

## 13 Trends in PM<sub>10</sub> Concentrations in New Zealand

The distribution of guideline value exceedences and maximum PM<sub>10</sub> concentrations across the country is shown in Figure 13.1 and Table 13.1. These data are based on conversions to a gravimetric equivalent for data collected using the TEOM (see Section 13.1) and extrapolations to annual estimates. With the exception of Wellington and Canterbury, they are for 24-hour averages based on a fixed monitoring period from midnight to midnight. For Wellington, data are based on a rolling 24-hour average for Lower and Upper Hutt and a fixed period from midday to midday for other sites. In Canterbury, all results are for the period 9 am to 9 am. Both reporting times are likely to provide a better indication of the PM<sub>10</sub> concentrations for these areas than a midnight-to-midnight averaging period. This is because the latter approach would split the pollution episodes across two days, providing an estimate of the PM<sub>10</sub> concentrations, which is less than the maximum 24-hour average exposure. Figure 13.2 shows the PM<sub>10</sub> monitoring results for each site within the air quality categories.

Results indicate that the PM<sub>10</sub> ambient air quality guideline value of 50 µgm<sup>-3</sup> (24-hour average) has been exceeded at the following locations:

- Auckland
- Hamilton
- Tokoroa
- Taupo
- Whangarei
- Rotorua
- Upper Hutt
- Lower Hutt
- Masterton
- Otaki
- Napier
- Wainuiomata
- Nelson
- Richmond
- Whakatane
- Timaru
- Ashburton
- Blenheim
- Kaiapoi
- Oamaru
- Christchurch
- Mosgiel
- Arrowtown
- Rangiora
- Dunedin
- Cromwell
- Alexandra
- Balclutha

In most areas, guideline value exceedences occur during the winter months under low wind speed and temperature inversion conditions. Emission inventory studies suggest domestic home heating is the main source of PM<sub>10</sub> emissions in most areas, although it is likely that motor vehicles are a key contributor in Auckland where a large proportion of the country's population resides. Air quality monitoring for that area indicates that the 24-hour average guideline value has been or is likely to have been exceeded at both the Henderson and Takapuna monitoring sites. Although annual average data for Auckland are limited, results suggest concentrations in excess of guideline values are likely to occur at Mt Eden, Takapuna and Henderson.

In the areas of Otaki and Whangarei, the measured guideline value exceedences have occurred during the summer months. Likely sources of these elevated levels include sea spray and dusts in Otaki (Perry Davy, WRC, personal communication, 2002) and dusts from local industry in Whangarei (Paul Baynham, NRC, personal communication, 2002).

It should also be noted that air quality monitoring in the areas of Canterbury, Lower Hutt, Upper Hutt, Hamilton, Te Kuiti, Rotorua and Tauranga have been carried out using the TEOM method, which underestimates PM<sub>10</sub> concentrations relative to the high-volume sampling method proposed in the ambient air quality guidelines (MfE and MoH, 2002). It is therefore possible that the areas of Tauranga and Te Kuiti also measure PM<sub>10</sub> concentrations in excess of the 2002 ambient air quality guideline values. An estimate of potential PM<sub>10</sub> concentrations in these locations based on relationships between the TEOM and high volume sampling methods for Christchurch is presented in Section 13.1.

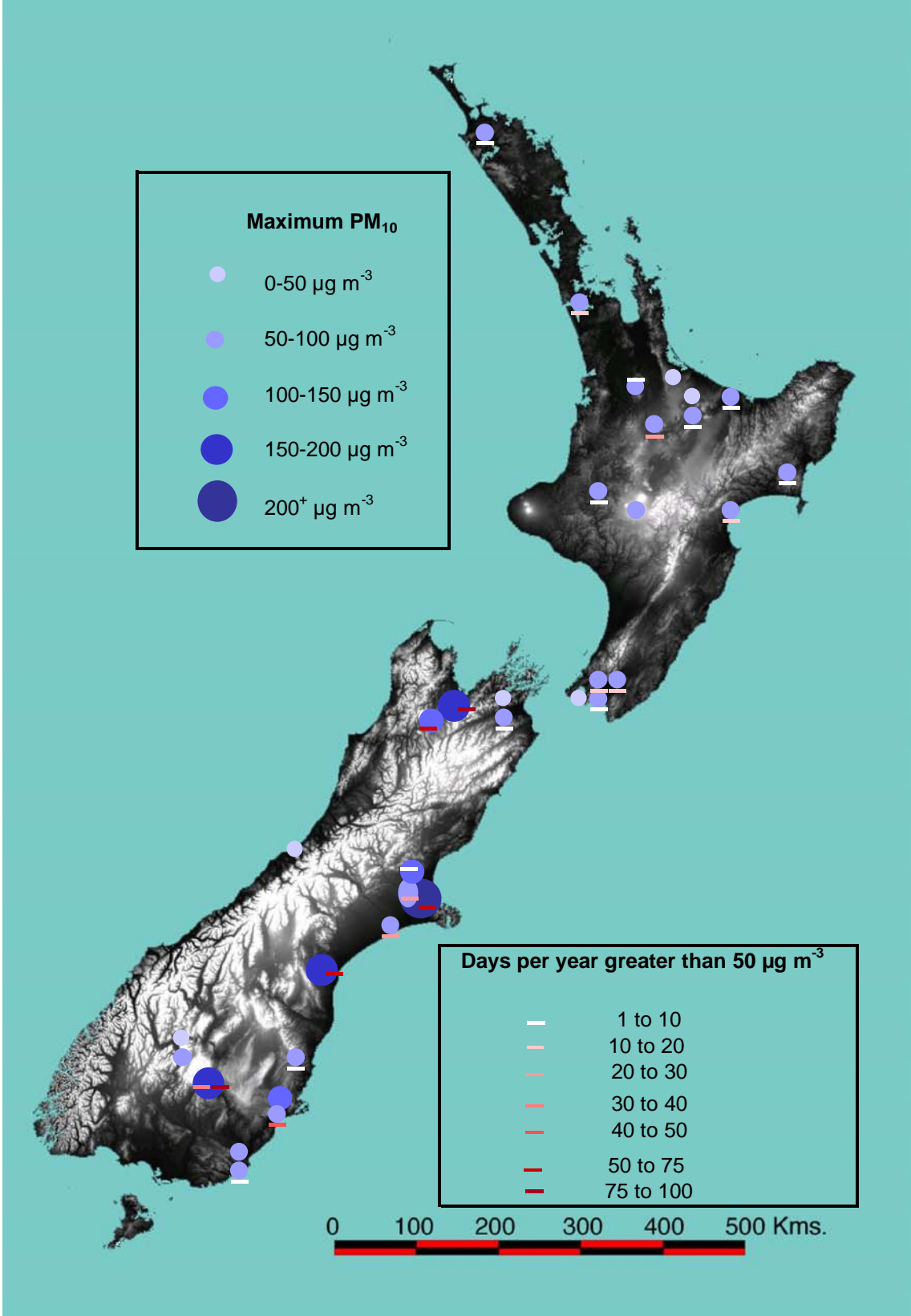
The annual average ambient air quality guideline value is also likely to have been exceeded at a number of locations. However, the low sampling frequency of many of the sampling regimes makes annual average PM<sub>10</sub> concentration estimates difficult. Table 13.2 summarises the annual average concentrations in areas where PM<sub>10</sub> concentrations were measured on greater than or equal to 15% of the days per year. From these data, exceedences of the annual average PM<sub>10</sub> guideline value have been measured in Alexandra, Mt Eden, Henderson, Tokoroa, Nelson, Christchurch, Kaiapoi and Timaru.

**Table 13.1: Maximum measured PM<sub>10</sub> concentrations and annual guideline exceedences**

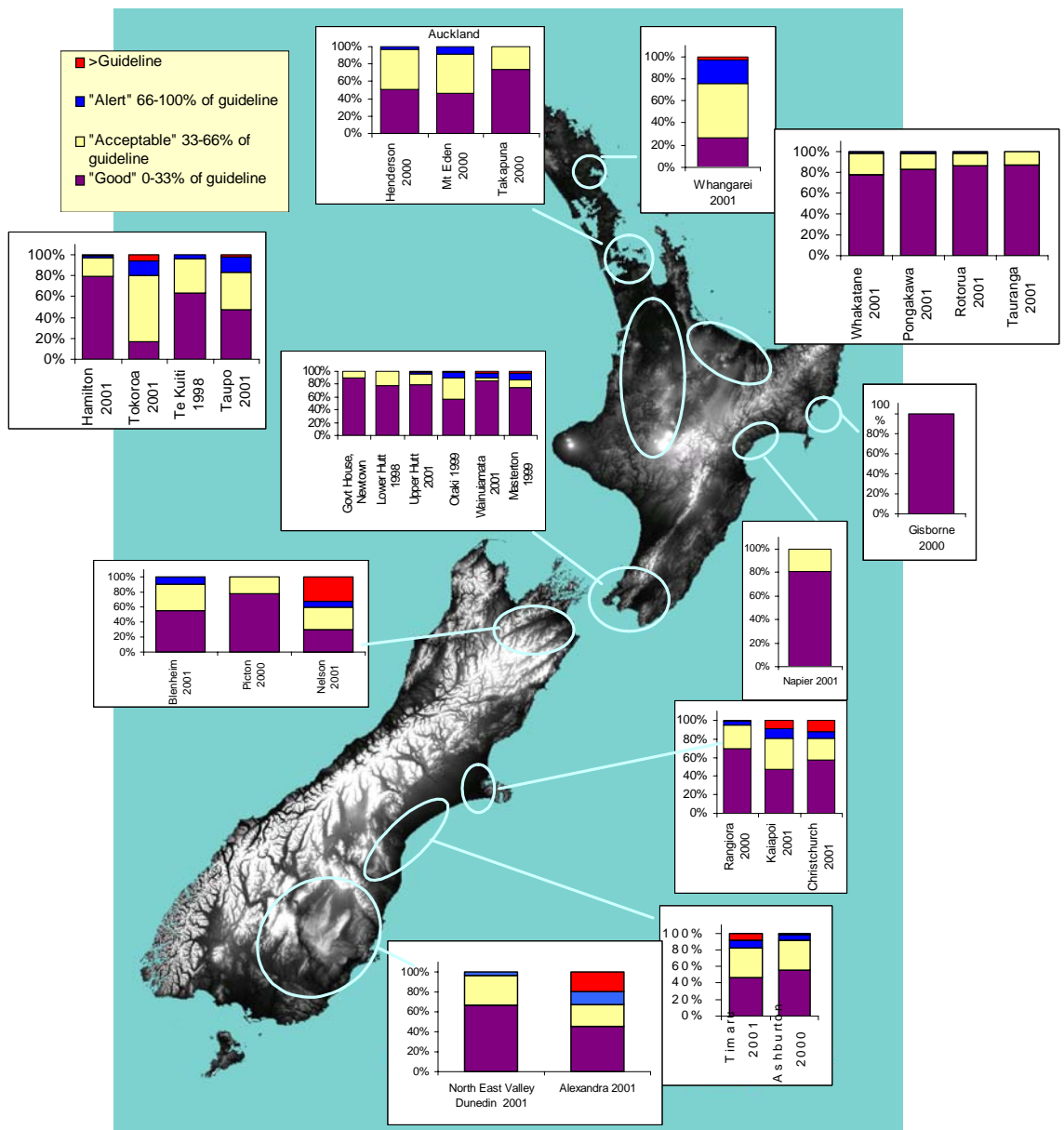
	Maximum PM <sub>10</sub> (24-hour)	Guideline exceedences		Maximum PM <sub>10</sub> (24-hour)	Guideline exceedences
Alexandra	87–193	53–78	Nelson	81–165	66–81
Arrowtown	55	18	Oamaru	61	8
Ashburton	94–100	23–24	Otaki	50	9
Auckland	30–72	6–12	Pongakawa	28–49	0
Balclutha	54	8	Picton	27	0
Blenheim	38–56	0–6	Queenstown	36	0
Christchurch	88–310	17–58	Rangiora	79–104	11–19
Cromwell	73	38	Richmond	111	60
Dunedin	22–107	0–25	Rotorua	50–72	2–4
Gisborne	16–70	8	Taupo	57	2
Greymouth	46	0	Tauranga	39–48	0
Hamilton	49–93	1–10	Te Kuiti	59	5
Kaiapoi	136	50	Timaru	104–156	42–62
Lower Hutt	42–53	1	Tokoroa	75	24
Masterton	87	11	Upper Hutt	72–85	7–15
Milton	57	19	Newtown, Wellington	31–53	6
Mosgiel	50–95	8–44	Whakatane	73	1
Napier	17–64	0–15	Whangarei	57	10

Note: See Figure 13.1 for spatial distribution.

**Figure 13.1: Maximum PM<sub>10</sub> concentrations and guideline value exceedences from 1990 to 2001**



**Figure 13.2: Percentage of measured 24-hour average PM<sub>10</sub> concentrations within air quality categories in New Zealand**



**Table 13.2: Annual average PM<sub>10</sub> concentrations within New Zealand**

Location	Method	1995	1996	1997	1998	1999	2000	2001
Mt Eden	Hi-vol				<b>21</b>	<b>20</b>		
Henderson	Hi-vol			<b>21</b>				
Takapuna	TEOM	17	17		18	17		
Takapuna	Hi-vol			19	15	14		
Gisborne	Hi-vol	8	9	9	12			
Hamilton	TEOM				15	16	15	14
Te Kuiti	TEOM				16			
Taupo	Partisol							18
Tokoroa	BAM							<b>26</b>
Rotorua	TEOM				14	14	12	12
Tauranga	TEOM				14	13	13	12
Whakatane	Partisol				19	16	14	13
Pongakawa	Partisol				12	11	13	11
Lower Hutt	TEOM				13	11		
Upper Hutt	TEOM						14	14
Masterton	TEOM						16	
Wainuiomata	Hi-vol							13
Nelson	Partisol							<b>36</b>
Blenheim	Hi-vol						19	17
Alexandra	Hi-vol					<b>22</b>	<b>23</b>	
Dunedin North	Hi-vol			19	18	18	14	15
Christchurch (St Albans)	TEOM	<b>21</b>	<b>21</b>	<b>22</b>	<b>23</b>	<b>23</b>	18	<b>22</b>
Timaru	TEOM			<b>23</b>	<b>25</b>	<b>23</b>	<b>23</b>	<b>23</b>
Ashburton	TEOM					18	18	
Rangiora	TEOM					15	14	
Kaiapoi	TEOM							<b>23</b>

Note: Guideline value exceedences are highlighted in bold.

## 13.1 Impact of monitoring methods

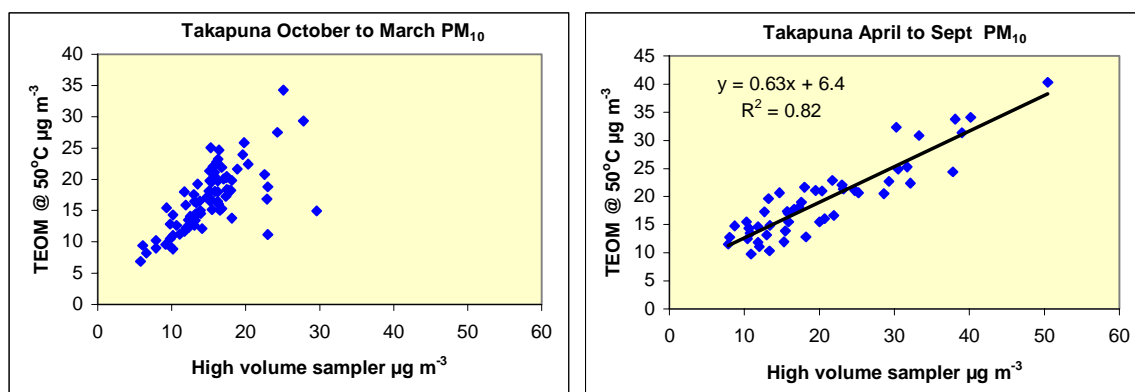
The 2002 ambient air quality guidelines for PM<sub>10</sub> specify US 40 CFR Part 50, Appendix J as the designated monitoring method for measuring PM<sub>10</sub> and allow methods that meet the USEPA equivalency requirements (MfE and MoH, 2002). The guidelines specify, however, that if a TEOM is used, then another recommended monitoring method should be co-located with the analyser for a period of one year to calculate an appropriate adjustment factor. This specification is included in the guidelines because the sample line of the TEOM is heated to remove moisture and also results in some loss of volatiles.

The difference between the TEOM method and a gravimetric method is likely to vary with location, particularly for areas where the sources of PM<sub>10</sub> vary. Greater differences are likely to occur in areas where wood smoke comprises a substantial proportion of the PM<sub>10</sub> as this source contains a significant fraction of low molecular weight volatile organic compounds that will not be captured using the heated sample line of the TEOM.

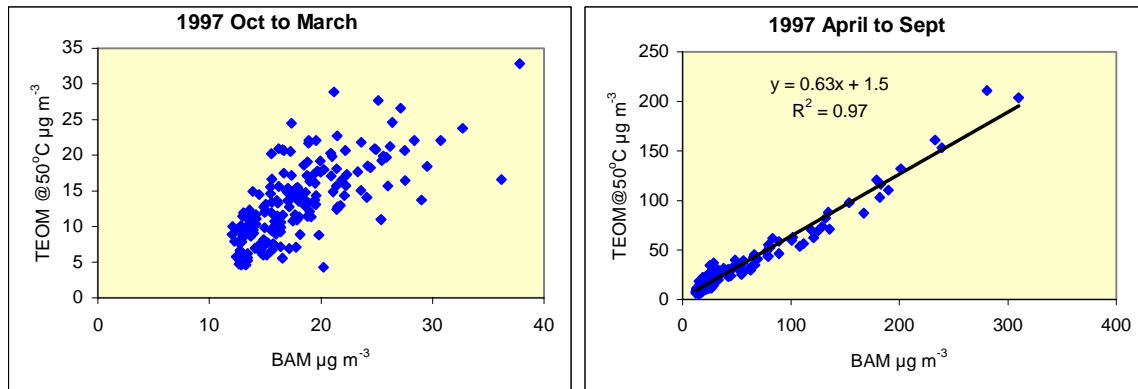
Comparisons between PM<sub>10</sub> concentrations measured using a TEOM and a co-located alternative PM<sub>10</sub> sampling method are limited to the Christchurch St Albans site and the Auckland Takapuna site for the period 1997 to 1999. Figures 13.3 to 13.6 show some seasonal variations in the relationship between the TEOM and the alternative sampling methods at both monitoring sites, as well as the impact of different TEOM sample temperatures at the Christchurch monitoring site. Seasonal variations are likely to reflect differences in sources contributing to PM<sub>10</sub> concentrations.

Although the Christchurch comparisons are made using a beta attenuation monitor (BAM) rather than a gravimetric method, a comparison of PM<sub>10</sub> concentrations measuring using a BAM and a high volume sampler in 1998 showed a good correlation ( $r^2=0.98$ ) with an average difference in concentrations of about 4% (Foster, 1998).

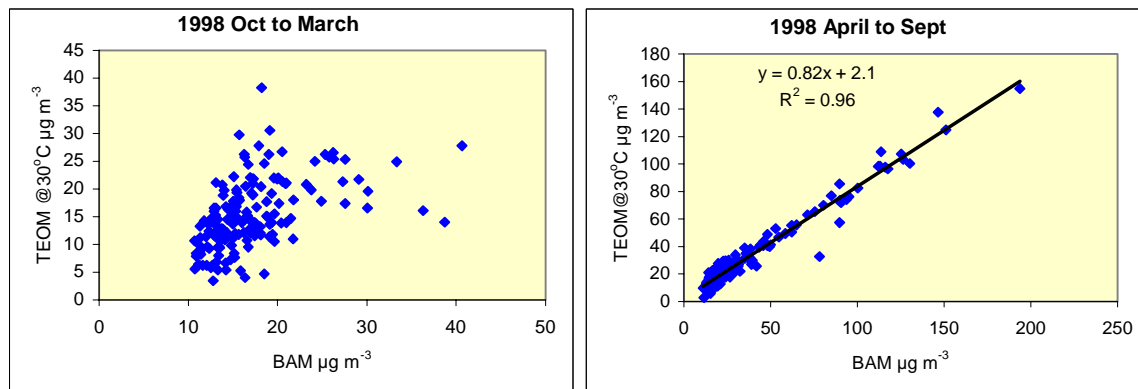
**Figure 13.3: Comparison between PM<sub>10</sub> concentrations measured using a high-volume sampler and TEOM with a 50°C sample temperature at Takapuna, Auckland**



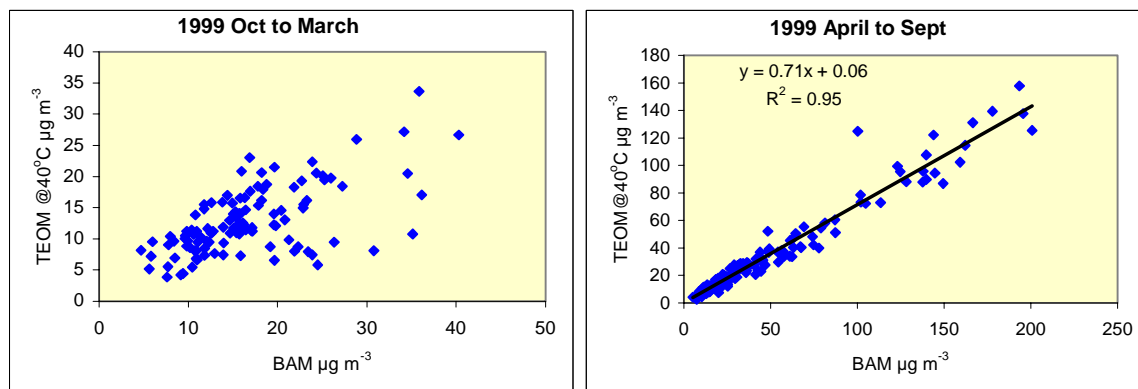
**Figure 13.4: Comparison between PM<sub>10</sub> concentrations measured using a beta attenuation monitor and a TEOM with a 50°C sample temperature at St Albans, Christchurch**



**Figure 13.5: Comparison between PM<sub>10</sub> concentrations measured using a beta attenuation monitor and a TEOM with a 30°C sample temperature at St Albans, Christchurch**



**Figure 13.6: Comparison between PM<sub>10</sub> concentrations measured using a beta attenuation monitor and a TEOM with a 40°C sample temperature at St Albans, Christchurch**



Other areas that have measured PM<sub>10</sub> using a TEOM in New Zealand include Timaru, Ashburton, Rangiora, Kaiapoi, Lower Hutt, Upper Hutt, Hamilton, Te Kuiti, Rotorua and Tauranga. Table 13.3 shows estimates of PM<sub>10</sub> concentrations and guideline value exceedences based on the following equations derived from relationships observed in Christchurch and Auckland:

- $PM_{10} = 1.18 (\text{TEOM}) - 0.25$  (for TEOM at 30 ° C)
- $PM_{10} = 1.4 (\text{TEOM}) + 0.06$  (for TEOM at 40 ° C)
- $PM_{10} = 1.53 (\text{TEOM}) - 1.6$  (for TEOM at 50 ° C)

**Table 13.3: Summary data estimates based on the conversion of TEOM data**

Area	Maximum	99.5 percentile	Annual average	Days > 50 µg <sup>m</sup> <sup>-3</sup>	% of winter days guideline was exceeded
Takapuna 1997	72	61	28	12 estimated 13 equivalent	11%
Takapuna 1998	56	52	28	6 estimated	5%
Takapuna 1999	70	63	26	6 estimated	5%
Hamilton 1998	49	46	20	0	0
Hamilton 1999	61	58	22	8 estimated	7%
Hamilton 2000	61	46	21	1 estimated	1%
Hamilton 2001	93	73	20	6 estimated 10 equivalent	8%
Te Kuiti 1998	59	59	22	5 estimated	4%
Rotorua 1998	72	56	19	3 estimated	2%
Rotorua 1999	61	49	19	2 estimated	2%
Rotorua 2000	50	44	17	2 estimated	2%
Rotorua 2001	53	51	17	4 estimated	4%
Tauranga 1998	44	40	20	0	0
Tauranga 1999	48	43	19	0	0
Tauranga 2000	40	37	19	0	0
Tauranga 2001	39	32	17	0	0
Lower Hutt 1998	53	44	18	1 estimated	1%
Lower Hutt 2001	42	37	18	0	0
Upper Hutt 2000	72	68	20	6 estimated 7 equivalent	6%
Upper Hutt 2001	85	79	20	10 estimated 15 equivalent	12%
Christchurch 1997	310	251	33	45 estimated 52 equivalent	42%
Christchurch 1998	194	148	26	30 estimated 32 equivalent	26%
Christchurch 1999	201	95	34	43 estimated 44 equivalent	36%
Christchurch 2000	224	168	29	36 estimated 39 equivalent	32%

Area	Maximum	99.5 percentile	Annual average	Days > 50 $\mu\text{g m}^{-3}$	% of winter days guideline was exceeded
Christchurch 2001	<b>257</b>	182	<b>32</b>	58 estimated	48%
Timaru 1997	<b>143</b>	106	<b>34</b>	53 measured 57 equivalent	46%
Timaru 1998	<b>104</b>	94	<b>30</b>	42 measured	34%
Timaru 1999	<b>151</b>	108	<b>32</b>	62 estimated	50%
Timaru 2000	<b>156</b>	132	<b>33</b>	60 estimated	49%
Timaru 2001	<b>140</b>	128	<b>32</b>	58 estimated	48%
Ashburton 1999	<b>94</b>	77	<b>25</b>	26 estimated	21%
Ashburton 2000	<b>100</b>	78	<b>25</b>	23 estimated	19%
Rangiora 1999	<b>79</b>	75	<b>21</b>	19 estimated	15%
Rangiora 2000	<b>104</b>	78	<b>20</b>	11 estimated	9%
Kaiapoi 2001	<b>136</b>	122	<b>33</b>	50 estimated	41%

Note: Guideline value exceedences are highlighted in bold.

These data suggest that the 24-hour average  $\text{PM}_{10}$  guideline value may also have been exceeded in Te Kuiti. Exceedences of the annual average guideline value are also possible in Auckland, Hamilton, Te Kuiti, Tauranga, Upper Hutt, Ashburton and Rangiora. Additional studies examining the relationships between the TEOM method and other approved  $\text{PM}_{10}$  sampling methods are required for these areas to determine site-specific adjustment factors.

## References

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## About the Ministry

The Ministry for the Environment works with others to identify New Zealand's environmental problems and get action on solutions. Our focus is on the effects people's everyday activities have on the environment, so our work programmes cover both the natural world and the places where people live and work.

We advise the Government on New Zealand's environmental laws, policies, standards and guidelines, monitor how they are working in practice, and take any action needed to improve them. Through reporting on the state of our environment, we help raise community awareness and provide the information needed by decision makers. We also play our part in international action on global environmental issues.

On behalf of the Minister for the Environment, who has duties under various laws, we report on local government performance on environmental matters and on the work of the Environmental Risk Management Authority and the Energy Efficiency and Conservation Authority.

Besides the Environment Act 1986 under which it was set up, the Ministry is responsible for administering the Soil Conservation and Rivers Control Act 1941, the Resource Management Act 1991, the Ozone Layer Protection Act 1996, and the Hazardous Substances and New Organisms Act 1996.

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