aromatic hydrocarbons (PAHs).

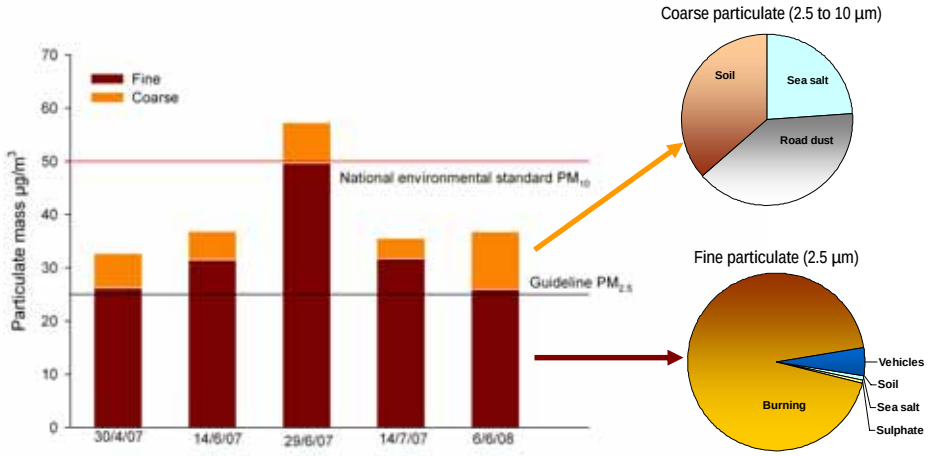


Figure 6.2: Relative source contributions to PM_{10} concentrations on winter days in Wainuiomata when pollution levels were elevated

7. Summary

- Apart from three days in Masterton and one day in central Wellington, particulate matter (PM_{10}) concentrations measured in the region were below the national environmental standard.

- The Wairarapa airshed did not comply with the national environmental standard in 2008 because there was more than one permitted exceedence of the PM_{10} daily limit at the Masterton monitoring station. An eight per cent reduction in domestic emissions in the Masterton urban area, from 2008 levels, is required to ensure that the national environmental standard will be met by 2013.

- During winter there were 15 days in Masterton and seven days in Wainuiomata where the 'alert' level for PM_{10} was reached (i.e., daily concentrations are above 66 percent of the limit allowed by the standard). On 'alert' days most of the PM_{10} in air is made up of fine particulate matter ($PM_{2.5}$). $PM_{2.5}$ causes the most harm to people's health because smaller particles can penetrate deeper into the lungs.

- Concentrations of two pollutants produced by vehicles, carbon monoxide and nitrogen oxides, were well within national environmental standards and guidelines at all monitoring stations. As expected, roadside air quality measured in central Wellington and at Melling intersection is poorest during peak commuter times.

- An air pollution study in Wainuiomata found that the principal source of PM_{10} during high pollution days in winter was domestic burning. Toxic compounds associated with woodsmoke were also detected in air during the winter months. For most of the year sea-salt and soils are the main sources of PM_{10} in Wainuiomata's air.

8. References

Davy, P.; Trompetter, W.; Markwitz, A. 2009. *Source apportionment of airborne particles at Wainuiomata, Lower Hutt.* GNS Science Consultancy Report 2009/188. July 2009.

Ministry for the Environment. 1997. *Environmental Performance Indicators. Proposals for air, fresh water, and land*. Ministry for the Environment, Wellington.

Ministry for the Environment. 2009. *Good-practice guide for air quality monitoring and data management 2009.* ME 933. Ministry for the Environment, Wellington. April 2009.

Wilton, E. 2008. *Management of PM_{10} in Masterton, Upper Hutt and Wainuiomata: An assessment of options to achieve National Environmental Standards.* Environet Ltd, Christchurch. September 2008.

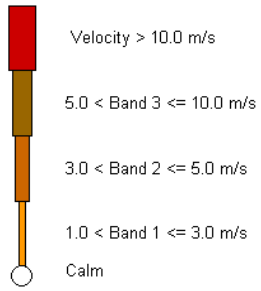
Acknowledgements

The work of Darren Li and Karl Watson in operating and maintaining monitoring equipment and stations is gratefully acknowledged. Thanks also to Jon Marks and his team for installing and maintaining the meteorological and communications equipment.

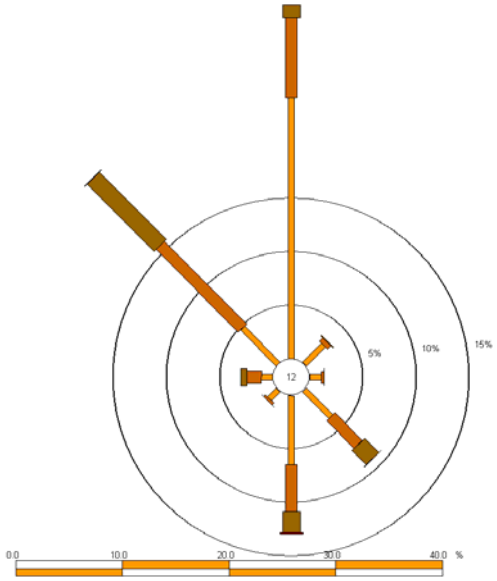
Appendix 1: Wind roses at monitoring sites

Wind speed and direction were recorded at all permanent air quality monitoring stations during the 2008 calendar year. The wind roses below show the percentage frequency of wind speeds (metres per second) recorded in five wind speed bands by eight main wind direction ranges. The number in the centre of the rose is the percentage frequency of calms (defined in this case as wind speeds less than 1 m/s). The bar points towards the direction the wind is blowing from.

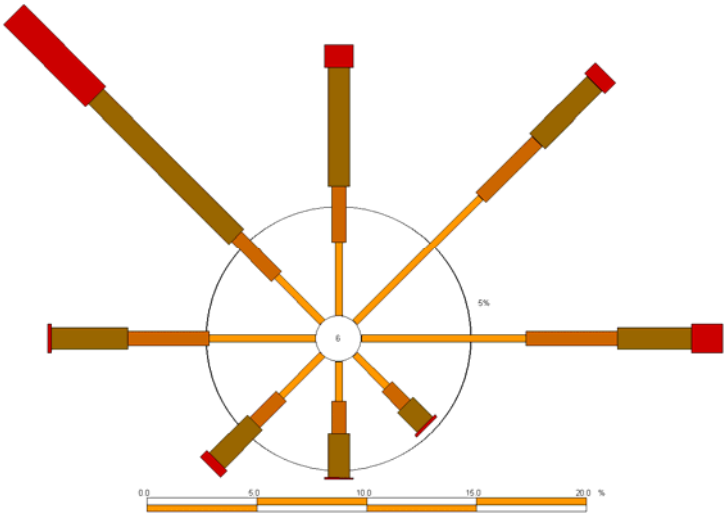
Key to wind speed bands



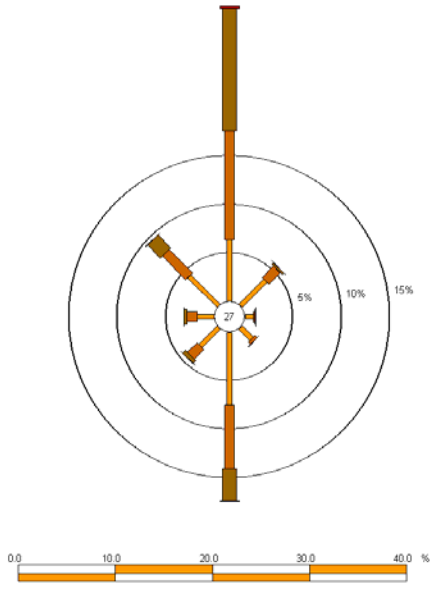
Lower Hutt: 1 January 2008 to 31 December 2008 (10 m)



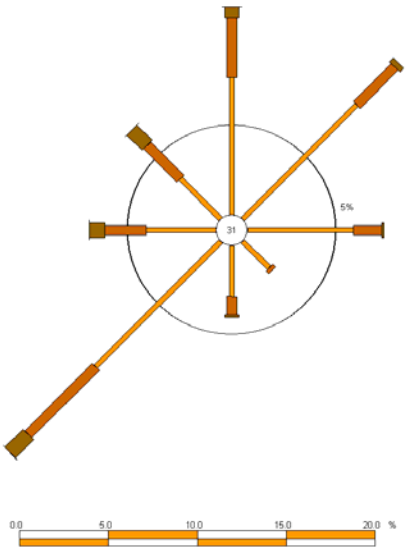
Upper Hutt: 1 January 2008 to 31 December 2008 (10 m)



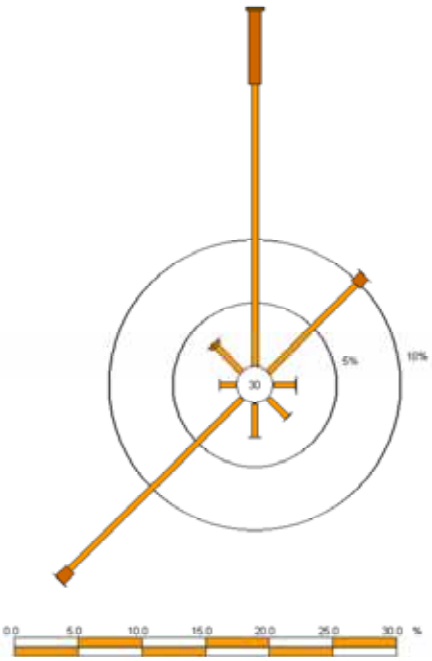
Wainuiomata: 1 January 2008 to 31 December 2008 (10 m)



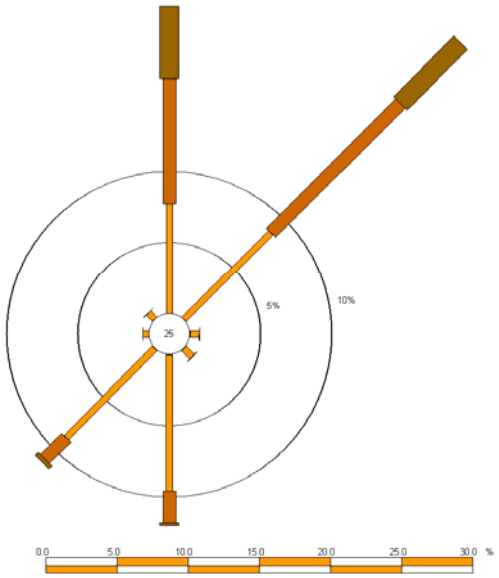
Masterton: 1 January 2008 to 31 December 2008 (10 m)



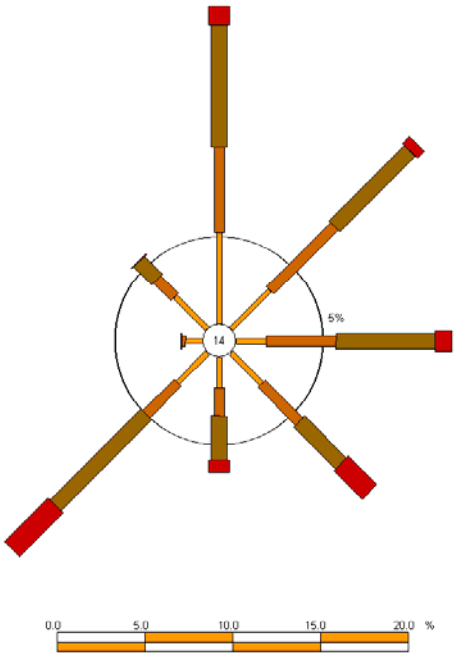
Wellington Central: 1 January 2008 to 31 December 2008 (4 m)



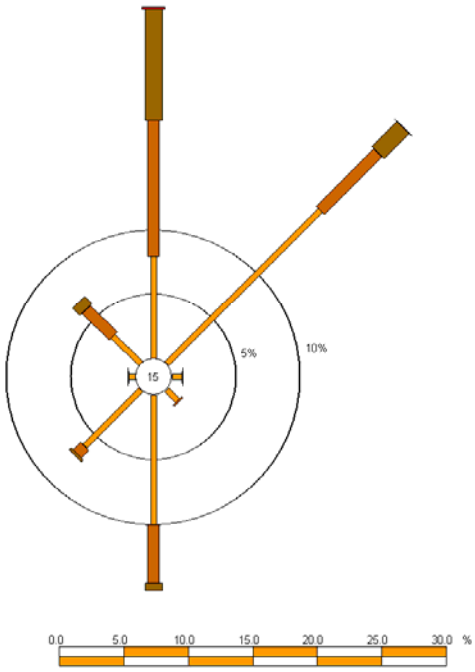
Tawa: 1 January 2008 to 31 December 2008 (6 m)



Karori: 1 January 2008 to 31 December 2008 (6 m)



Shandon Golf Course: 1 January 2008 to 31 December 2008 (10 m)



Appendix 2: Data presentation methods

Quality assurance

Greater Wellington's Environmental Monitoring and Investigations Department collects, checks and archives air quality data in accordance with a Quality Management System based on the requirements of AS/NZ ISO 9001:2000. Data may be amended or revised, where necessary and without notice, at any time.

Data averaging

All pollutants are monitored continuously with instruments that are connected by digital interface to dataloggers. All logged data are stored as five or 10 minute averages at New Zealand Standard Time (NZST).

- Daily means are defined as the period from midnight to midnight.
- 8-hour moving means are calculated on the hour for the preceding eight hour period

Valid data

A 75 per cent data capture threshold is required for an averaging period to be considered valid and therefore be included in the calculation of summary statistics. Therefore, an hourly average requires at least four 10 minute averages and a 24-hour mean requires at least 18 one-hour averages.

Data precision

In accordance with MfE good practice (MfE 2009), reported PM_{10} values have been rounded up to the nearest whole number and carbon dioxide and nitrogen dioxide values are reported to one significant figure.

Percentiles

The reported percentiles for each contaminant are interpolated from the data and therefore do not necessarily represent actual values.

Appendix 3: Air quality reporting categories

Table A3.1: PM_{10} - number of days (24-hour average) in 2008 by air quality category

Monitoring sites	Total days sampled	Excellent < 5 µg/m³	Good 5 to 16.5 µg/m³	Acceptable 16.5 to 33 µg/m³	Alert 33 to 50 µg/m³	Action > 50 µg/m³
Wellington central	360	0	273	87	0	0
Lower Hutt	362	4	275	83	0	0
Wainuiomata	365	29	283	46	7	0
Upper Hutt	361	15	298	48	0	0
Masterton	366	13	255	80	15	5
Tawa	365	0	217	148	0	0
Karori	359	13	289	57	0	0

Table A3.2: CO - number of hours (8-hour moving average) in 2008 by air quality category

Monitoring sites	Total no. hours sampled	Excellent < 1 mg/m³	Good 1 to 3.3 mg/m³	Acceptable 3.3 to 6.6 mg/m³	Alert 6.6 to 10 mg/m³	Action > 10 mg/m³
Wellington central	8691	7060	1631	0	0	0
Lower Hutt	8501	8311	190	0	0	0
Upper Hutt	8514	8065	449	0	0	0
Masterton	8658	8074	584	0	0	0
Tawa	8711	8384	327	0	0	0
Karori	8677	8572	105	0	0	0

Table A3.3: NO_2 - number of hours (1-hour average) in 2008 by air quality category

Monitoring sites	Total no. hours sampled	Excellent < 20 µg/m³	Good 20 to 66 µg/m³	Acceptable 66 to 133 µg/m³	Alert 133 to 200 µg/m³	Action > 200 µg/m³
Wellington central	8451	1675	6266	510	0	0
Lower Hutt	8509	7063	1446	0	0	0
Upper Hutt	8438	7436	1002	0	0	0
Masterton	8458	7904	554	0	0	0
Tawa	8561	7512	1049	0	0	0
Karori	8540	8277	263	0	0	0

Appendix 4: Public notices for breaches of national standard

Wairarapa Times Age: 26 July 2008

Breach of the National Environmental Standard for Air Quality

In accordance with regulation 16 of the Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulations 2004, referred to as the NESAQ, the Wellington Regional Council gives notice that the NESAQ for PM_{10} (airborne particles 10 microns or less in diameter) has been breached in the Wairarapa airshed.

The following PM_{10} concentrations were recorded by the Masterton monitoring station at Wairarapa College:

- 13 June 2008 59 µg/m3
- 14 July 2008 52 µg/m3

The NESAQ for PM_{10} allows the threshold of 50 µg/m3 (24-hour average, measured from midnight to midnight) to be exceeded only once in a 12-month period.

Further information is available at: **www.gw.govt.nz/airquality**

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Wairarapa Times Age: 30 August 2008

Breach of National Environmental Standard for Air Quality

In accordance with regulation 16 of the Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulations 2004, referred to as the NESAQ, the Wellington Regional Council gives notice that the NESAQ for PM_{10} (airborne particles 10 microns or less in diameter) has been breached in the Wairarapa airshed. The following PM_{10} concentrations were recorded by the Masterton monitoring station at Wairarapa College:

- **13 June 2008** 59 µg/m³
- **14 July 2008** 52 µg/m³
- **6 August 2008** 51 µg/m³

The NESAQ for PM_{10} allows the threshold of 50 µg/m³ (24-hour average, measured from midnight to midnight) to be exceeded only once in a 12-month period.

Further information is available at **www.gw.govt.nz/airquality**

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Photo Credit
Air quality monitoring station in central Wellington

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