Technical Report
Environmental
Monitoring Group

Suspended particulate monitoring in Lyttelton

Report No. U03/61

Environment Canterbury
Your regional council

Suspended particulate monitoring Lyttelton

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Executive Summary

In June 2003 Environment Canterbury established four temporary monitoring sites in Lyttelton. The purpose was to measure suspended particulate matter (airborne particles less than ten microns in diameter, referred to as PM_{10}). This would allow a comparison to be made to the Ministry for the Environment guideline of 50 μgm^{-3} for a 24 hour period. Monitoring was carried out on 16 days during June.

The maximum concentration was 43 μgm^{-3}, which was recorded at the swimming pool. The maximum PM_{10} concentration recorded at the Kindergarten was 41 μgm^{-3}. Maximum concentrations of 24 μgm^{-3} were recorded at both the cemetery and Webb Lane sites, both of these sites are in less populated areas of Lyttelton.

$PM_{2.5}$ concentrations were measured at the swimming pool and Kindergarten sites during the 16 days of sampling. The results indicate most of the PM_{10} detected at these sites came from combustion sources.

During the 16 days of sampling the PM_{10} guideline was exceeded on six days at the Environment Canterbury air monitoring site in St Albans, Christchurch. The maximum concentration measured was 118 μgm^{-3}, in previous winters concentrations have reached in excess of 200 μgm^{-3}. This indicates that although meteorological conditions in June were conducive to high PM_{10} concentrations, higher concentrations have been measured in St Albans and could be measured in Lyttelton.

This report recommends that further monitoring is required to determine if PM_{10} concentrations will exceed the guideline. Monitoring of carbon monoxide, wind and temperature should also be included and be carried for at least one winter.

Table of Contents

List of Figures

1 Objective

In June 2003 Environment Canterbury established four temporary monitoring sites in Lyttelton. The purpose was to measure suspended particulate (airborne particles less than ten microns in diameter, referred to as PM_{10}). This would allow a comparison to be made to the Ministry for the Environment guideline of 50 μgm^{-3} for a 24 hour period (MfE, 2002). Monitoring was carried out on 16 days during June.

An instrument of the same type was used at the Environment Canterbury air monitoring site at Coles Place, St. Albans. This allowed a comparison to a High Volume Sampler, which is a method recommended by the Ministry for the Environment for measuring PM_{10}.

2 Sites

Lyttelton is situated in a harbour (figure 2.1) and most of the residential properties are on hill slopes. The topography consists of several valleys and ridges, which is likely to result in differing airsheds for different parts of Lyttelton. Lyttelton is 10 km from Christchurch, but on the other side of the Port Hills which means Lyttelton does not share a common airshed with Christchurch. The four sites were selected to give a representative coverage of the residential areas of Lyttelton. The locations of these sites are shown in figure 2.2.

Figure 2.1 Aerial photograph of Lyttelton Harbour

Figure 2.2 Location of Lyttelton monitoring sites

2.1 Webb Lane

The Webb Lane site was selected to monitor the valley area to the west of the Lyttelton road tunnel. This area is less densely populated than the area to the east of the road tunnel. Webb Lane is a small cul-de-sac of four houses. The instrument was attached 3m up a power pole 8m west of the junction with Voelas Road. This site is at an elevation of approximately 50m above sea level.

2.2 Kindergarten

This site was located in the grounds of Lyttelton Kindergarten, which is 15m south of Winchester Street in the central part of Lyttelton. The instrument was attached to a fence post and positioned at a height of 2.5m. The site is approximately 35m above sea level.

2.3 Swimming pool

The swimming pool is on Oxford Street. This site was selected to monitor the area towards the eastern part of Lyttelton. The instrument was attached at a height of 3.5m to a lamppost, 15m east of Oxford Street. The swimming pool is approximately 40m above sea level.

2.4 Cemetery

The Cemetery is in the north east part of Lyttelton and is at an elevated position of 100m above sea level. The instrument was attached to the railings of a memorial at a height of 2m, 40m east of Canterbury Street.

3 Instruments

The instruments used to measure the particulate concentrations in Lyttelton were Airmetrics Minivol Portable Air Samplers fitted with either a PM_{10} or a $PM_{2.5}$ inlet head assembly. This method is not recommended for compliance with monitoring guidelines, but being portable these instruments are useful for initial investigations into air quality, especially where there may be some spatial variation and a number of instruments are required.

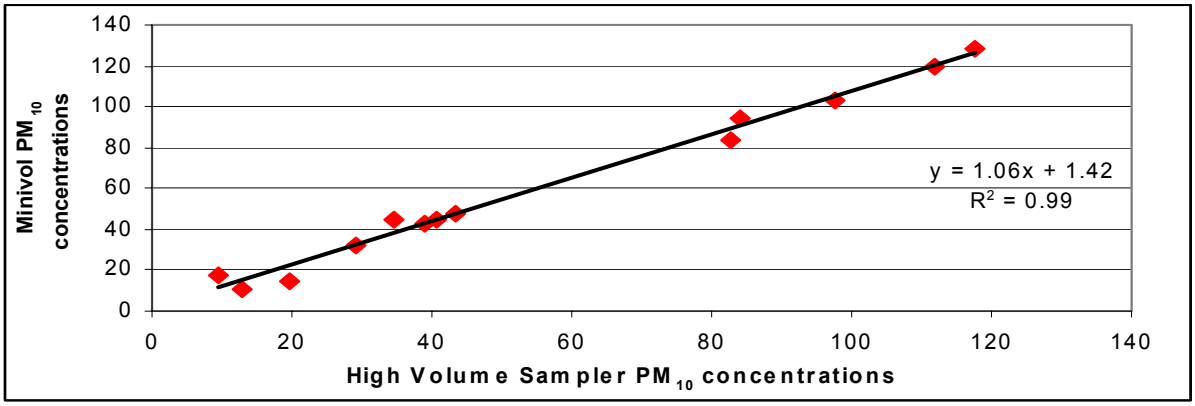

Figure 3.1 Comparison of High Volume and Minivol PM_{10} concentrations

The Minivol draws in ambient air through a 47mm glass fibre filter at a flow rate of 5 litres per minute for 24 hours. The glass fibre filters are conditioned for 24 hours at approximately 20°C and 20% relative humidity, and weighed prior to sampling. After sampling the filters are conditioned again and re-weighed. The weight gained by the filter during sampling can then be divided by the total volume of air that passed through the filter during the sampling period. This gives the PM_{10} concentration, which is reported in μgm^{-3}.

Minivols can give inconsistent results for low concentrations. This is probably due to loss of precision during handling and weighing of filters with minute amounts of particulate matter on them. For PM_{10} concentrations greater than about 40 μgm^{-3} measured at the St Albans monitoring site the Minivol measured comparable results to within 10% with the High Volume Sampler. For concentrations less than 40 μgm^{-3} the difference ranged between 9% and 46% (figure 3.1).

4 Results

4.1 Maximum concentrations

During the 16 days sampling was carried out in Lyttelton, PM_{10} concentrations measured at St. Albans exceeded the 24 hour guideline of 50 μgm^{-3} six times. For the same period the maximum PM_{10} concentration measured in Lyttelton was 43 μgm^{-3}. This was recorded at the swimming pool site.

The kindergarten instrument recorded a maximum PM_{10} concentration of 41 μgm^{-3}. The Webb Lane and Cemetery sites both measured maximum concentrations of 24 μgm^{-3}. Both of these sites are in less densely populated areas of Lyttelton, so it would be expected that the PM_{10} concentrations would be lower than those recorded at the kindergarten and swimming pool sites (figure 4.1).

4.2 Sources

Concentrations of $PM_{2.5}$ were also measured at the kindergarten and swimming pool sites. This was to gain a better understanding of possible sources of the particulate matter. The smaller particles (less than 2.5 µm in diameter) are more likely to be from combustion sources, whereas particles between 2.5 and 10 µm are more likely to be from natural sources like salt or dust. The smaller particles can be inhaled further into the lungs and are more likely to cause health effects.

Concentrations of $PM_{2.5}$ measured at St. Albans indicate that for high concentrations, around 90% of the PM_{10} is made up of $PM_{2.5}$ and the main source is from home heating. In contrast in coastal sites like Kaikoura and Sumner, only about 30% of the PM_{10} is made up of $PM_{2.5}$ and salt particles are likely to be the main source. Concentrations of PM_{10} measured at the kindergarten were made up of between 44% and 96% $PM_{2.5}$. Those at the swimming pool were between 63% and 100%. This indicates that most of the PM_{10} recorded at these sites is likely to have come from combustion sources (figures 4.2 and 4.3).

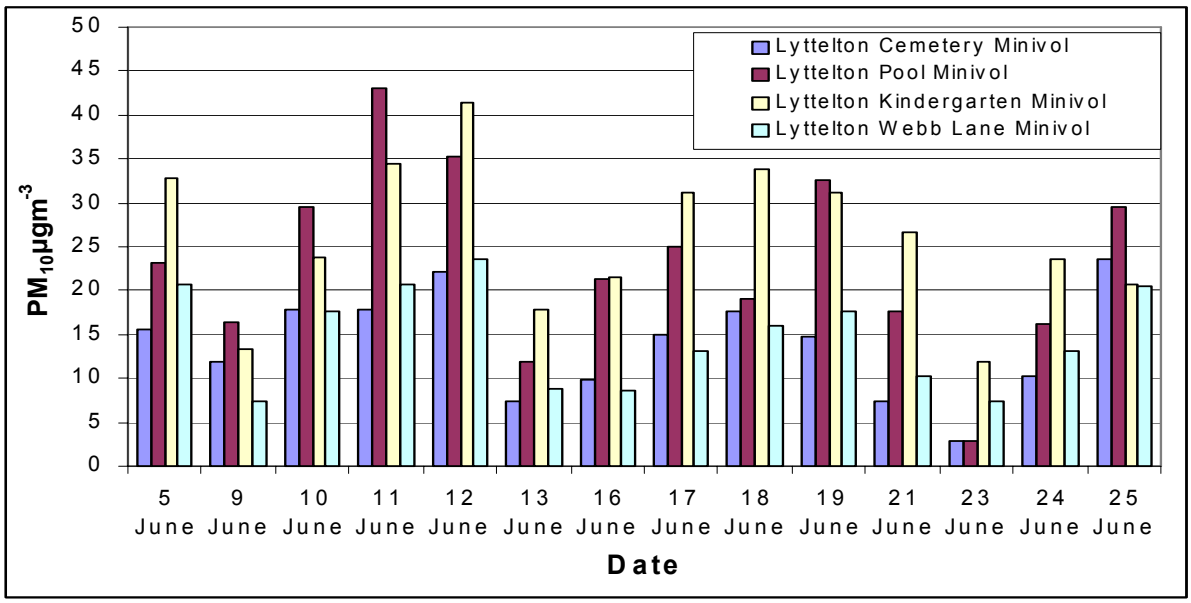

Figure 4.1 **Lyttelton PM_{10} concentrations**

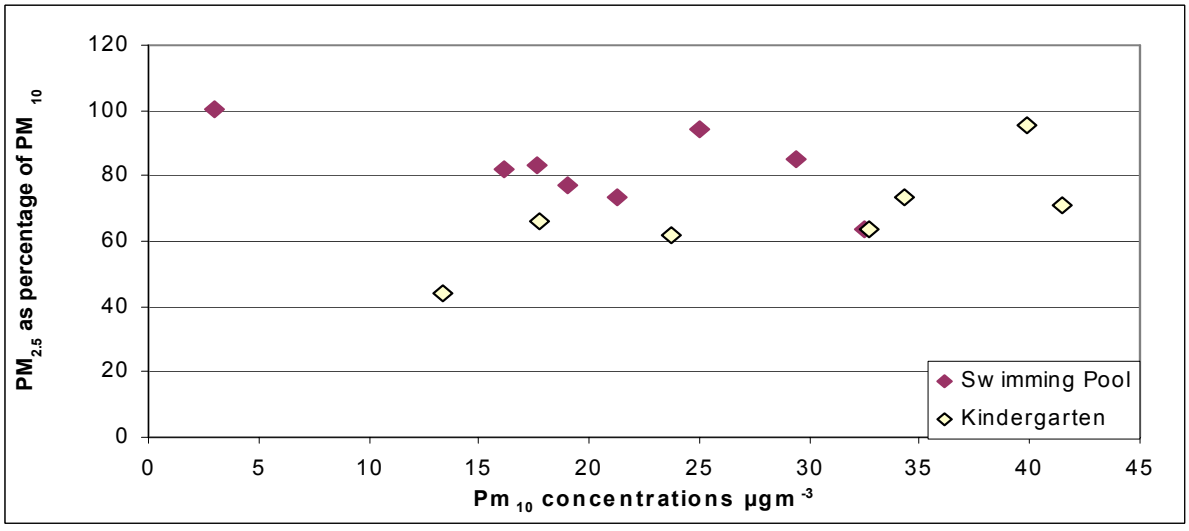

Figure 4.2 **Kindergarten and Swimming Pool $PM_{2.5}$ concentrations as a percentage of PM_{10}**

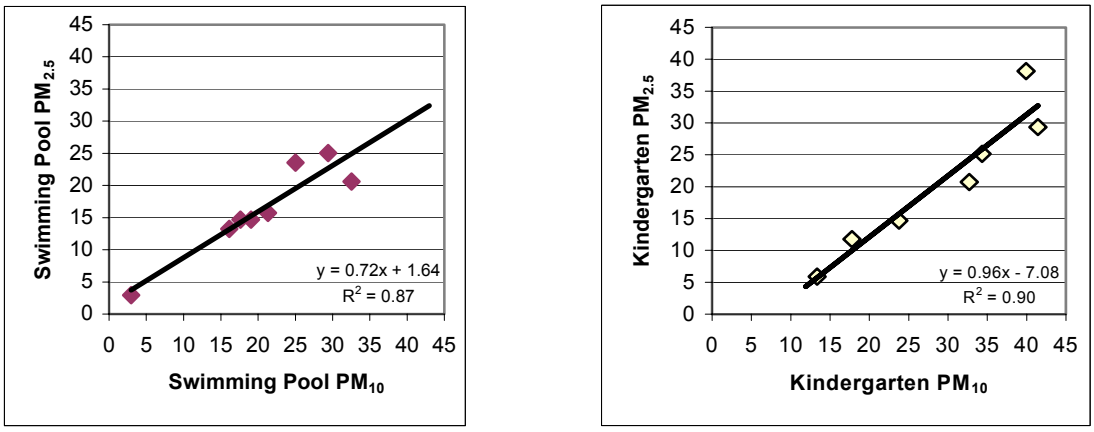

Figure 4.3 Kindergarten and Swimming Pool $PM_{2.5}$ concentrations as a percentage of PM_{10}

4.3 Do these results represent typical wintertime air quality in Lyttelton?

Air pollution is worst in periods of settled weather with clear skies, cold temperatures, calm winds and long nights. June and July are the months when the worst air pollution occurs in Canterbury towns. June 2003 was an average month for high pollution measured in St Albans compared to the last four years (13 days in 1999, 6 in 2000, 12 in 2001, 6 in 2002 and 9 in 2003). The concentrations measured in St Albans on the 16 sampling days ranged from 10 μgm^{-3} to 118 μgm^{-3}. These days did not include the highest concentration measured in 2003, which occurred in August with a concentration of 139 μgm^{-3}. Concentrations of PM_{10} at St Albans have reached in excess of 200 μgm^{-3} in previous winters. This indicates that although meteorological conditions in June were conducive to high PM_{10} concentrations, higher concentrations have been measured in St Albans and could be measured in Lyttelton. This assumes that similar meteorological conditions occur in Lyttelton.

Regional and local weather patterns contribute to the stable meteorological conditions conducive to high pollution concentrations. The conditions that are important for stability are low wind speeds and temperature inversions. These occur under anticyclonic weather patterns that affect the region. Under these weather patterns local effects come into play. Because of the topography of the Lyttelton area there is likely to be a light down slope wind at night, which could prevent a build up of pollution. Down slope wind at night occurs when slopes cool by radiation and the air in contact with them is cooled by conduction and convection. As the air becomes colder it also becomes denser and flows down slope (Sturman, 2001).

Concentrations of PM_{10} measured in Lyttelton and St Albans are shown in figure 4.4. These vary from each other on any given day. The maxima measured in Lyttelton occurred on the 11th and 12th of June, whereas the maximum in St Albans occurred on June 17. While meteorological data are not available for Lyttelton, these variations indicate that meteorological conditions in Lyttelton differ from those in St Albans and confirm that they do not share the same airshed. It is therefore difficult to use concentrations measured in St Albans to predict concentrations in Lyttelton. It is possible PM_{10} concentrations could exceed the guideline in Lyttelton if the weather was more stable regionally, but the local conditions may mean that this would not occur.

Further monitoring in Lyttelton is required to determine if PM_{10} concentrations will exceed the guideline. This should be for at least one winter and include monitoring of wind and temperature to gain a better understanding of meteorological conditions in Lyttelton and the likelihood of higher concentrations than those measured in June 2003.

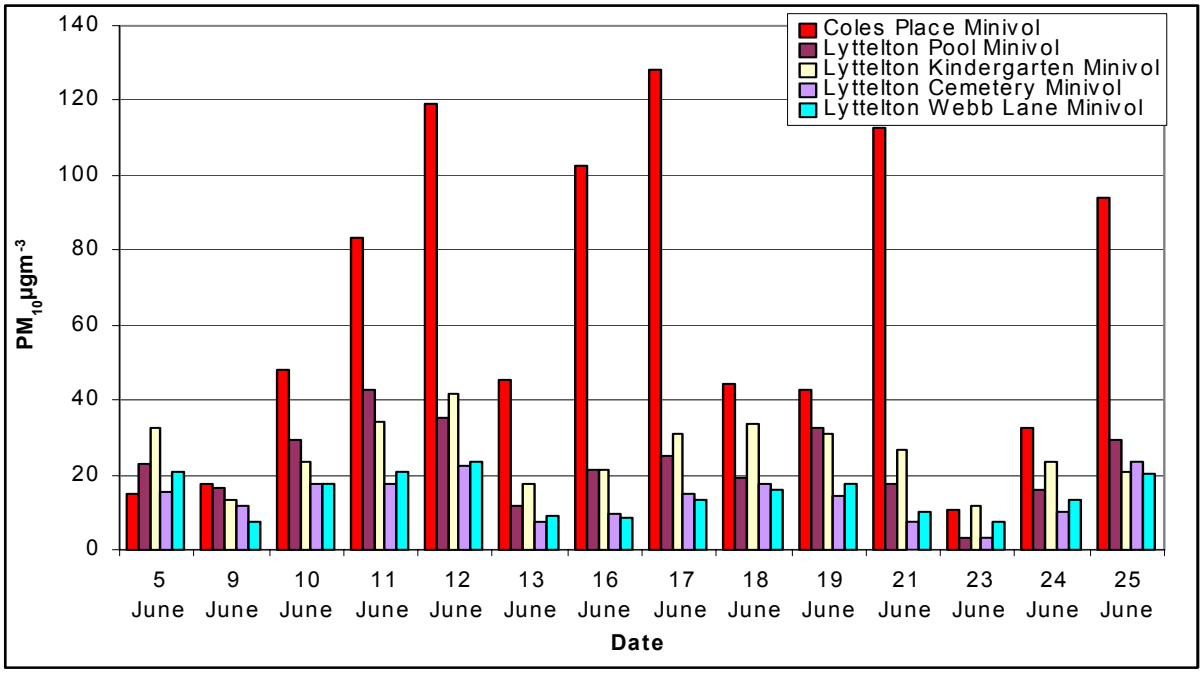

Figure 4.4 Lyttelton and Coles Place PM_{10} concentrations

5 Conclusions

During the 16 days of sampling in Lyttelton the PM_{10} guideline of 50 μgm^{-3} was not exceeded.

The maximum PM_{10} concentration was 43 μgm^{-3}, which was recorded at the swimming pool site.

The maximum PM_{10} concentration recorded at the kindergarten was 41 μgm^{-3}.

Maximum PM_{10} concentrations of 24 μgm^{-3} were recorded at both the cemetery and Webb Lane sites, both of these sites are in less densely populated areas of Lyttelton.

$PM_{2.5}$ concentrations at the swimming pool and kindergarten sites indicate most of the PM_{10} detected at these sites came from combustion sources.

The results from sampling in Lyttelton and St. Albans confirm Lyttelton has a different airshed to St Albans.

6 Recommendations

Further monitoring in Lyttelton is required to determine if PM_{10} concentrations will exceed the guideline. Monitoring of carbon monoxide, wind and temperature should also be included and be carried out for at least one winter.

7 References

Ministry for the Environment, 2002. Ambient Air Quality Guidelines (2002 update)

Sturman, A. and Zawar-Reza, P. 2001. Application of back-trajectory techniques to the delimitation of a Clean Air Zone for the Christchurch airshed. Environment Canterbury Report U01/3.

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