

OZONE MONITORING AT CRAIGIEBURN, SEPTEMBER 2003 TO JUNE 2004

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1. SUMMARY

EPA conducted a study in 2003–04 to investigate ozone levels at Craigieburn, in the outer northern suburbs of Melbourne. Ozone is the main ingredient in summer smog, and in high concentrations can affect human health.

Over the past 25 years, ozone levels in Melbourne have reduced considerably, mainly because of improvements to car and truck exhaust emissions. EPA is continuing to monitor ozone pollution and is currently examining ozone in areas not previously monitored.

After monitoring for ten months, ozone levels at Craigieburn were found to be similar to levels at other Melbourne locations. Peak levels were found on warm to hot days with light northerly winds followed by a sea breeze.

Air quality objectives for ozone are set in the State of Victoria to protect human health. Ozone levels at Craigieburn were generally low and met the objectives throughout the study. These findings are consistent with air pollution modelling, which predicts that high levels of ozone will be uncommon in the northern suburbs.

2. INTRODUCTION

2.1 The Craigieburn ozone study

Ozone has been monitored for over 25 years in Melbourne and the patterns of ozone development and movement are generally well understood. However, there are still areas of uncertainty, particularly in outer suburbs of the city.

EPA's air monitoring plan supports a national monitoring program, and provides guidance for air monitoring work.¹ The plan requires ozone to be monitored on a short-term basis in three outer suburban areas of Melbourne. Campaigns at Pakenham² (*outer south-east*) and Craigieburn (*outer north*) have been completed, and the third is under way at Moorooduc (*outer south*).

Model calculations predict that ozone can be found in populated areas when pollutants are transported away from the city then returned some hours later. Craigieburn might occasionally experience significant ozone ('summer smog') in this way.

¹ *Ambient air quality NEPM monitoring plan Victoria* (2001), EPA Publication 763, available from www.epa.vic.gov.au/Publications.

² *Ozone Monitoring at Pakenham, August 2002 to June 2003* (2004), EPA Publication 934, available from www.epa.vic.gov.au/Publications.

The key questions to be answered by this monitoring campaign were:

- How high are the ozone concentrations at Craigieburn?
- Are the patterns of ozone at Craigieburn different from those measured elsewhere in Melbourne?

2.2 Why monitor ozone?

Ozone (O₃) is a naturally occurring gas. It is like oxygen (O₂), but has one extra atom, which makes it quite reactive, and gives it a sharp odour.

Ozone is also a pollutant, being the main ingredient in summer smog. Exposure to high levels of ozone can result in increases in asthma attacks and hospitalisations associated with heart and lung conditions.

In the air we breathe, ozone is found naturally in low concentrations. Higher concentrations of ozone are formed when chemical reactions between certain pollutants (nitrogen dioxide and hydrocarbons) take place in the presence of sunlight. Ozone is only a problem between late spring and early autumn, when there is enough warmth and sunlight for these reactions to happen.

It is important to note that ozone in the air we breathe should be distinguished from ozone in the stratosphere (the ozone layer), which has the beneficial effect of absorbing harmful radiation.

2.3 What are the policy objectives?

Ozone is one of the seven air pollutants for which Victoria has set policy objectives.³ The objectives are pollutant concentrations against which air quality can be assessed. The objectives for ozone are:

- averages over one hour ('1-hr ozone') not to exceed 100 parts per billion (ppb)
- averages over four hours ('4-hr ozone') not to exceed 80 parts per billion (ppb).

These are very small concentrations; for example, a pollutant concentration of 100 ppb is equivalent to 0.00001% of pollutant in the air.

2.4 When and where did EPA monitor?

Ozone was monitored at Craigieburn from 12 September 2003 to 24 June 2004. Craigieburn is 25 km north of the Melbourne central business district and is located in an area experiencing significant urban growth.

The monitoring station was located in Dunhelen Lane, 4 km west of the Hume Highway (see Figure 1), at Melway Reference 386 C11.

2.5 How does ozone form in Melbourne?

High levels of ozone can develop in Melbourne on warm to hot summer afternoons. Because the reactions take many hours, high ozone levels only develop in the city when pollutants move away and return later in the day, or when there is very little wind.

³ State Environment Protection Policy (Ambient Air Quality), Victoria Government Gazette No. S19, 9 Feb 1999 (amended Dec 2001).

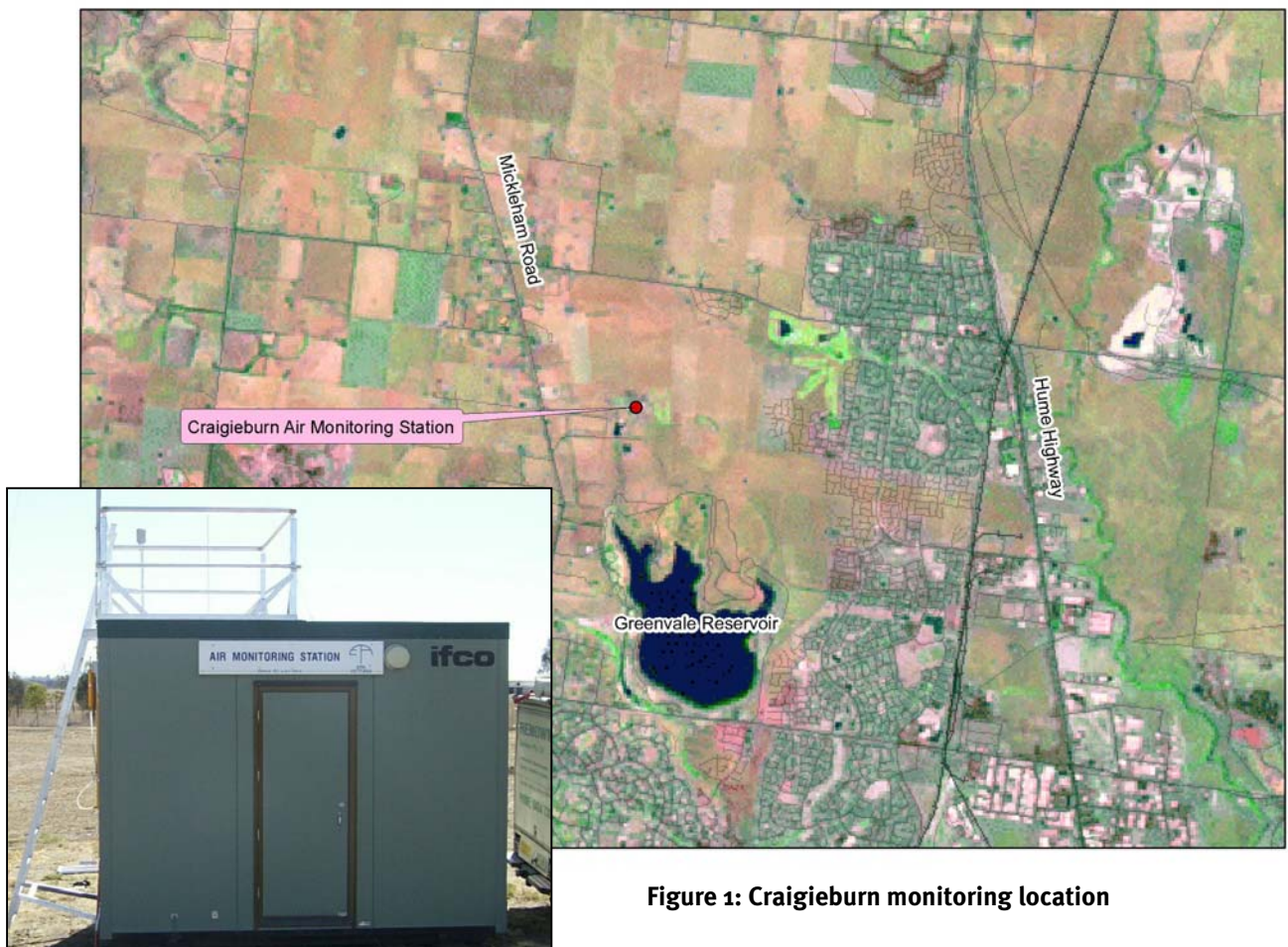


Figure 1: Craigieburn monitoring location

The chemical ingredients needed to form ozone mainly come from motor vehicles. Other contributions of pollutants come from fuel burning, bacteria in soils and natural volatile oils emitted by plants in warm weather.

In the early 1980s ozone levels above the objectives were common in Melbourne, with around 20 events each year. Since then there have been significant improvements in pollution control. In recent years, such ozone events have only been recorded about once every two years. This is mainly due to

progressive improvements in vehicle emission standards.

In almost all cases, high ozone levels are caused by pollution generated in the city. Exceptional ozone events may occur if bushfire smoke is blown towards Melbourne; a number of such events occurred during the major fires of January–February 2003⁴.

⁴ Air Quality During Victorian Bushfires of 2002–03, EPA Publication SR5.

2.6 What can we expect from other studies of ozone?

Computer models predict that the western coastal suburbs are most likely to record high ozone levels. The particular combination of light north-east morning winds, a strong temperature ‘inversion’ (which traps pollutants) and a sea breeze tends to be the most common weather pattern leading to summer smog.

This pattern of winds results in the ozone being pushed to the west of Melbourne; however, other weather patterns do occur, and on occasion peak ozone levels are expected in the northern and eastern suburbs.

Computer models and historical studies have also shown that coastal stations record more frequent high ozone levels than inland stations. As Craigieburn is 26 km inland, high levels at this location are unlikely to be common.

Previous studies of ozone over Melbourne provide a broad picture of the likely ozone situation in the northern suburbs. Monitoring of ozone at Craigieburn allows a check on these predictions, and provides some real data values to assess air quality in this region.

3. FINDINGS

3.1 The ozone objectives were met at Craigieburn.

Figure 2 shows that there were no readings above the one-hour ozone objective at Craigieburn during the period monitored. The highest one-hour levels were 94 ppb (14 February 2004) and 68 ppb (15 December 2003). The four-hour average ozone

showed a similar pattern, with no readings above the four-hour objective, and peak levels on the same days as the one-hour peaks.

When the ozone levels at Craigieburn were examined in terms of the EPA Air Quality Index⁵, it was found that 99% of readings were classified as either Good or Very Good air quality.

3.2 How does Craigieburn compare with other locations?

Figure 3 shows the ozone readings at Craigieburn compared to other Melbourne stations. For each week of the study period, the highest Craigieburn ozone level in the week is shown, along with a bar that shows the range of highest weekly values obtained from other locations around Melbourne.

From October to January, Craigieburn’s ozone level was towards the low end of the range of Melbourne readings. The coastal western and north-western suburbs typically recorded the highest ozone during these months, associated with light north-easterly winds in the morning, followed by a sea breeze.

In contrast, during the period from February to April, Craigieburn levels were often close to the highest in Melbourne, associated with light northerly winds in the morning, followed by a sea breeze.

Results from Craigieburn may also be compared to other stations by counting up the number of days on which the peak ozone in the Melbourne monitoring network was at Craigieburn.

⁵ “The EPA Air Quality Index – Overview”, www.epa.vic.gov.au/Air/Bulletins/abindex.asp

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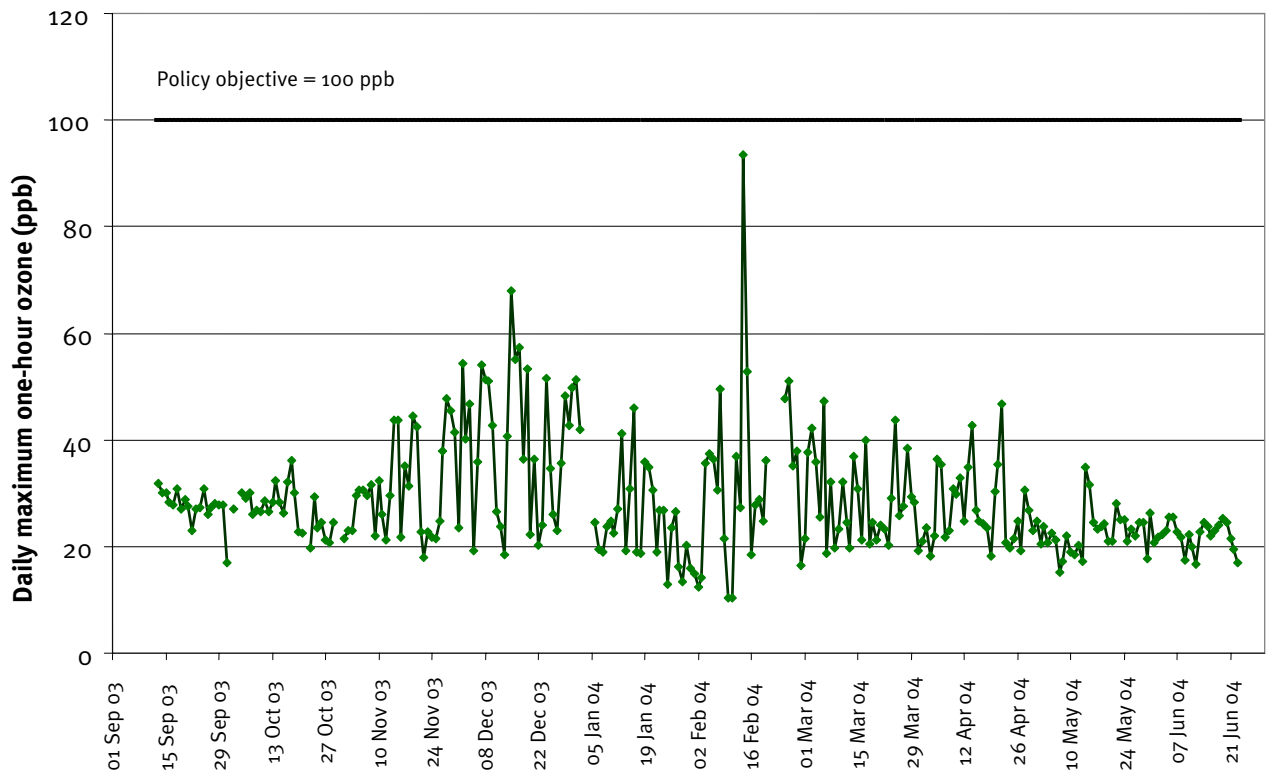


Figure 2: Maximum one-hour ozone on each day of the study period

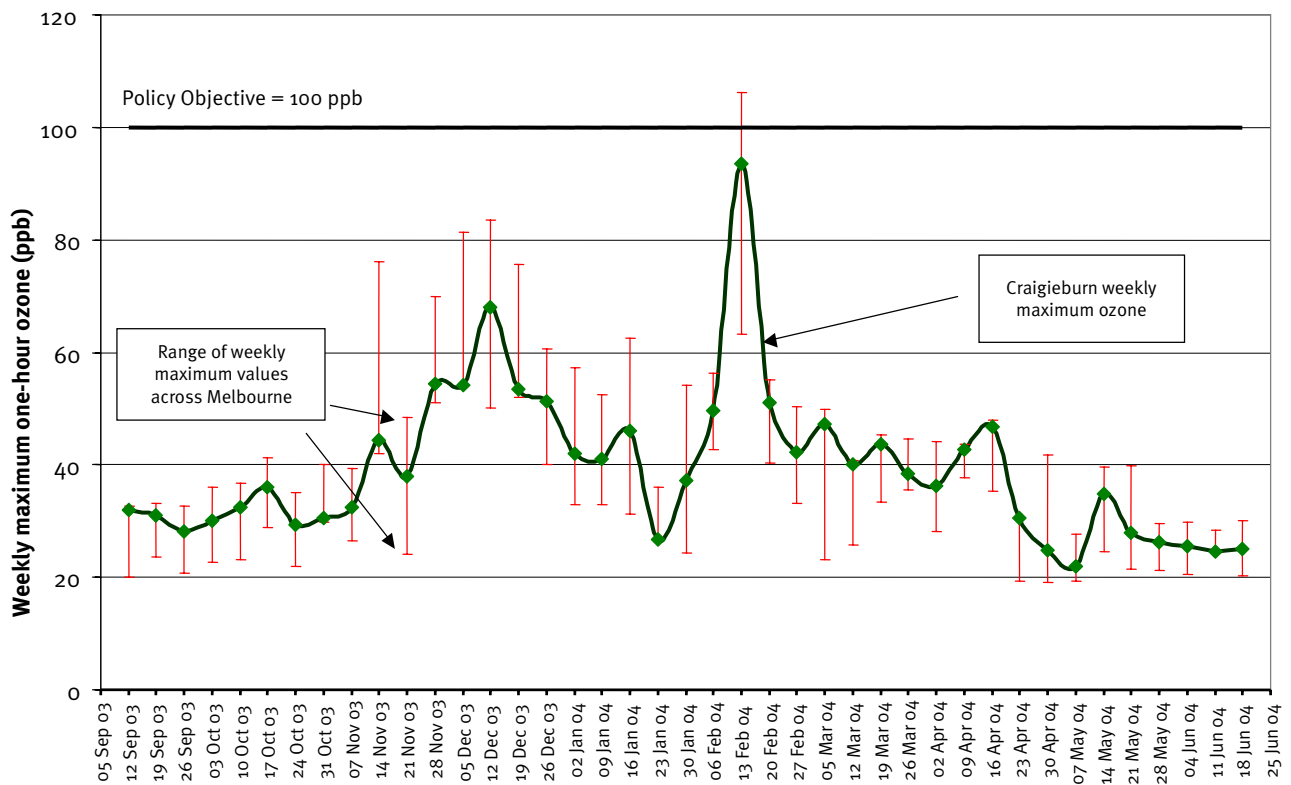


Figure 3: Comparison of Craigieburn with other locations in Melbourne

During the ozone season (212 days from October to April), Craigieburn recorded the highest ozone in the city on 12 days, or about 6% of the time. Using this percentage as a way to compare pollution levels across Melbourne, it was found that four monitoring stations were ranked higher than Craigieburn and six monitoring stations were ranked lower.

In general, the results show that Craigieburn ozone levels are similar to those at other locations in Melbourne. The variation seen from early to late summer is associated with changes in wind direction, which are part of a natural seasonal variation in high-pressure weather systems.

3.3 Ozone peak on 14 February 2004

The peak ozone level recorded at Craigieburn was 94 ppb on 14 February 2004. The build-up of ozone on this day is shown in Figure 4. Compared to other stations, ozone at Craigieburn was in the mid to high range of readings taken from around Melbourne.

The fourteenth of February 2004 was a hot day, with the temperature reaching 39 °C at Craigieburn. Winds were northerly until the onset of a southerly sea breeze during the afternoon. Ozone peaked initially at Craigieburn⁶ at 2 pm, but then rose sharply to a maximum at 6 pm as the sea breeze arrived in the northern suburbs.

An analysis of wind speed and direction showed that pollutants had drifted over Melbourne and Port Phillip Bay during the earlier part of the day. This represents a typical ozone formation scenario.

Ozone readings on this day show the pollutants moving north in the afternoon. The peak ozone at

Brighton (south of Melbourne) occurred at 4 pm (106 ppb). Ozone then travelled towards the inner western suburbs, which recorded peaks at 5 pm (98 ppb at Altona, and 106 ppb at Footscray). Finally, Craigieburn recorded its peak at 6 pm (94 ppb).

Craigieburn ozone remained in the mid to high range of readings during the evening, but eventually fell to natural background levels, which range from 0 to about 30 ppb. As the ozone plume moved further inland it is likely to have been well dispersed.

3.4 Ozone on 15 December 2003

On 15 December 2003, Craigieburn recorded a four-hour ozone level of 65 ppb, which is 81% of the four-hour ozone objective. The four-hour objective is set to protect human health from ozone episodes that last for several hours.

The range of one-hour ozone concentrations over Melbourne on this day is shown in Figure 5. Winds were very light south-easterly during the morning, followed by a sea breeze bringing air from over Port Phillip Bay and Melbourne. The temperature reached 30 °C at Craigieburn.

These conditions supported the development of summer smog, with ozone concentrations reaching 68 ppb at Craigieburn and 69 ppb at Melton. The lightness of the winds on this day resulted in ozone levels persisting for long enough to affect the four-hour average. At 8 pm ozone levels began to fall and by 10 pm levels were within the natural background range.

⁶ Craigieburn was off-line from 9 am to 11 am, because of temporary instrument difficulties.

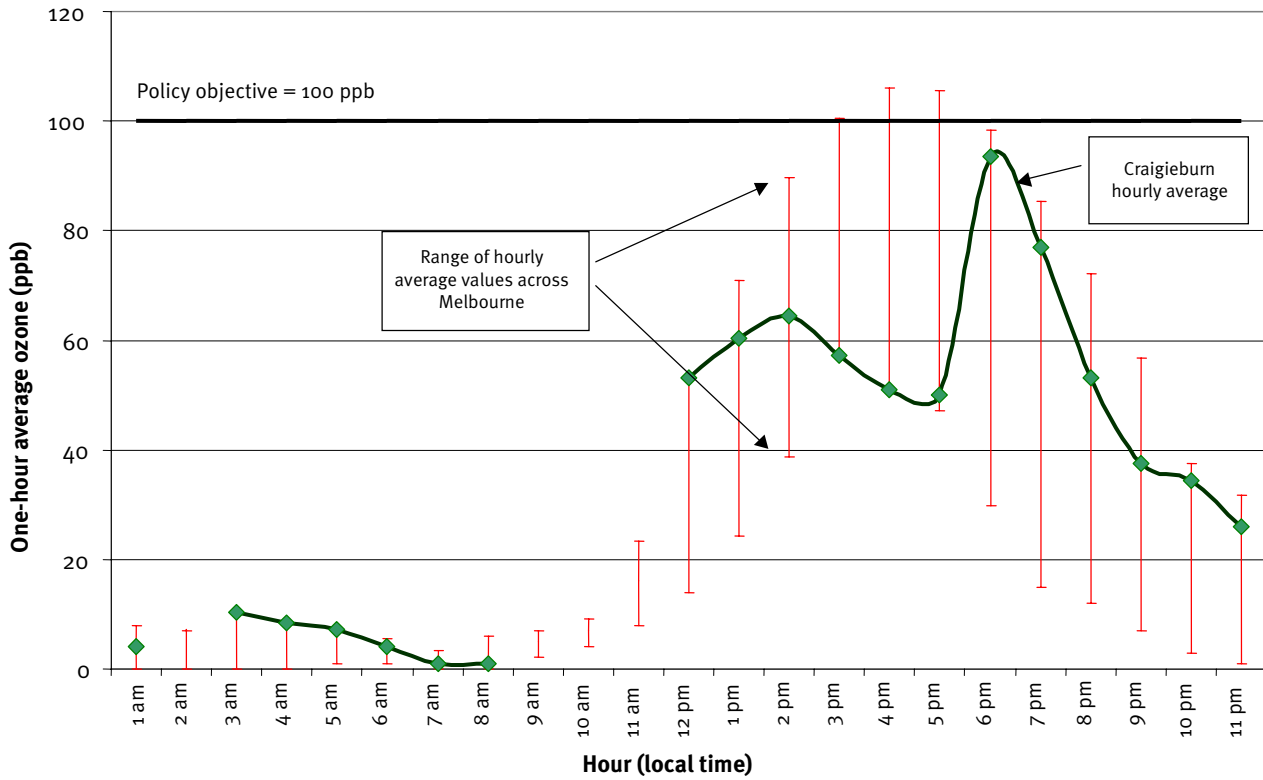


Figure 4: Hourly ozone on 14 February 2004

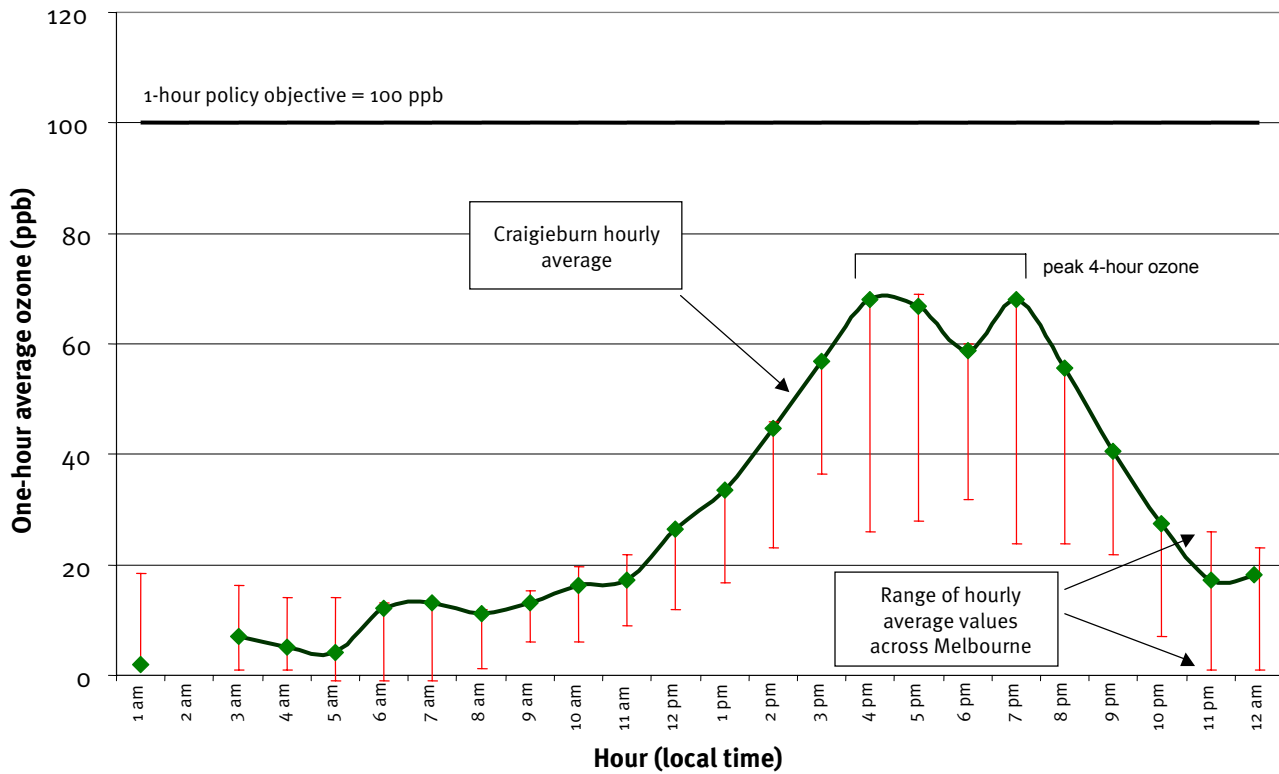


Figure 5: Hourly ozone on 15 December 2003

The following two days were quite hot (34 °C and 35 °C), resulting in elevated ozone levels across Melbourne. Ozone at Craigieburn was in the range 20–55 ppb on 16 December (the fourth highest day recorded) and 26–57 ppb on 17 December (the third highest day recorded).

4. CONCLUSION

Monitoring conducted for a 10-month period at Craigieburn found no levels above the ozone policy objectives. As with other locations in Melbourne, most ozone levels at Craigieburn were well below these objectives.

Overall, the patterns of ozone observed at Craigieburn were consistent with modelling studies. Peak ozone levels at Craigieburn occurred later in the day than at other locations, as ozone plumes usually form over Port Phillip Bay and reach coastal and inner suburbs first.

Detailed studies predict that coastal areas west of Melbourne will experience the most frequent high levels of ozone. However, other locations, including the northern suburbs, may occasionally experience elevated ozone, depending on which way the wind is blowing on the day. Peak ozone levels at Craigieburn may be expected on warm to hot days with a light northerly wind and an afternoon sea breeze.

Through modelling studies and 25 years of monitoring, EPA has developed a substantial body of knowledge about ozone pollution in Melbourne. EPA is continuing to refine this knowledge through monitoring and other studies. As of January 2005, campaign monitoring for ozone is under way at Moorooduc, representing the outer south area of

Melbourne, in accordance with EPA's monitoring plan.

ACKNOWLEDGEMENTS

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