ACT Government
Environment and Sustainable Development

ACT AIR QUALITY REPORT 2011

Environment Protection Authority | June 2012

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LIST OF DEFINITIONS AND ABBREVIATIONS

Term	Definition
AAQ NEPM	National Environment Protection (Ambient Air Quality) Measure
ACT	Australian Capital Territory
CO	Carbon Monoxide
BAM	Beta Attenuation Monitor
NATA	National Association of Testing Authorities
ND	Not Demonstrated
NEPC	National Environment Protection Council
NO_2	Nitrogen Dioxide
O_3	Ozone
PMS	Performance Monitoring Station
$PM_{2.5}$	Particles with an equivalent aerodynamic diameter less than or equal to 2.5 Micrometers
PM_{10}	Particles with an equivalent aerodynamic diameter less than or equal to 10 Micrometers
ppm	Parts per million by volume – parts of pollutant per million parts of air
Q	Quarter (e.g. Q1 means the first quarter of the year)
SO_2	Sulphur Dioxide
$\mu g/m^3$	micrograms per cubic metre

OVERVIEW

This report presents the results of ambient air quality monitoring in the ACT for the 2011 calendar year and assesses them in accordance with the requirements of the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) which was made by the National Environment Protection Council (NEPC) on 26 June 1998.

Monitoring results demonstrate that the major impacts on Canberra's air quality in 2011, as in previous years, came from the accumulation of combustion particles from wood heaters in cold, highly stable air, hazard reduction burns and dust storms. With the exception of particulate matter less than 2.5 microns ($PM_{2.5}$) all measured parameters are below the AAQ NEPM standards.

There were four exceedances of the $PM_{2.5}$ 24-hr advisory reporting standard which occurred in May and July 2011. These exceedences were due to wood heater emissions in winter.

Monitoring was performed in accordance with the ACT's monitoring plan, AAQ NEPM Technical Papers and ACT Health's accreditation by the National Association of Testing Authorities (NATA).

MONITORING SUMMARY

Current Performance Monitoring Stations

The ACT Government has been undertaking ambient air quality monitoring in Canberra since the early 1990's. The Health Directorate is responsible for the Government's ambient air quality monitoring network. The Environment and Sustainable Development Directorate is responsible for annual reporting under the AAQ NEPM.

The AAQ NEPM monitoring network in the ACT currently consists of two performance monitoring stations (PMS) at Monash and Civic respectively. The Monash station is approximately 300 metres west of Cockcroft Avenue in the Monash district playing fields. The Civic station is located at the northern end of the carpark on the western side of the Olympic swimming pool adjacent to Allara Street. The compliance and non-compliance criteria for both PMS against the siting standard AS/NZS 3580.1.1:2007 are listed in Table 1 below.

Table 1 Summary of stations' siting compliance with AS 3580.1.1-2007

Station	Station type	Height above ground	Minimum distance to support structure	Clear sky angle of 120°	Unrestricted airflow of 270°/360°	20m from trees	No boilers or incinerators nearby	Minimum distance from road or traffic
Monash	T	☑	☑	☑	☑	☑	☑	☑
Civic	P	☑	☒	☒	☒	☒	☑	☒

T denotes trend; P denotes performance

Under Clause 13 of the AAQ NEPM a PMS should, to the extent practicable, be sited in accordance with AS/NZS 3580.1.1:2007 and must be located in a manner such that they contribute to obtaining a representative measure of the air quality likely to be experienced by the general population in the region. Unfortunately as can see from Table 1 the Civic station is not sited in accordance with the standard. In addition to this it is located on the outskirts of the central business district of Civic and is not representative of general population exposure as required by Clause 13(2) of the AAQ NEPM.

Based on the 2012-13 ACT Budget released on 5 June 2012, the ACT Government will allocate funding for establishing another PMS that would be fully compliant with the AAQ NEPM. The Health Directorate has consulted within Government and based on a preliminary analysis of site requirements/constraints short listed a site in the central Belconnen area.

Until this AAQ NEPM monitoring station can be established, data from the Civic station, whilst not sited or located in accordance with Clause 13 of the AAQ NEPM, is being used for annual reporting purposes.

Consistent with the ACT's Ambient Air Quality Monitoring Plan, which was approved by NEPC in 2001, this report only covers four of the six criteria pollutants, namely carbon monoxide (CO), nitrogen dioxide (NO_2), photochemical oxidants as ozone (O_3) and particulate matter less than 10

micrometres (PM_{10}). Because of a lack of heavy industry the ACT has never monitored sulphur dioxide (SO_2), and ceased monitoring lead in July 2002, following the phase out of leaded fuel on 1 January 2002, with ambient air lead levels being less than 2% of the standard. The report also covers $PM_{2.5}$.

Both stations contain instrumentation that continuously monitors CO, O_3, and NO_2. PM_{10} and $PM_{2.5}$ monitoring is undertaken at Monash and only PM_{10} monitoring at Civic.

Monitoring Methods

The ACT monitoring is conducted in accordance with the relevant Australian standard as shown in Table 2.

Table 2 Methods used for monitoring AAQ NEPM pollutants

Pollutant	Standard	Title	Method Used
Carbon Monoxide	AS 3580.7.1-1992	Ambient Air – Determination of Carbon Monoxide – Direct Reading Instrument Method	Gas filter correlation/ Infrared.
Nitrogen dioxide	AS 3580.5.1-1993	Ambient Air – Determination of Oxides of Nitrogen – Chemiluminescence Method	Gas phase chemiluminescence.
Photochemical oxidant (ozone)	AS 3580.6.1-1990	Ambient Air – Determination of Ozone – Direct Reading Instrument Method	Non-dispersive ultraviolet.
Particles PM_{10}	AS 3580.9.11-2008	Method for sampling and analysis of ambient air Method 9.11: Determination of suspended particles matter – PM_{10} beta attenuation monitors	Beta Attenuation Monitor (BAM)
PM_{10}	AS/NZS 3580.9.6-2003	Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM_{10} high volume sampler with size-selective inlet - Gravimetric method	Gravimetric reference method
$PM_{2.5}$	AS/NZS 3580.9.10-2006	Reference Method for the Determination of Fine Particulate matter as $PM_{2.5}$ in the Atmosphere	Gravimetric reference method

NATA Accreditation Status

The ACT Government monitoring network is accredited by NATA for the measurement of all AAQ NEPM pollutants except SO_2 as required under Clause 12 of the AAQ NEPM.

ASSESSMENT OF COMPLIANCE WITH STANDARDS AND 2008 GOAL

For the purpose of this report, air quality is assessed against the AAQ NEPM standards and goals as specified in Schedule 2 of the AAQ NEPM and reproduced in Table 3.

The standards against which air quality is assessed are concentrations in parts per million (ppm) or micrograms per cubic metre (µg/m^3) (refer to column 3,Table 3).

The goal of the AAQ NEPM is to achieve the Standards as assessed in accordance with the monitoring protocol within 10 years of commencement (i.e. 2008) to the extent specified in Schedule 2 of the AAQ NEPM. The extent is expressed as a maximum allowable number of exceedences for each standard (refer to column 4,Table 3). These are set to account for unusual meteorological conditions and, in the case of particles, natural events such as dust storms and bushfires, which cannot be controlled through normal air quality management programs.

The AAQ NEPM also specifies advisory reporting standards for $PM_{2.5}$. The goal for $PM_{2.5}$ is to collect sufficient data to facilitate a review of the $PM_{2.5}$ standards, which has been completed through the review of the AAQ NEPM.

Table 3: AAQ NEPM standards and goals

Pollutant	**Averaging Period**	**Maximum concentration**	**Goal within 10 years Maximum allowable exceedences**
Carbon monoxide	8 hours	9.0 ppm	1 day a year
Nitrogen dioxide	1 hour 1 year	0.12 ppm 0.03 ppm	1 day a year none
Photochemical oxidants	1 hour 4 hours	0.10 ppm 0.08 ppm	1 day a year 1 day a year
Sulfur dioxide	1 hour 1 day 1 year	0.20 ppm 0.08 ppm 0.02 ppm	1 day a year 1 day a year none
Lead	1 year	0.050 µg/m^3	none
Particles as PM_{10}	1 day	50 µg/m^3	5 days a year
Particles as $PM_{2.5}$ #	1 day 1 year	25 µg/m^3 8 µg/m^3	Not applicable Not applicable

- Advisory reporting standards only

The following tables (Table 4 to Table 8) summarise compliance with the standards and goals of the AAQ NEPM. For each pollutant, the data availability (quarterly and annual), the number of days when standards were exceeded, the annual mean (where an annual standard exists) and an assessment of compliance, are given for each monitoring station.

A station's performance is assessed as complying with the AAQ NEPM (i.e. 'MET') if the number of exceedances is no more than the number specified in Schedule 2 of the AAQ NEPM and data availability was at least 75% in each quarter of the year. A region demonstrates compliance with the AAQ NEPM when either all stations in the region demonstrate compliance, or when the region meets approved pollutant screening criteria.

A station's performance is assessed as not complying with the AAQ NEPM (i.e. 'NOT MET') if there is more than the number of exceedances specified in Schedule 2 of the AAQ NEPM, even if the data availability rates are less than the 75% required.

A station's performance is assessed as 'NOT DEMONSTRATED' (ND) if it records exceedances on a number of days less than that allowed, but has data availability rates less than 75% in any quarter. This may be due to instrument failures, temporary closures for upgrading or closures to allow relocation of the station.

These categories (i.e. MET, NOT MET and ND) are used in the tables on the following pages.

Carbon monoxide

During 2011, no exceedences of the CO standard were recorded in the ACT and compliance against the AAQ NEPM goal was demonstrated at both stations.

Table 4: 2011 compliance summary for CO

AAQ NEPM standard - 9.0 ppm (8-hr average)

Performance monitoring station	Data availability rates (% of hours)					Number of exceedences (days)	Performance against the standards and goal
	Q1	Q2	Q3	Q4	Annual		
Monash	95.6	94.4	95.6	95.4	95.3	0	MET
Civic	94.2	93.4	93.6	94.7	94.0	0	MET

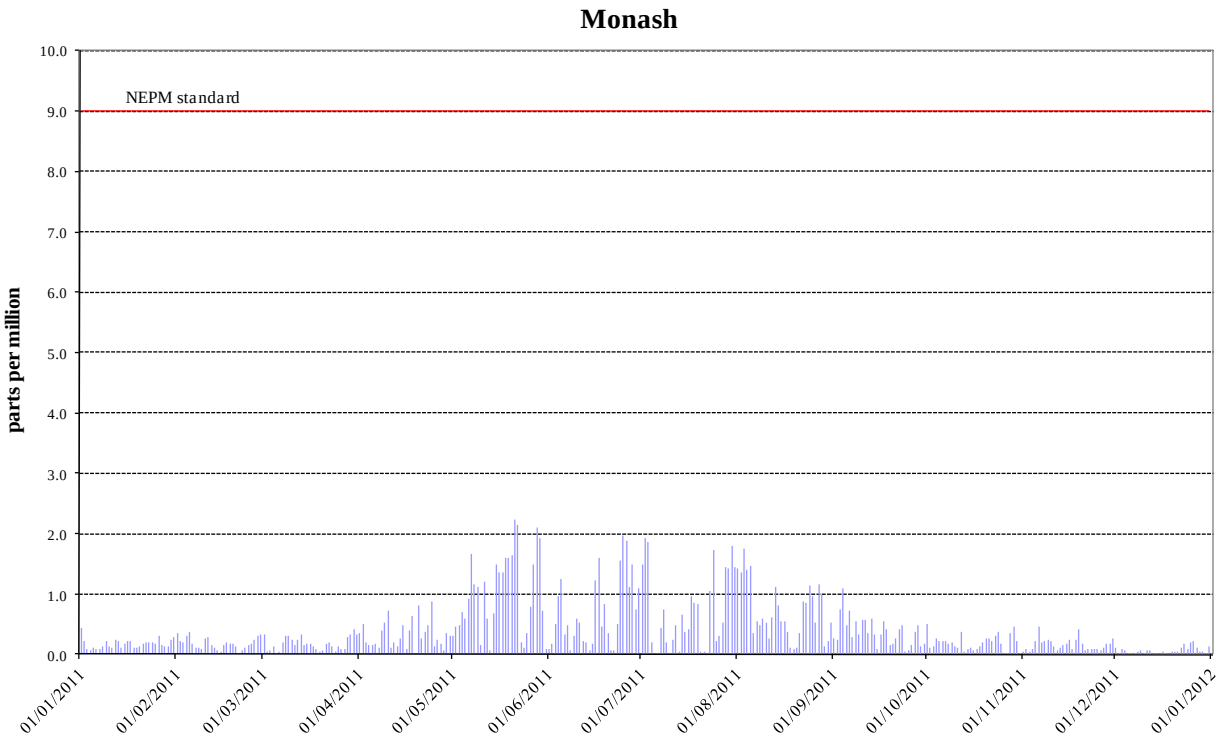

Figure 1: Daily max for CO 8-hr average - Monash

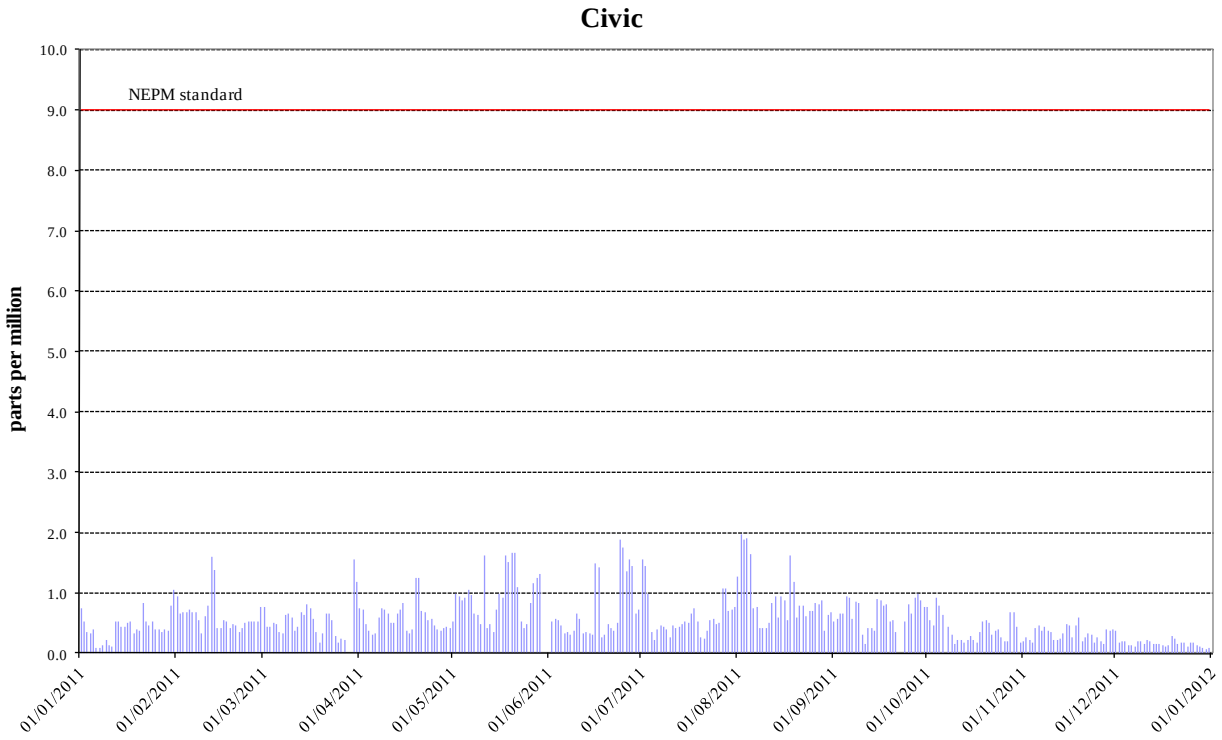

Figure 2: Daily max for CO 8-hr average - Civic

Nitrogen dioxide

During 2011, no exceedences of the NO_2 standards were recorded in the ACT. Compliance against the AAQ NEPM goal was demonstrated at Monash but not at Civic because of instrument failures at various times throughout the third quarter.

Table 5: 2011 compliance summary for NO_2

AAQ NEPM standard – 0.12 ppm (1 hour average), 0.03 ppm (1 year average)

Performance monitoring station	Data availability rates (% of hours)					Annual mean Concentration (ppm)	Number of 1 hour exceedences (days)	Performance against the standards and goal	
	Q1	Q2	Q3	Q4	Annual			1 hour	1 year
Monash	95.5	94.4	94.7	89.6	93.6	0.005	0	MET	MET
Civic	94.1	89.1	70.9	90.5	86.1	0.008	0	ND	ND

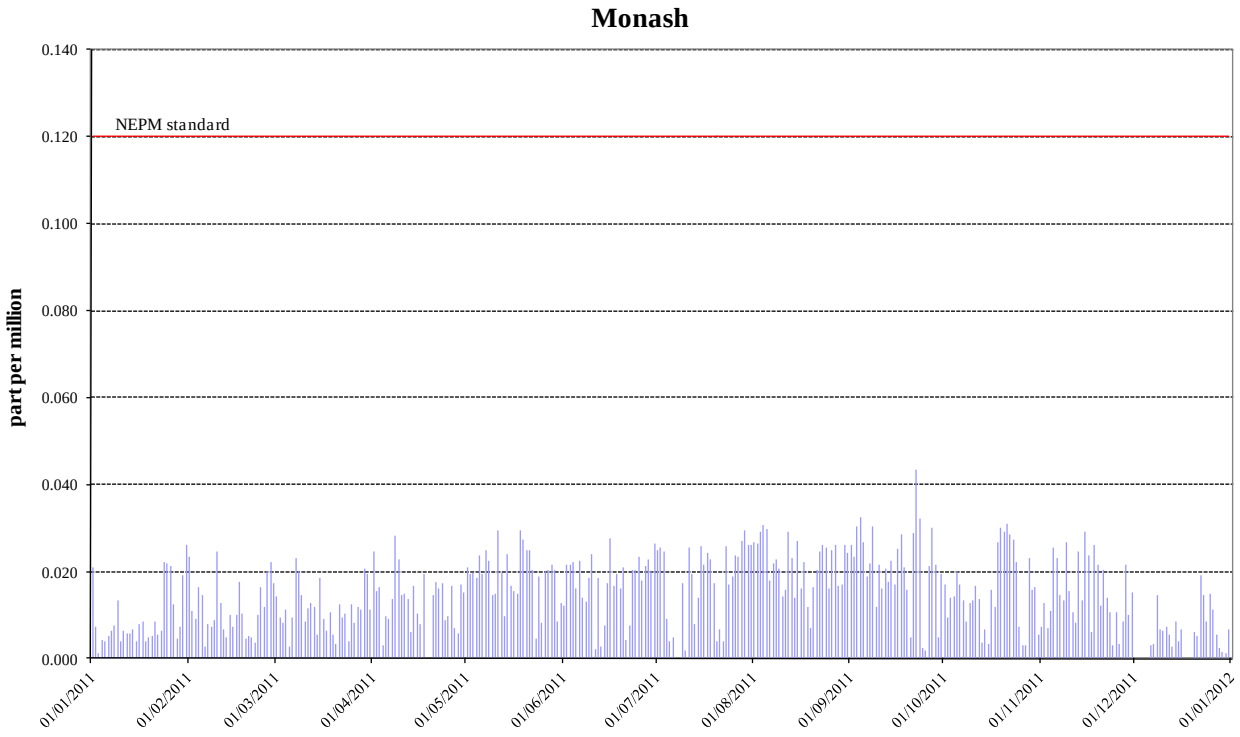

Figure 3: Daily max for NO_2 - Monash

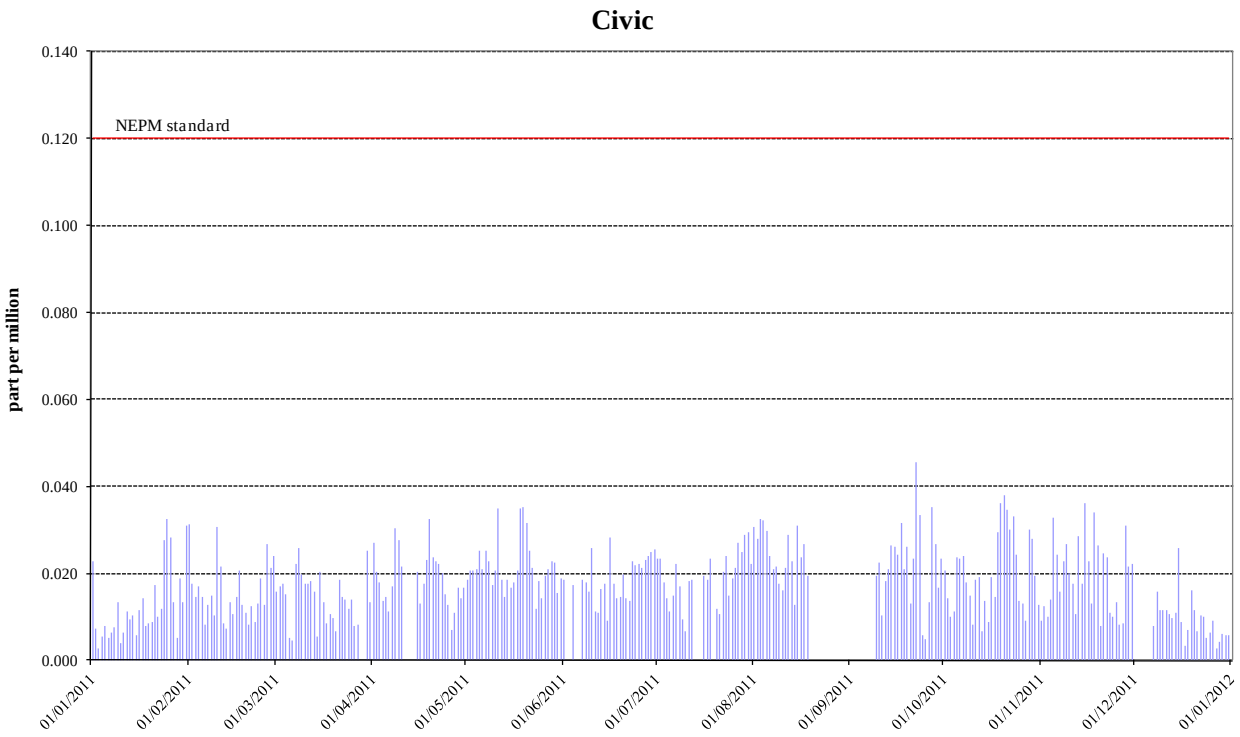

Figure 4: Daily max for NO_2 – Civic

Ozone

During 2011, no exceedences of the 1 hour and 4 hour standards for O_3 were recorded in the ACT, and compliance against the AAQ NEPM goal was demonstrated at both stations.

Table 6: 2011 compliance summary for O_3

AAQ NEPM standard – 0.10 ppm (1 hour average), 0.08 ppm (4 hour average)

Performance monitoring station	Data availability rates (% of hours)					Number of exceedences (days)		Performance against the standards and goal	
	Q1	Q2	Q3	Q4	Annual	1 hour	4 hours	1 hour	4 hours
Monash	95.7	93.8	95.6	95.2	95.1	0	0	MET	MET
Civic	93.8	86.1	95.8	95.8	92.9	0	0	MET	MET

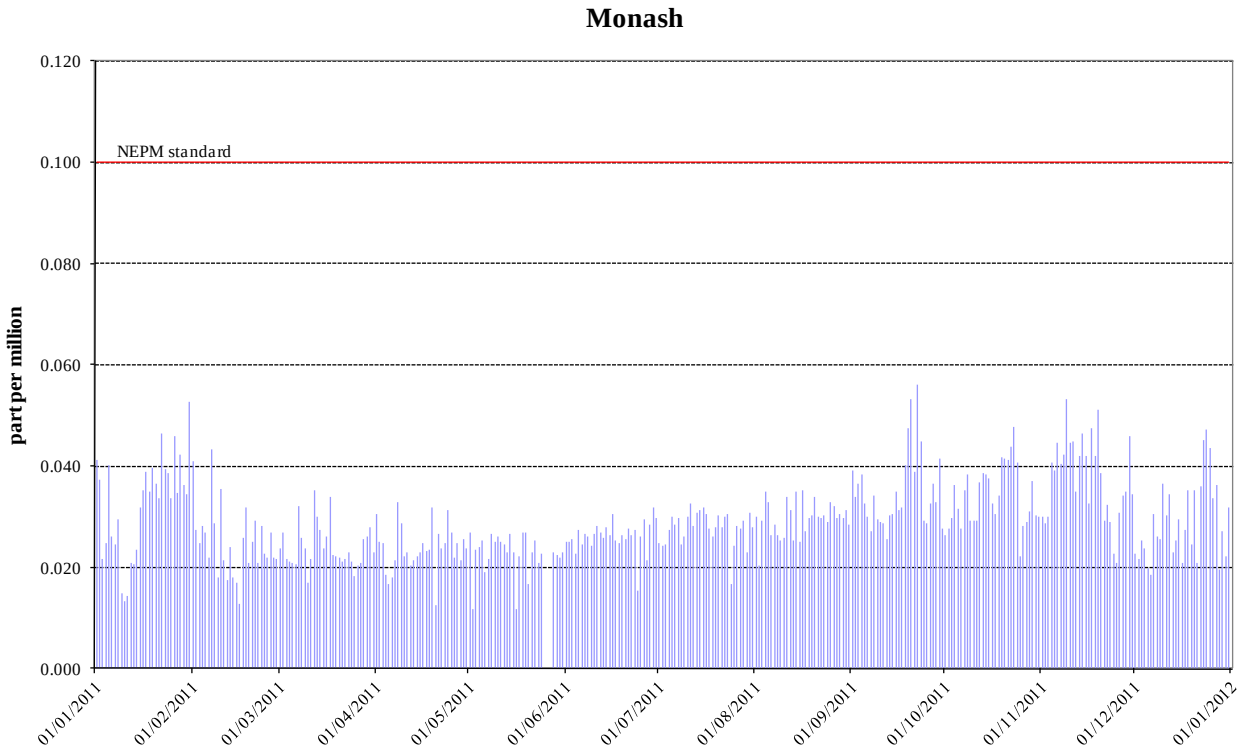

Figure 5: Daily max for 1 hour O_3 – Monash

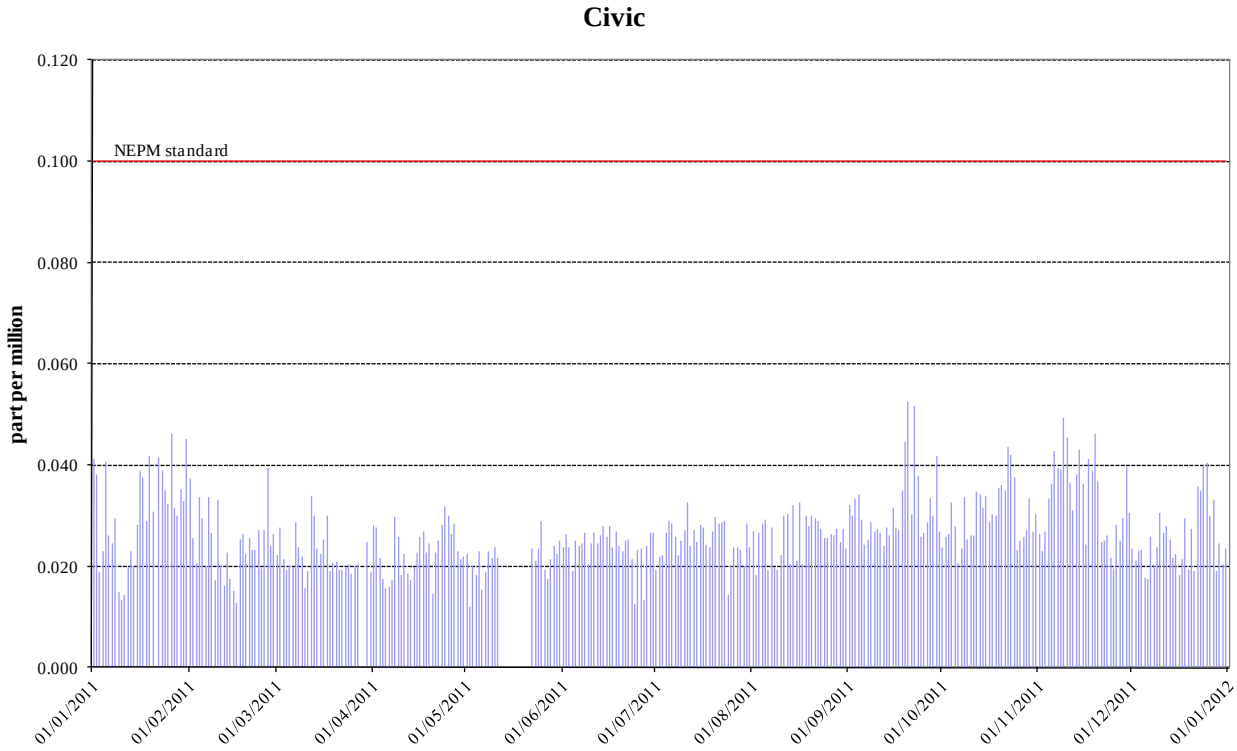

Figure 6: Daily max for 1 hour O_3 – Civic

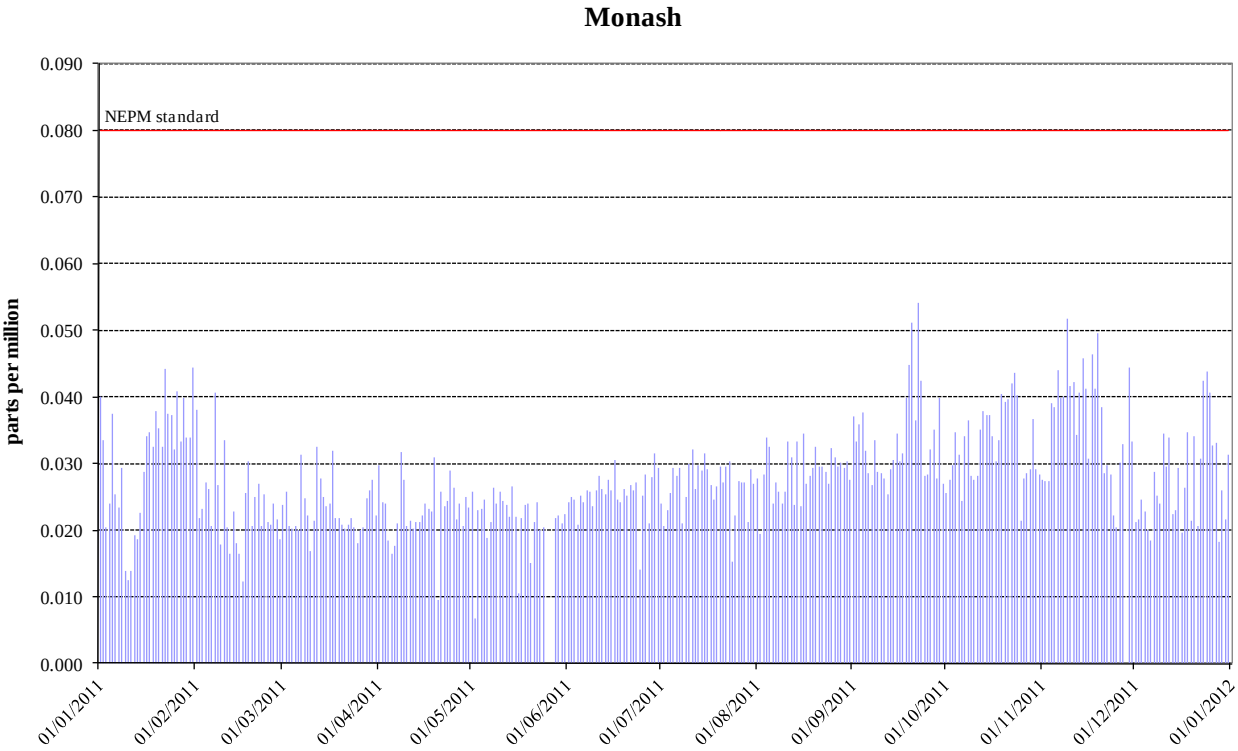

Figure 7: Daily max for 4 hours O_3 - Monash

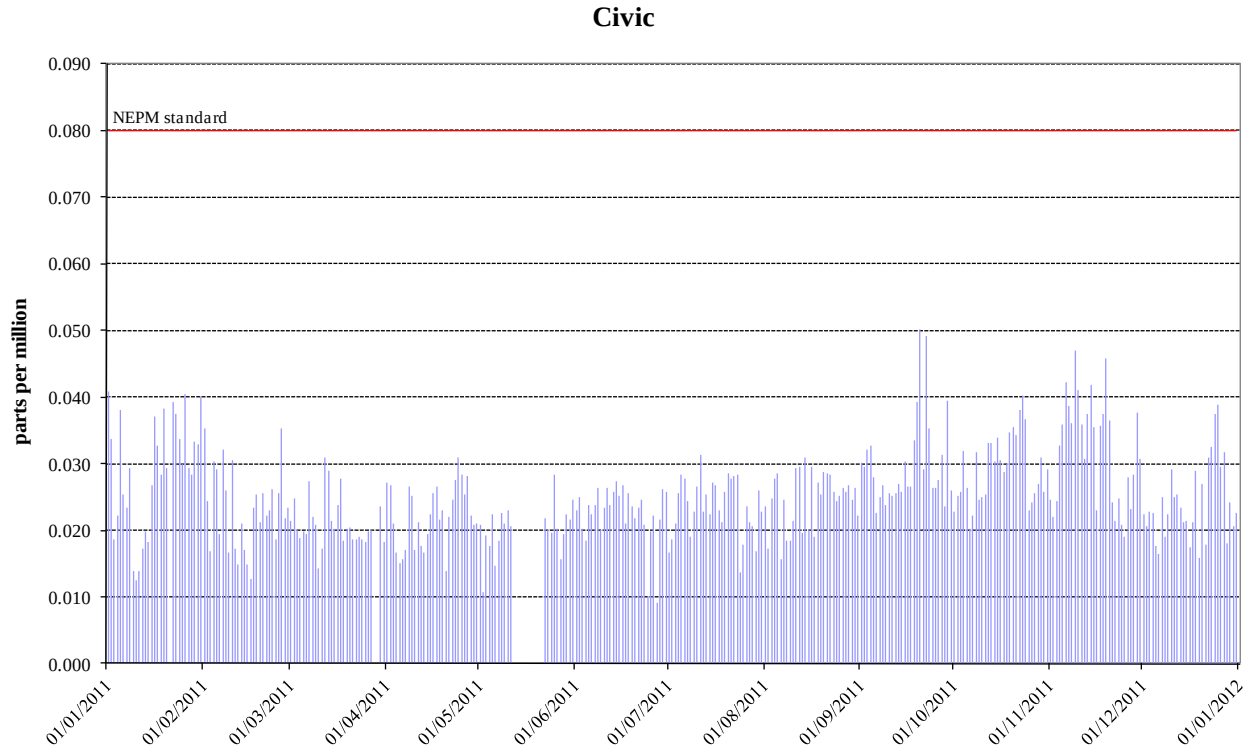

Figure 8: Daily max for 4 hours O_3 - Civic

PM_{10}

During 2011, there were no exceedences of the 24-hr PM_{10} standard recorded in the ACT, and compliance against the AAQ NEPM goal was demonstrated at both stations.

Table 7: 2011 compliance summary for PM_{10}

AAQ NEPM standard 50 µg/m^3 1 day average

Performance monitoring station	Data availability rates (% of days)					Number of exceedences (days)	Performance against the standards and goal
	Q1	Q2	Q3	Q4	Annual		
Monash	96.7	100	100	100	98.9	0	MET
Civic	98.9	100	100	91.7	96.7	0	MET

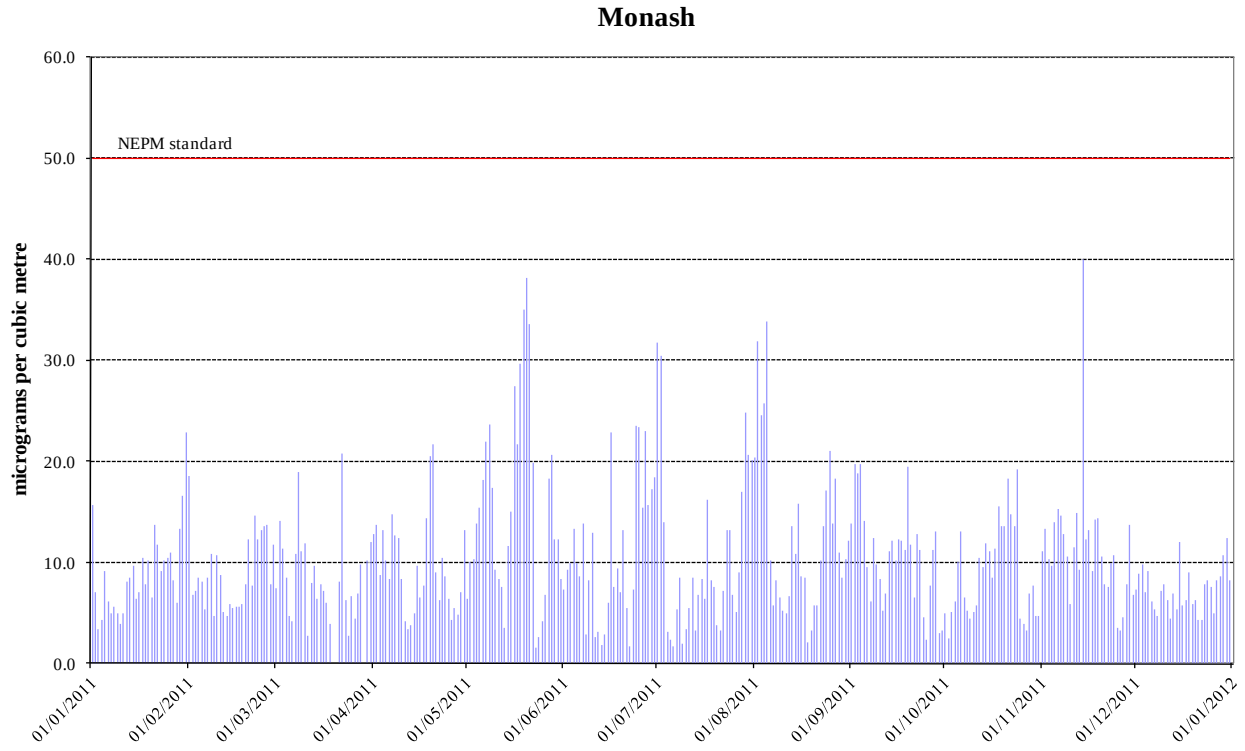

Figure 9: Daily max for PM_{10} – Monash.

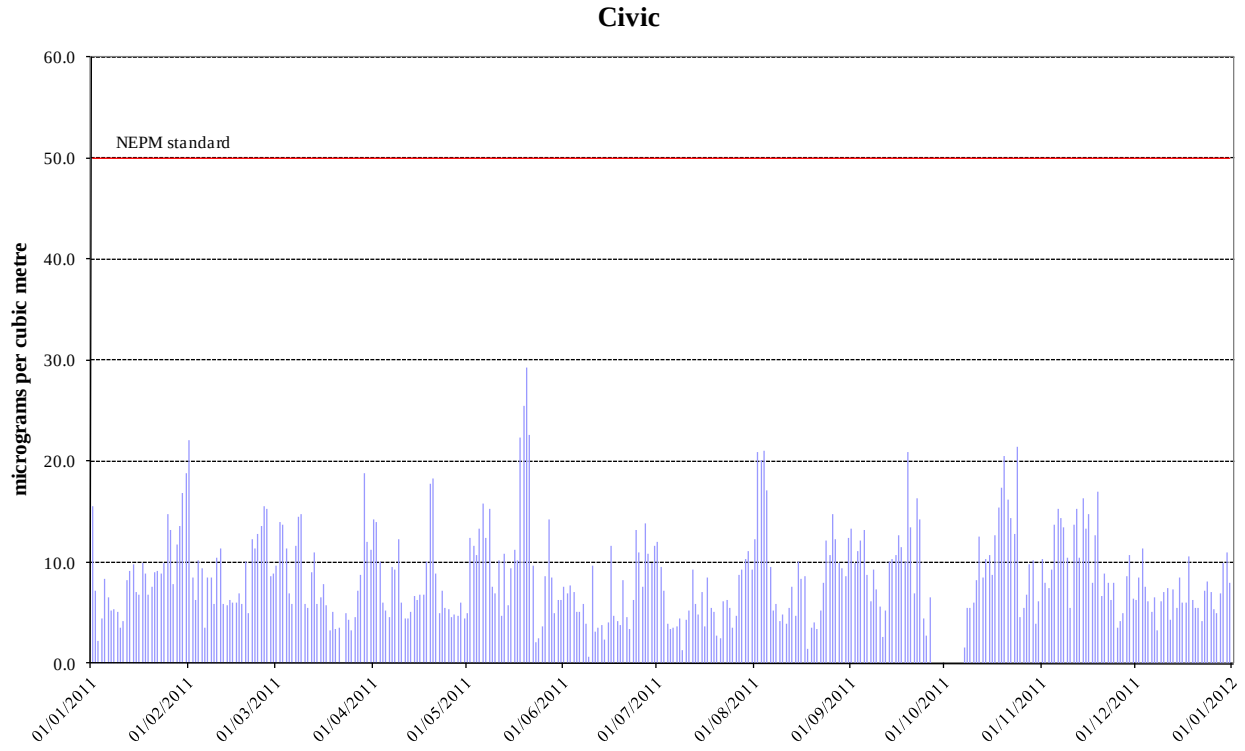

Figure 10: Daily max for PM_{10} – Civic.

$PM_{2.5}$

Four exceedences of the 24-hr advisory reporting standard were recorded at Monash during 2011.

Table 8: 2011 compliance summary for $PM_{2.5}$

AAQ NEPM standard – 25 μg/m^3 (1 day), 8 μg/m^3 (1year)

Performance monitoring station	Data availability rates (% of days)					Annual mean Concentration (μg/m^3)	Number of exceedences (days)
	Q1	Q2	Q3	Q4	Annual		
Monash	95.6	98.9	94.6	85.1	92.3	6.4	4

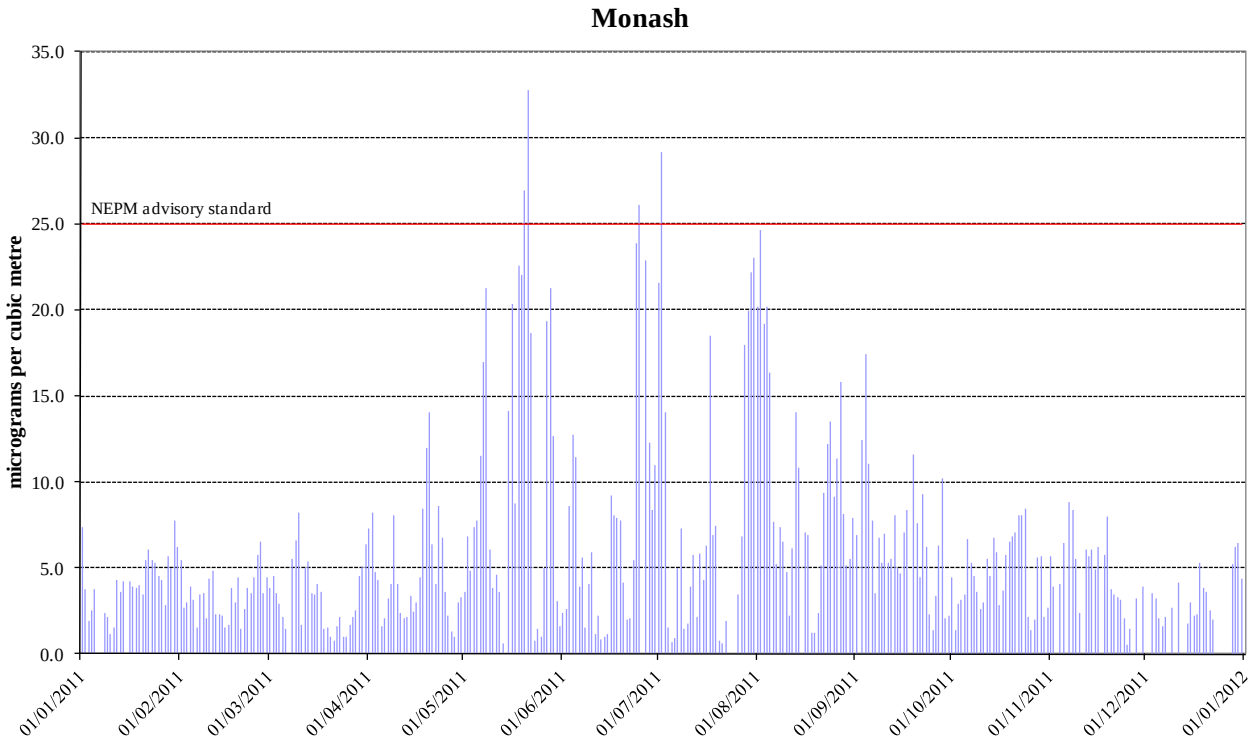

Figure 11: Daily max for $PM_{2.5}$ – Monash.

ANALYSIS OF AIR QUALITY MONITORING

Annual summary statistics contained in Table 9 to Table 14 below allow assessment of air quality against the standards and the extent of compliance with the goal. Instances where the standard or goal has been exceeded are highlighted in bold. The AAQ NEPM states that the short-term standards should not be exceeded on more than one day for CO, NO_2 and O_3, and on no more than five days per year for PM_{10}. The second highest daily value for the year (or the sixth for PM_{10}) indicates the extent to which the standards are or are not met.

Carbon monoxide

Table 9: 2011 summary statistics for daily peak 8-hour CO

AAQ NEPM standard - 9.0 ppm (8-hr average)

Performance monitoring station	Number of valid days	Highest (ppm)	Highest (date/time)	2nd Highest (ppm)	2nd Highest (date/time)
Monash	360	2.2	21 May 03:00	2.1	22 May 05:00
Civic	357	2.0	02 Aug 23:00	1.9	04 Aug 21:00

Carbon monoxide levels are well below the AAQ NEPM standard. Because of both an improvement in vehicle emissions and a decline in wood heaters numbers, levels are trending down (refer to **Figure 12** and **Figure 13**). The highest recorded value in the ACT during 2011 was 2.2ppm at Monash. This is only 24% of the standard.

Nitrogen dioxide

Table 10: 2011 summary statistics for daily peak 1-hour NO_2

AAQ NEPM standard 0.12 ppm (1 hour average)

Performance monitoring station	Number of valid days	Highest (ppm)	Highest (date/time)	2nd Highest (ppm)	2nd Highest (date/time)
Monash	353	0.043	22 Sept 21:00	0.033	04 Sept 20:00
Civic	324	0.046	22 Sept 21:00	0.038	20 Oct 22:00

Nitrogen dioxide levels are well below the AAQ NEPM standard and have remained stable over the last decade. The highest recorded 1 hour value during 2011 was 0.046ppm at Civic, which is only

38% of the standard. The highest recorded annual average in 2011 was 0.008ppm at Civic. This is only 27% of the standard.

Ozone

Table 11: 2011 summary statistics for daily peak 1-hour O_3

AAQ NEPM standard 0.10 ppm (1-hour average)

Performance monitoring station	Number of valid days	Highest (ppm)	Highest (date/time)	2nd Highest (ppm)	2nd Highest (date/time)
Monash	362	0.056	22 Sept 15:00	0.053	20 Sept 01:00
Civic	352	0.052	20 Sept 01:00	0.052	22 Sept 14:00

Table 12: 2011 summary statistics for daily peak 4-hour O_3

AAQ NEPM standard 0.08 ppm (4-hour average)

Performance monitoring station	Number of valid days	Highest (ppm)	Highest (date/time)	2nd Highest (ppm)	2nd Highest (date/time)
Monash	361	0.054	22 Sept 18:00	0.052	09 Nov 18:00
Civic	352	0.050	20 Sept 03:00	0.049	22 Sept 17:00

Ozone levels are below the AAQ NEPM standard. The highest recorded 1-hour value in the ACT during 2011 was 0.056ppm at Monash, which is 56% of the standard. The highest recorded 4-hour value in the ACT during 2011 was 0.054ppm at Monash. This is 68% of the standard.

PM_{10}

Table 13: 2011 summary statistics for daily peak PM_{10}

AAQ NEPM standard 50 µg/m^3 (24-hour average)

Performance monitoring station	Number of valid days	Highest (µg/m^3)	Highest (date)	6th Highest (µg/m^3)	6th Highest (date)
Monash	362	40.0	14 Nov	31.9	20 May
Civic	354	29.2	20 May	21.5	19 May

PM_{10} levels are below the AAQ NEPM standard. The highest PM_{10} level recorded during 2011 was 40.0µg/m^3 on 14 November 2011. This is 80% of the AAQ NEPM standard.

$PM_{2.5}$

Table 14: 2011 summary statistics for daily peak $PM_{2.5}$

AAQ NEPM standard 25 µg/m^3 (24-hour average)

Performance monitoring station	Number of valid days	Highest (µg/m^3)	Highest (date)	6th Highest (µg/m^3)	6th Highest (date)
Monash	336	**32.8**	21 May	23.8	24 Jun

The 24-hour advisory reporting standard for $PM_{2.5}$ was exceeded four times at Monash. The exceedences happened during late May to early July 2011 because of particle emissions from wood heaters during winter.

ASSESSMENT OF PROGRESS TOWARDS ACHIEVING THE GOAL

The ACT is currently compliant with the goal specified in Schedule 2 of the AAQ NEPM.

Historical monitoring indicates that the only AAQ NEPM pollutant of concern in the Canberra airshed is particulate matter, which increases during winter because of emissions from domestic wood heaters. In more recent years exceedences of the particulate matter standard have also been attributed to dust storms and smoke from controlled burns.

The ACT Government acknowledges that woodsmoke is a problem and is working towards addressing the issue in an informed and measured manner to ensure a satisfactory outcome for all Canberrans.

It will continue to implement an integrated program to address woodsmoke. This will involve public education and enforcement activities, the licensing of firewood merchants, the implementation of the 'Don't Burn Tonight Campaign' and the on-going implementation of the Wood Heater Replacement Program.

It is pleasing to note that there were no exceedences of the PM_{10} standard in 2011 because of wood heater emissions, although monitoring clearly shows that levels increase during the winter months (refer to Figure 9 and Figure 10 for details). Since 2002 the 95th percentile for PM_{10} at Monash has fallen from 42.4µg/m^3 to 22.8µg/m^3. This is a significant improvement.

The ACT will also work with the Commonwealth and other jurisdictions at a national level through the Standing Council on Environment and Water to progress actions to improve air quality, in particular national reforms to manage wood heather emissions.

APPENDIX A: STATISTICAL SUMMARY AND TRENDS

The following section provides a basic statistical summary, using percentiles, for each station and for each standard. Percentiles for daily maximum values are presented.

Carbon monoxide

Table 15: Statistical summary for daily maximum 8-hour CO Monash 2002 – 2011

Year	Data Availability (%)	No. of Exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2002	92	0	4.3	3.7	3.4	2.9	2.3	1.2	0.4
2003	86.8	0	3.7	3.0	2.8	2.5	2.0	0.8	0.3
2004	94.1	0	3.2	2.7	2.5	2.0	1.6	0.9	0.5
2005	99.5	0	3.2	2.8	2.5	2.2	1.7	1.0	0.4
2006	99.7	0	3.7	2.8	2.6	2.2	1.8	1.1	0.4
2007	95.3	0	2.6	2.5	2.4	2.0	1.5	0.7	0.4
2008	88.0	0	2.4	2.2	2.1	1.8	1.5	0.8	0.3
2009	96.4	0	2.0	1.7	1.5	1.4	1.1	0.6	0.3
2010	99.2	0	1.8	1.7	1.6	1.4	1.1	0.6	0.3
2011	98.6	0	2.2	1.9	1.8	1.5	1.1	0.5	0.2

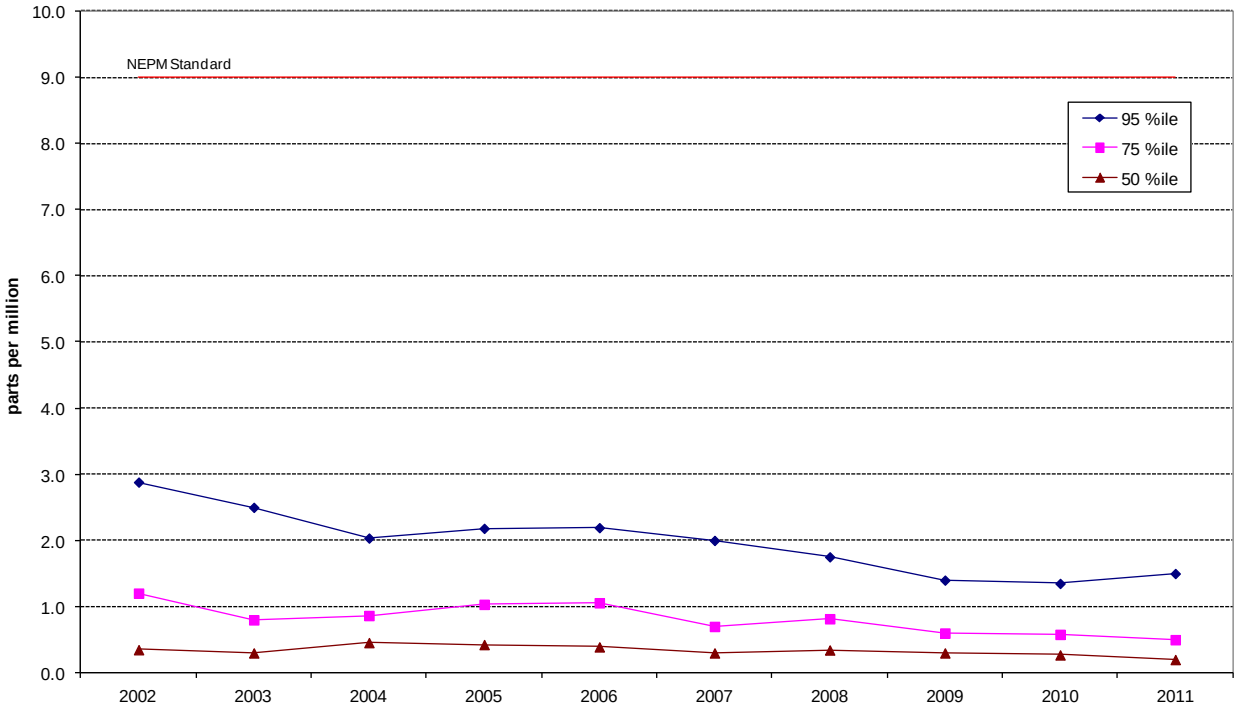

Figure 12: Statistical summary for daily maximum 8-hour CO Monash 2002 – 2011

Table 16: Statistical summary for daily maximum 8-hour CO Civic 2002 – 2011

Year	Data Availability (%)	No. of Exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2002	86.8	0	5.1	4.7	4.4	3.52	2.9	1.6	0.6
2003	95.7	0	3.5	2.8	2.6	2.2	1.8	1.0	0.6
2004	95.7	0	4.6	3.6	3.2	2.3	1.6	0.6	0.6
2005	95.6	0	3.7	3.4	3.2	2.6	1.7	1.1	0.7
2006	95.4	0	2.8	2.7	2.6	2.1	1.4	0.8	0.5
2007	93.2	0	2.8	2.3	2.0	1.6	1.3	0.8	0.5
2008	92.7	0	2.3	2.1	2.0	1.6	1.2	0.7	0.4
2009	95.1	0	1.9	1.6	1.2	1.0	0.8	0.6	0.4
2010	98.6	0	2.0	1.9	1.8	1.4	1.2	0.9	0.6
2011	97.8	0	2.0	1.8	1.6	1.4	1.0	0.7	0.5

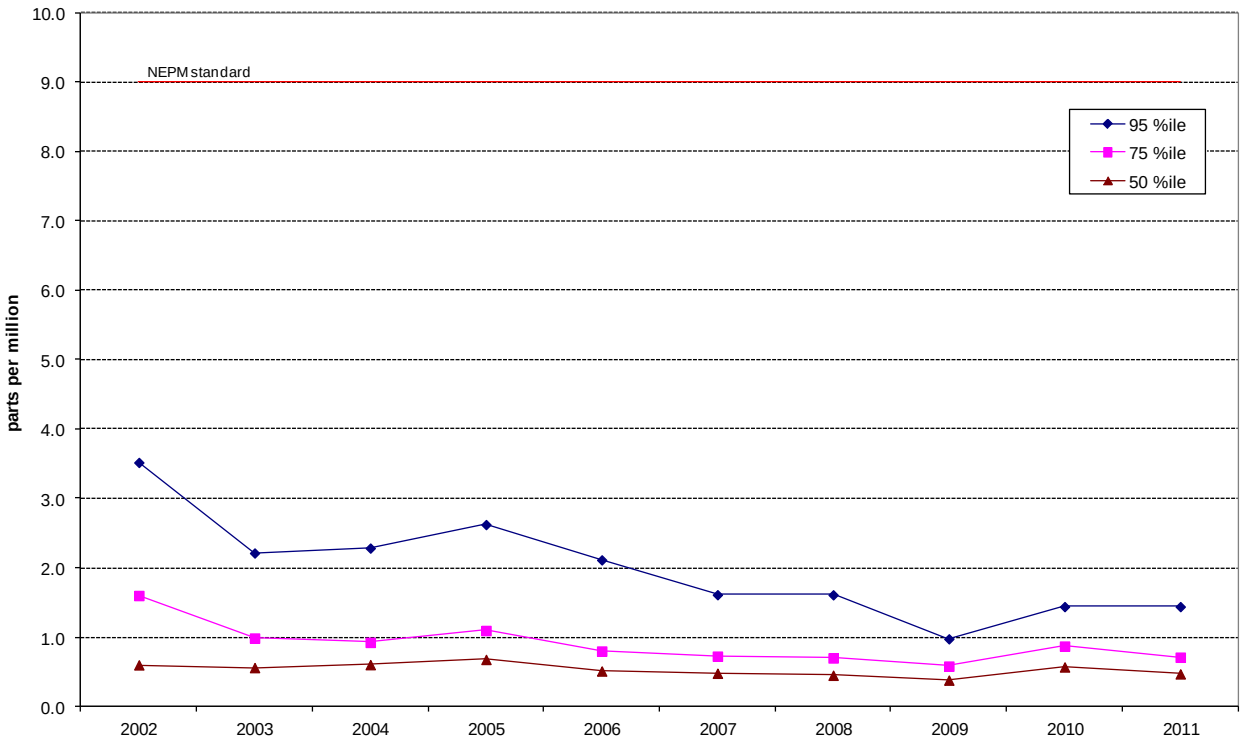

Figure 13: Statistical summary for daily maximum 8-hour CO Civic 2002 – 2011

Nitrogen dioxide

Table 17: Statistical summary for daily maximum 1-hour NO_2 Monash 2002 – 2011

Year	Data Recovery (%)	No. of Exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2002	88.3	0	0.045	0.036	0.034	0.031	0.026	0.022	0.017
2003	90.4	0	0.064	0.042	0.033	0.028	0.025	0.021	0.016
2004	91.8	0	0.040	0.033	0.031	0.028	0.026	0.022	0.018
2005	97.8	0	0.041	0.034	0.031	0.028	0.027	0.024	0.018
2006	98.4	0	0.044	0.036	0.033	0.031	0.029	0.024	0.019
2007	97.0	0	0.039	0.037	0.035	0.030	0.028	0.023	0.018
2008	86.5	0	0.103	0.040	0.032	0.031	0.028	0.025	0.019
2009	92.6	0	0.041	0.034	0.033	0.029	0.027	0.023	0.019
2010	89.1	0	0.037	0.029	0.028	0.025	0.023	0.021	0.017
2011	96.7	0	0.043	0.031	0.030	0.029	0.026	0.022	0.015

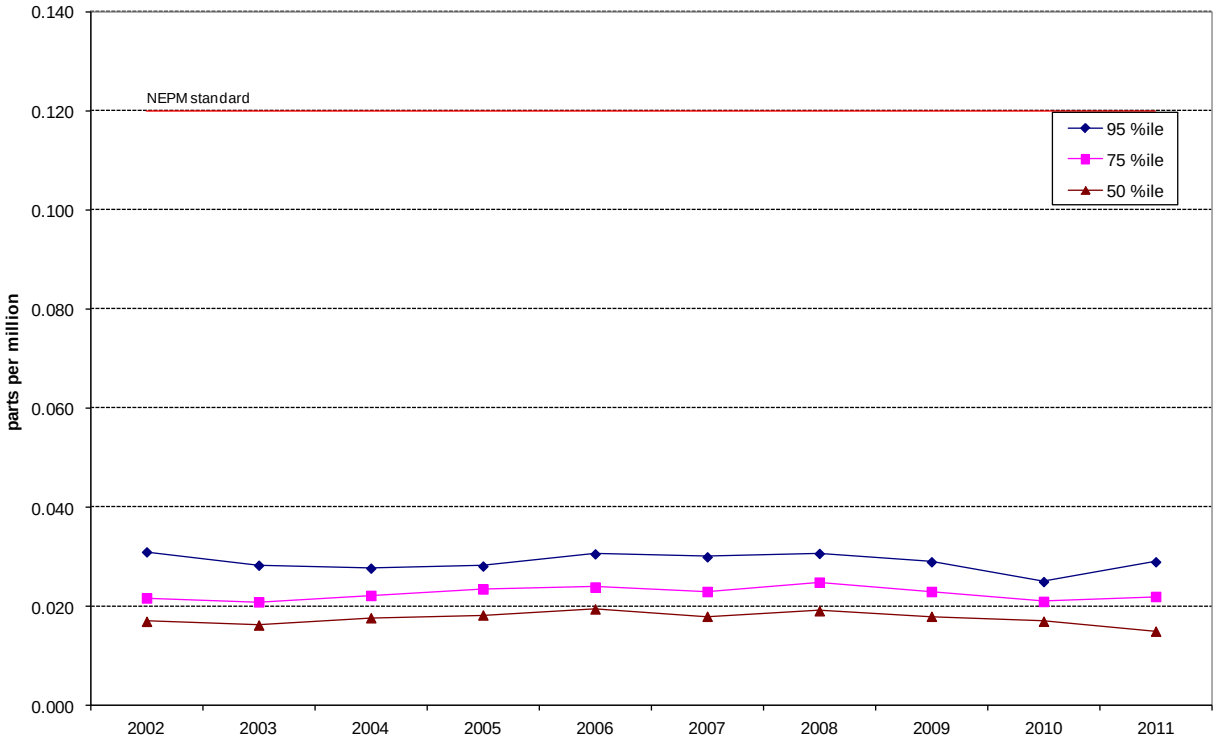

Figure 14: Statistical summary for daily maximum 1-hour NO_2 Monash 2002 – 2011

Table 18: Statistical summary for daily maximum 1-hour NO_2 Civic 2002 – 2011

Year	Data Recovery (%)	No. of Exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2002	88.2	0	0.062	0.050	0.044	0.038	0.034	0.029	0.024
2003	83.6	0	0.087	0.050	0.045	0.034	0.028	0.022	0.018
2004	88.3	0	0.042	0.037	0.035	0.030	0.027	0.022	0.018
2005	95.3	0	0.040	0.036	0.033	0.030	0.029	0.024	0.020
2006	95.2	0	0.044	0.035	0.034	0.031	0.028	0.022	0.018
2007	92.8	0	0.059	0.042	0.039	0.035	0.030	0.025	0.021
2008	88.6	0	0.046	0.037	0.035	0.033	0.030	0.026	0.020
2009	79.5	0	0.044	0.038	0.036	0.030	0.027	0.023	0.018
2010	74.9	0	0.039	0.035	0.033	0.030	0.027	0.024	0.021
2011	88.8	0	0.046	0.036	0.035	0.032	0.029	0.023	0.018

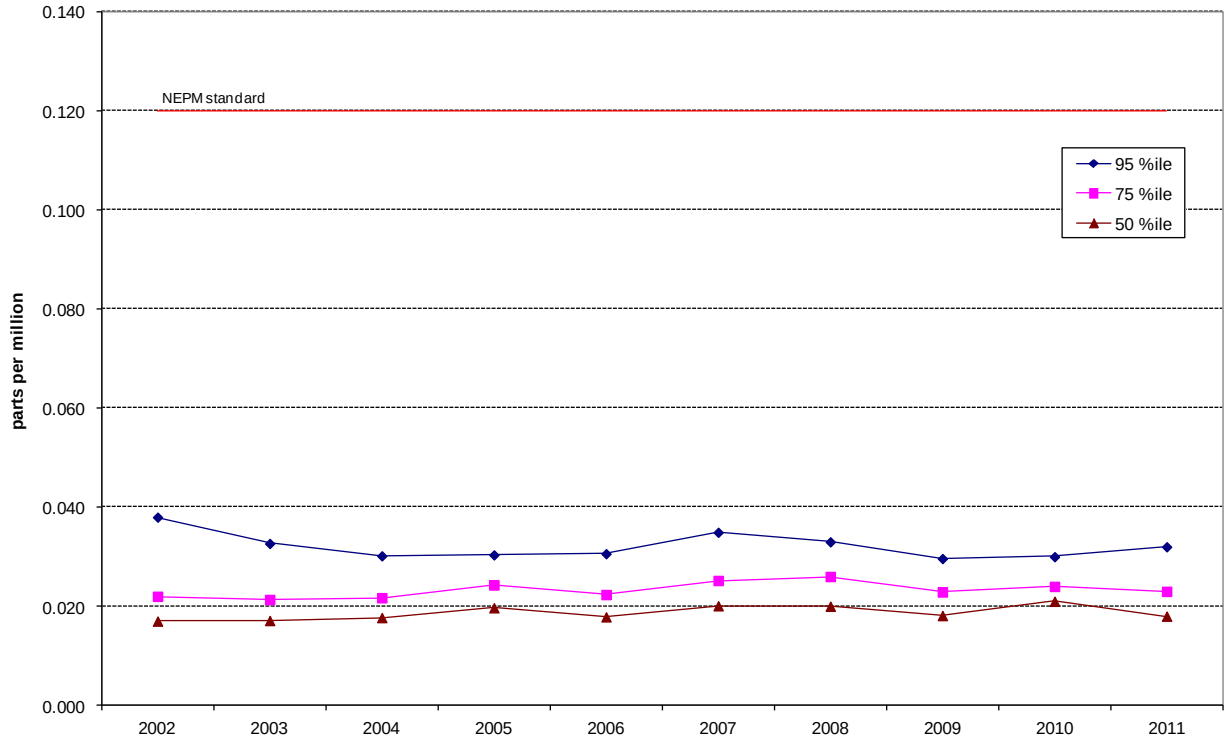

Figure 15: Statistical summary for daily maximum 1-hour NO_2 Civic 2002 – 2011

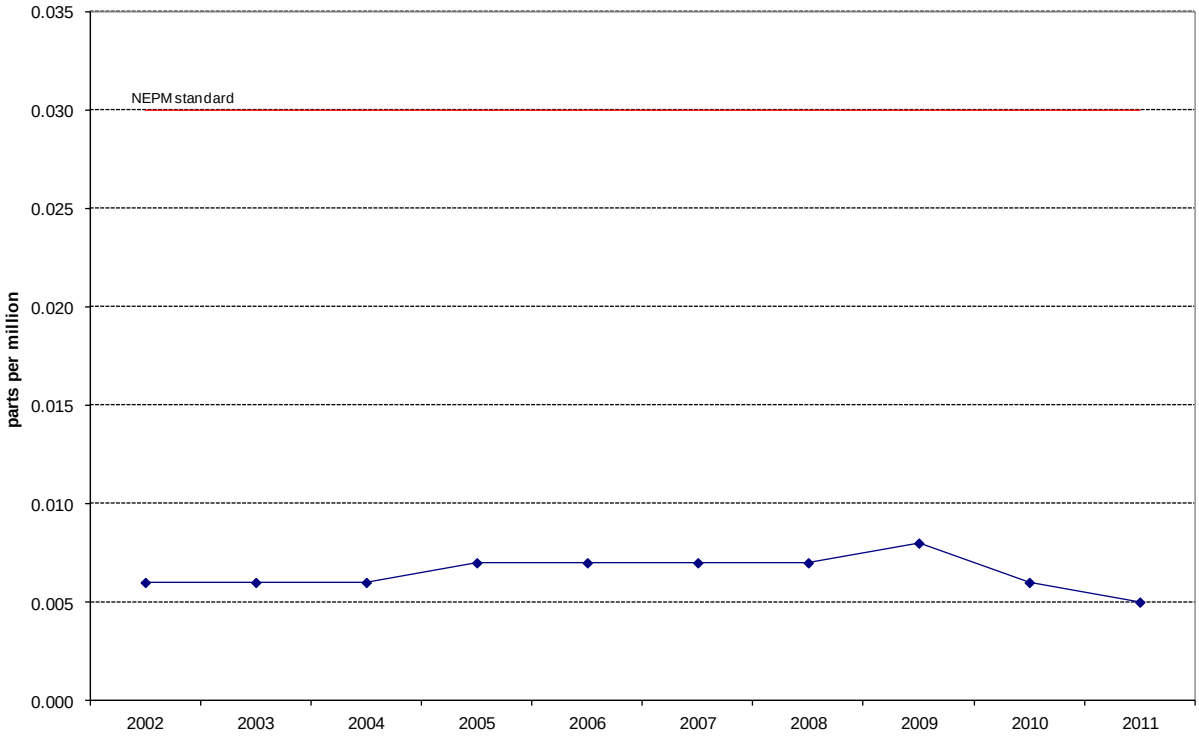

Figure 16: Annual average 1-hour NO_2 Monash 2002 – 2011

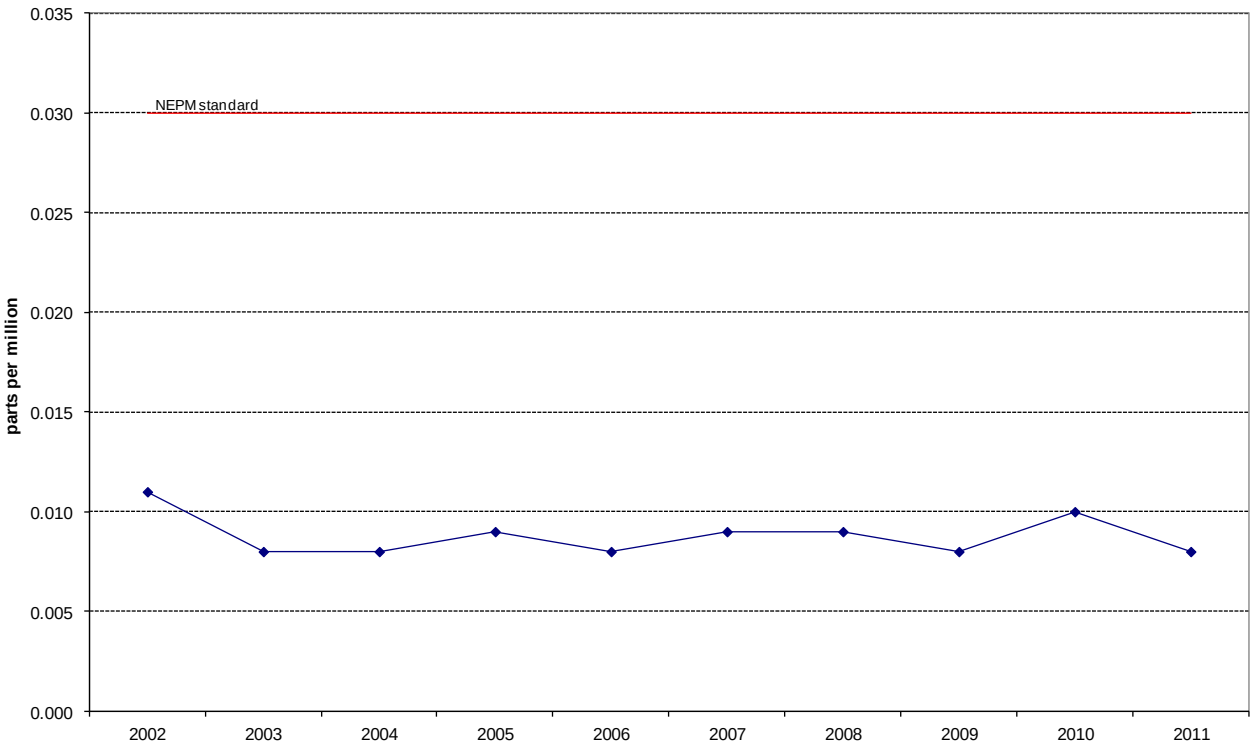

Figure 17: Annual average 1-hour NO_2 Civic 2002 – 2011

Ozone

Table 19: Statistical summary for daily maximum 1-hour O_3 Monash 2002 – 2011

Year	Data Recovery (%)	No. of Exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2002	93.5	0	0.063	0.055	0.052	0.047	0.042	0.032	0.024
2003	92.4	0	0.102	0.069	0.061	0.050	0.045	0.035	0.025
2004	94.1	0	0.064	0.56	0.054	0.048	0.044	0.038	0.030
2005	97.8	0	0.065	0.058	0.053	0.045	0.041	0.034	0.030
2006	99.7	0	0.067	0.060	0.057	0.052	0.049	0.040	0.032
2007	95.4	0	0.075	0.064	0.062	0.057	0.052	0.043	0.032
2008	84.2	0	0.065	0.055	0.053	0.047	0.040	0.031	0.026
2009	96.4	0	0.073	0.063	0.059	0.052	0.045	0.038	0.030
2010	86.6	0	0.051	0.048	0.046	0.042	0.037	0.033	0.030
2011	99.2	0	0.056	0.052	0.047	0.044	0.040	0.033	0.028

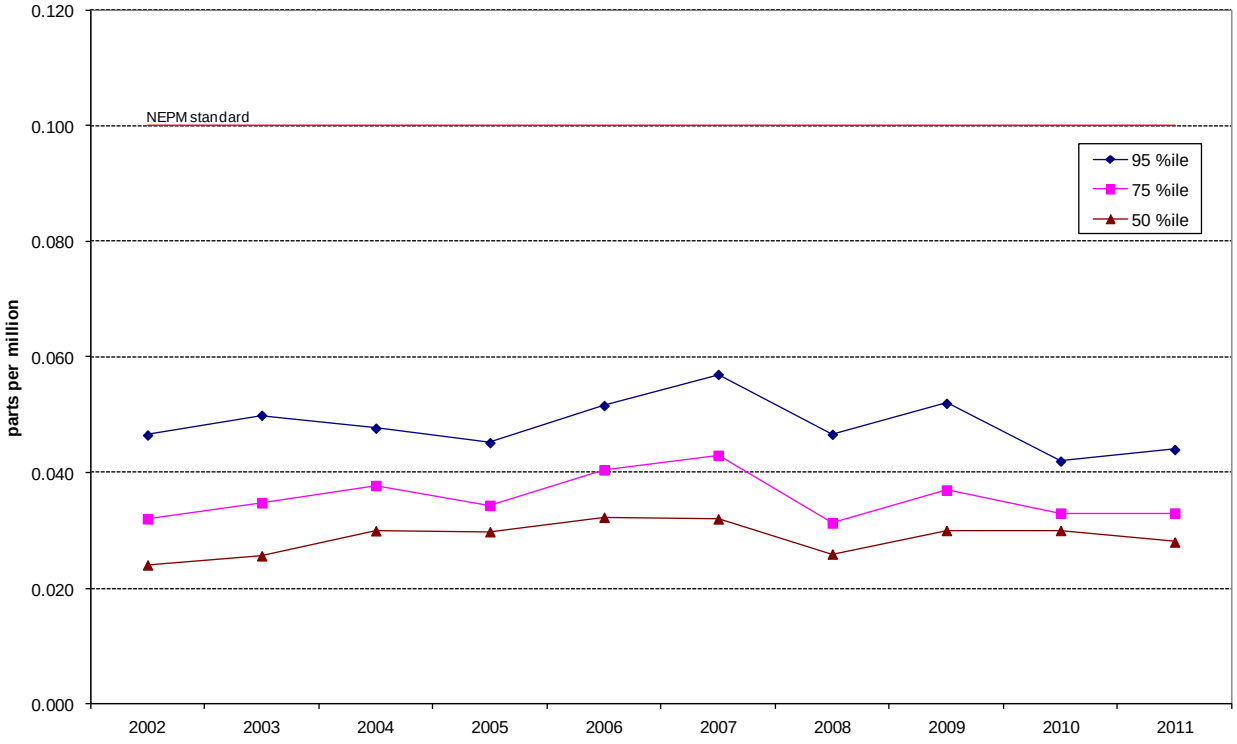

Figure 18: Statistical summary for daily maximum 1-hour O_3 Monash 2002 – 2011

Table 20: Statistical summary for daily maximum 1-hour O_3 Civic 2002 – 2011

Year	Data Recovery (%)	No. of Exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2002	79.8	0	0.082	0.060	0.053	0.049	0.044	0.035	0.029
2003	93.6	0	0.094	0.065	0.055	0.049	0.045	0.037	0.031
2004	93.5	0	0.071	0.055	0.053	0.045	0.041	0.034	0.028
2005	85.5	0	0.070	0.061	0.051	0.042	0.038	0.032	0.028
2006	95.5	3	0.252	0.084	0.060	0.049	0.043	0.034	0.027
2007	91.5	1	0.112	0.057	0.050	0.044	0.040	0.032	0.026
2008	91.4	0	0.052	0.050	0.044	0.039	0.034	0.028	0.023
2009	97.8	0	0.060	0.055	0.052	0.044	0.040	0.031	0.024
2010	99.2	0	0.058	0.050	0.048	0.040	0.036	0.029	0.025
2011	96.4	0	0.052	0.046	0.045	0.041	0.036	0.030	0.026

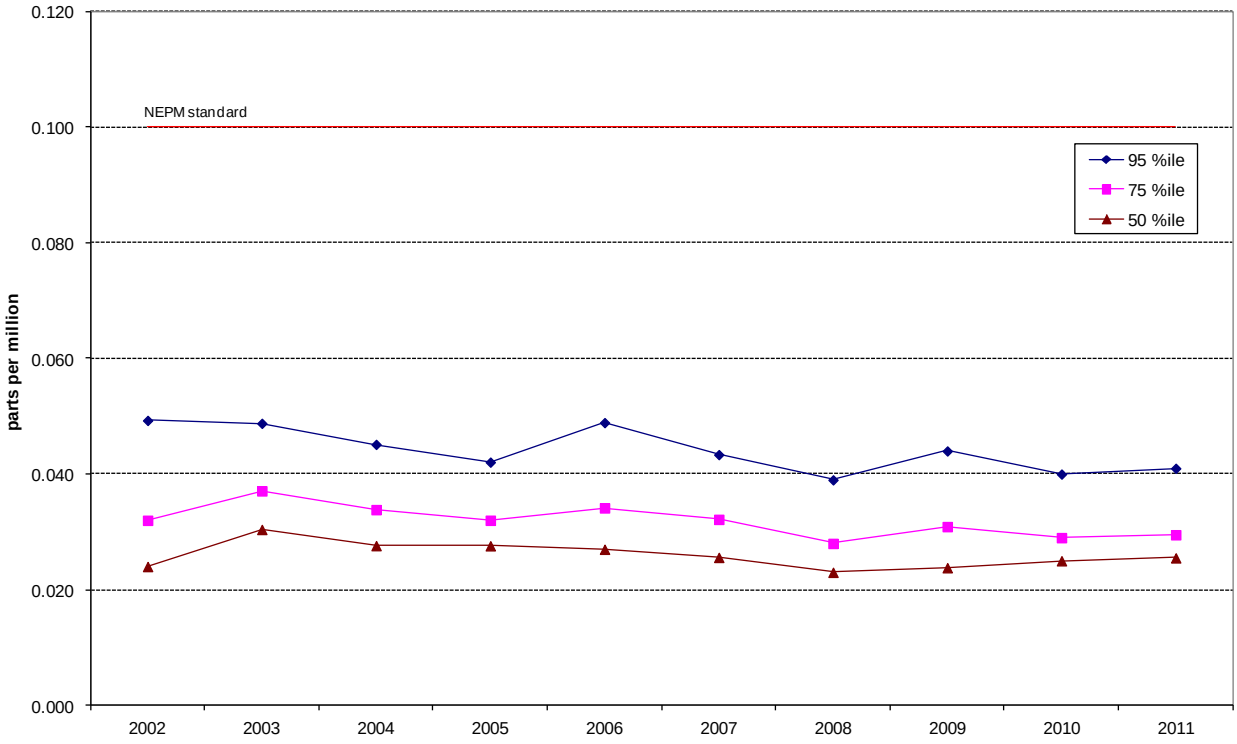

Figure 19: Statistical summary for daily maximum 1-hour O_3 Civic 2002 – 2011

Table 21: Statistical summary for daily maximum 4-hour O_3 Monash 2002 – 2011

Year	Data Recovery (%)	No. of Exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2002	93.5	0	0.058	0.051	0.049	0.044	0.039	0.031	0.023
2003	92.4	1	0.082	0.063	0.058	0.048	0.043	0.033	0.025
2004	94.1	0	0.060	0.053	0.051	0.045	0.042	0.036	0.029
2005	97.5	0	0.062	0.054	0.049	0.044	0.039	0.033	0.029
2006	99.7	0	0.061	0.056	0.055	0.050	0.046	0.038	0.031
2007	100	0	0.072	0.061	0.059	0.054	0.050	0.040	0.032
2008	84.2	0	0.061	0.052	0.049	0.045	0.038	0.030	0.025
2009	96.2	0	0.068	0.058	0.056	0.048	0.044	0.036	0.029
2010	86.6	0	0.049	0.046	0.043	0.040	0.037	0.032	0.029
2011	98.9	0	0.054	0.048	0.044	0.041	0.038	0.032	0.027

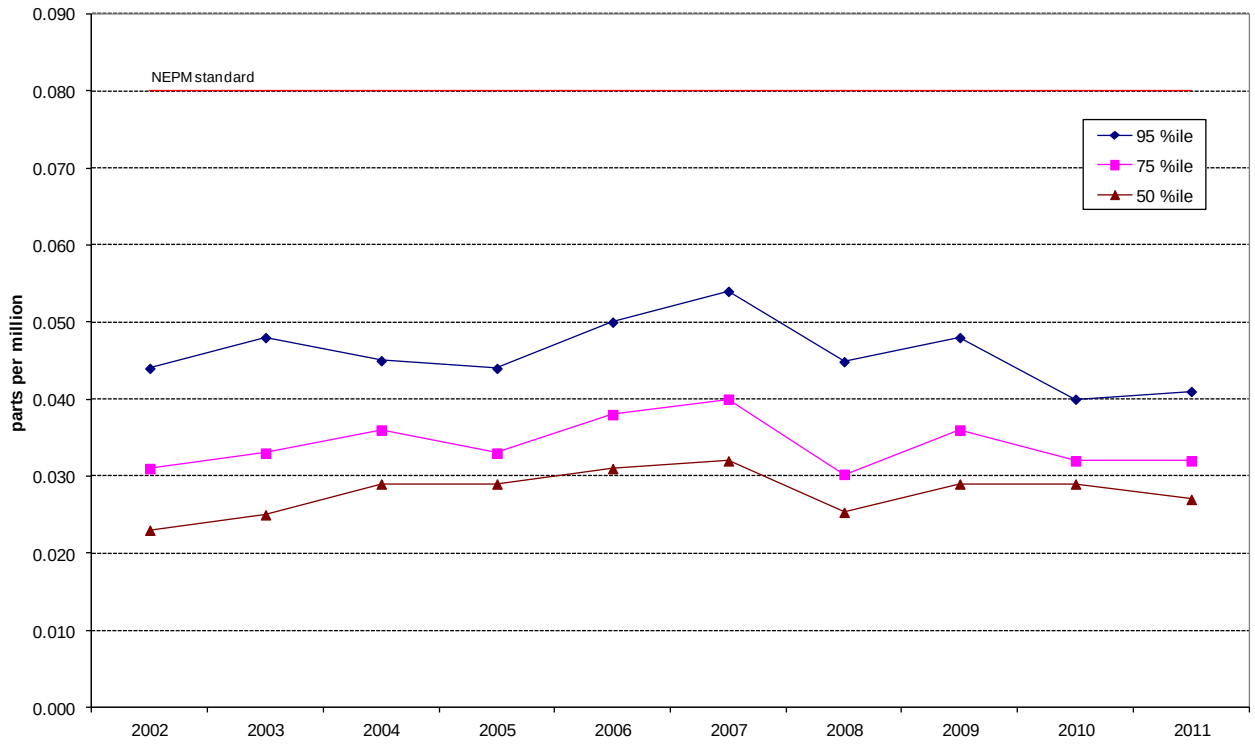

Figure 20: Statistical summary for daily maximum 4-hour O_3 Monash 2002 – 2011

Table 22: Statistical summary for daily maximum 4-hour O_3 Civic 2002 – 2011

Year	Data Recovery (%)	No. of Exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2002	79.8	0	0.073	0.057	0.051	0.046	0.042	0.033	0.027
2003	93.6	0	0.078	0.055	0.051	0.046	0.042	0.036	0.029
2004	93.5	0	0.062	0.052	0.048	0.043	0.039	0.32	0.026
2005	85.5	0	0.061	0.054	0.047	0.040	0.036	0.031	0.026
2006	95.5	1	0.145	0.066	0.053	0.045	0.040	0.032	0.026
2007	91.5	1	0.097	0.052	0.046	0.040	0.037	0.030	0.025
2008	91.4	0	0.051	0.047	0.039	0.036	0.033	0.027	0.022
2009	97.8	0	0.059	0.049	0.047	0.041	0.037	0.030	0.023
2010	99.2	0	0.056	0.047	0.044	0.037	0.034	0.028	0.024
2011	96.4	0	0.050	0.044	0.041	0.038	0.035	0.029	0.025

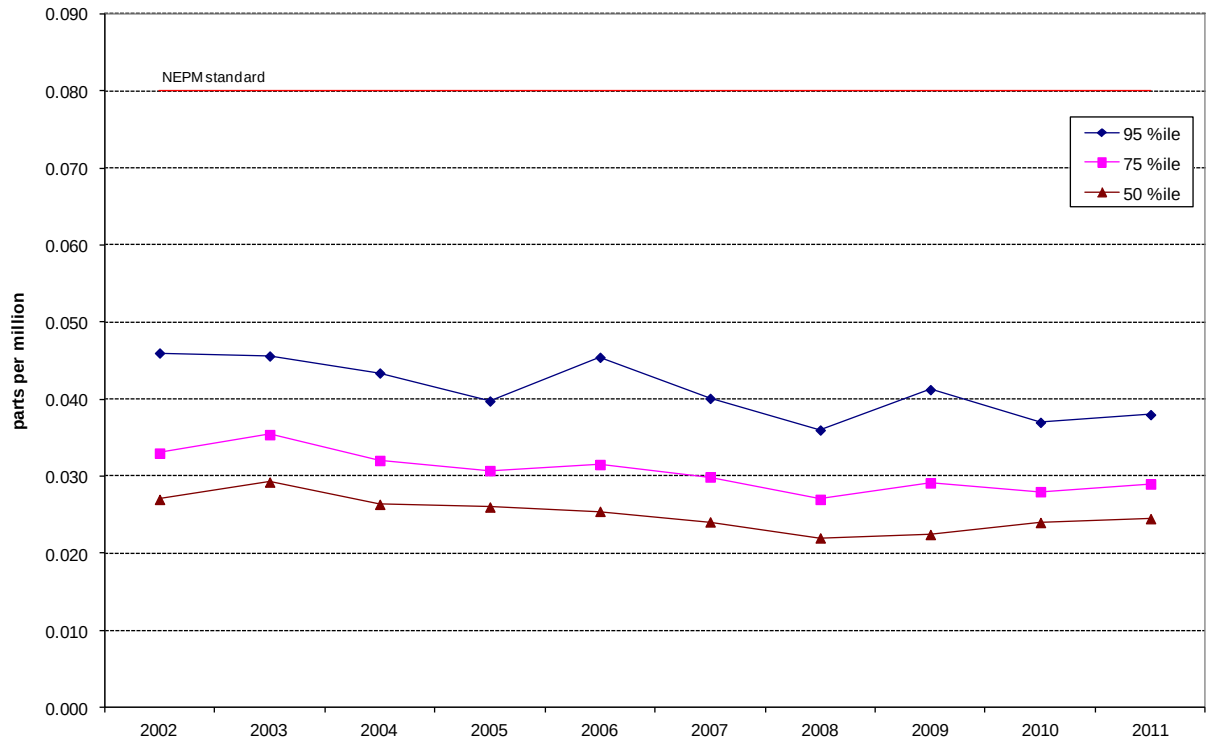

Figure 21: Statistical summary for daily maximum 4-hour O_3 Civic 2002 – 2011

PM_{10}

Table 23: Statistical summary for daily maximum 24-hour PM_{10} Monash 2002 – 2011

Year	Data Recovery (%)	No. of Exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2002	75	0	108.4	56.6	48.5	42.4	37.7	25.3	16.2
2003	97.5	13	350.4	136.4	105.3	39.6	30.3	21.2	14.6
2004	99.7	3	52.0	48.2	46.0	33.8	28.5	20.7	14.7
2005	97.5	10	98.8	57.6	52.7	37.3	31.0	21.2	14.5
2006	83.8	4	55.2	51.0	44.9	33.9	28.3	22.7	16.9
2007	99.7	5	117.7	61.8	42.5	35.3	28.0	21.0	14.9
2008	82	3	96.6	45.8	35.7	29.9	26.6	20.1	14.8
2009	42.3	9	210.0	116.0	62.4	50.5	37.7	25.5	15.2
2010	95.4	0	48.4	35.6	27.4	23.5	20.2	14.7	10.0
2011	99.2	0	40.0	33.7	30.3	22.8	18.6	13.2	8.7

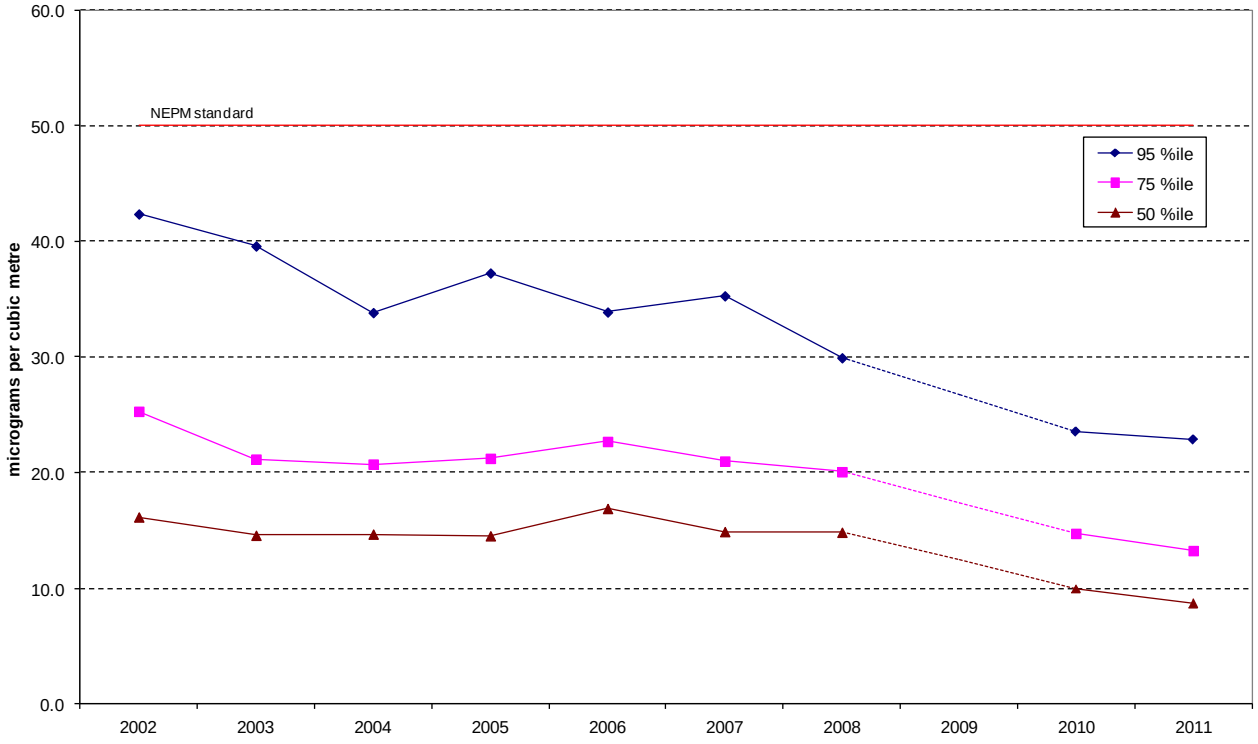

Figure 22: Statistical summary for daily maximum 24-hour PM_{10} Monash 2002 – 2011

Note 2009 data has not been included in **Figure 22** as the percentile data has been skewed because of insufficient data in Q1 and Q2 (zero and twenty five percent respectively) and the extreme readings associated with the dust storm which affected most of eastern Australia on 22 and 23 September, 2009.

Table 24: Statistical summary for daily maximum 24-hour PM_{10} Civic 2002 – 2011

Year	Data Recovery (%)	No. of Exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2002	15.6	3	67.4	67.1	66.3	42.7	25.4	18.7	15.3
2003	12.6	0	20.8	20.8	20.7	19.3	17.3	13.6	9.3
2004	16.7	0	33.2	32.4	32.0	28.1	22.5	17.9	14.4
2005	9.6	1	50.64	47.2	43.8	34.8	27.5	19.5	12.7
2006	13.2	2	70.8	61.2	51.5	46.5	35.1	26.0	17.6
2007	13.2	1	50.9	48.7	46.5	42.7	31.4	20.1	13.8
2008	12.0	1	53.3	42.5	31.7	26.1	24.2	17.3	11.9
2009	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2010	57.6	0	23.8	19.7	17.1	14.7	13.7	11.1	8.4
2011	97.0	0	29.2	22.3	20.9	16.9	14.4	11.0	7.9

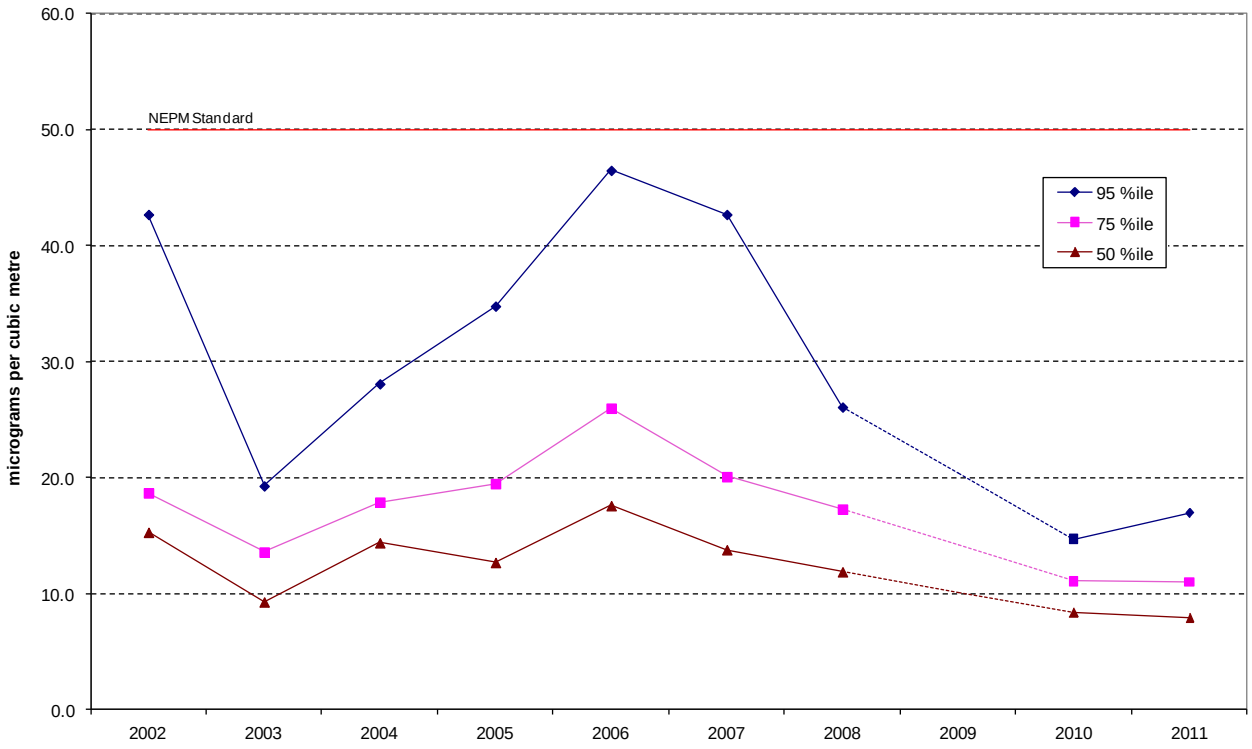

Figure 23: Statistical summary for daily maximum 24-hour PM_{10} Civic 2002 – 2011

Note No PM_{10} monitoring was conducted at Civic in 2009.

$PM_{2.5}$

Table 25: Statistical summary for daily maximum 24-hour $PM_{2.5}$ Monash 2004 – 2011

Year	Data Recovery (%)	No. of Exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2004	93.1	15	38.3	35.8	31.5	23.5	16.6	9.5	6.2
2005	73.6	14	38.6	31.4	29.3	25.0	20.7	9.0	4.9
2006	83.3	20	46.9	35.6	33.3	27.8	15.6	8.7	5.8
2007	58.1	8	45.7	27.8	27.6	20.9	15.7	8.8	5.4
2008	45.4	6	30.7	28.0	25.7	23.5	19.7	12.4	6.3
2009	64.5	2	33.5	23.0	20.0	14.6	12.2	7.6	5.0
2010	95.1	2	52.4	22.1	20.9	17.4	14.3	7.8	4.4
2011	92.1	4	32.8	25.6	22.9	20.0	12.5	7.0	4.5

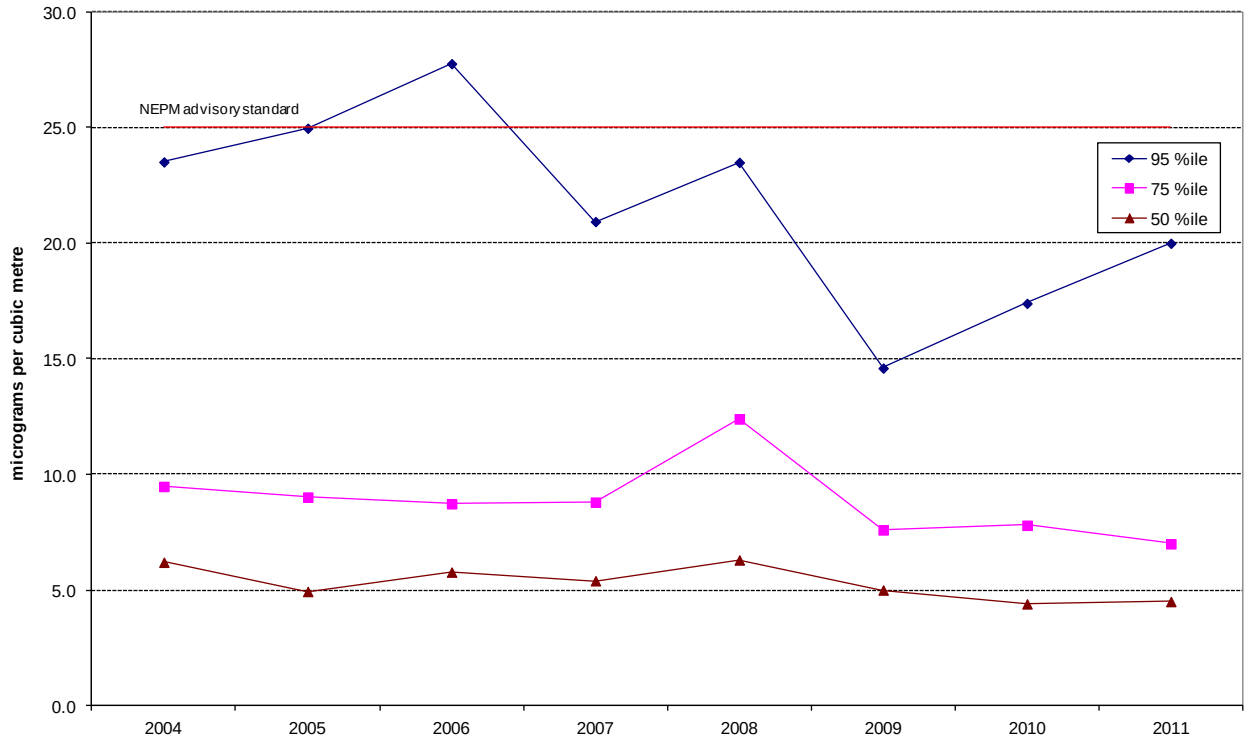

Figure 24: Statistical summary for daily maximum 24-hour $PM_{2.5}$ Monash 2004 – 2011

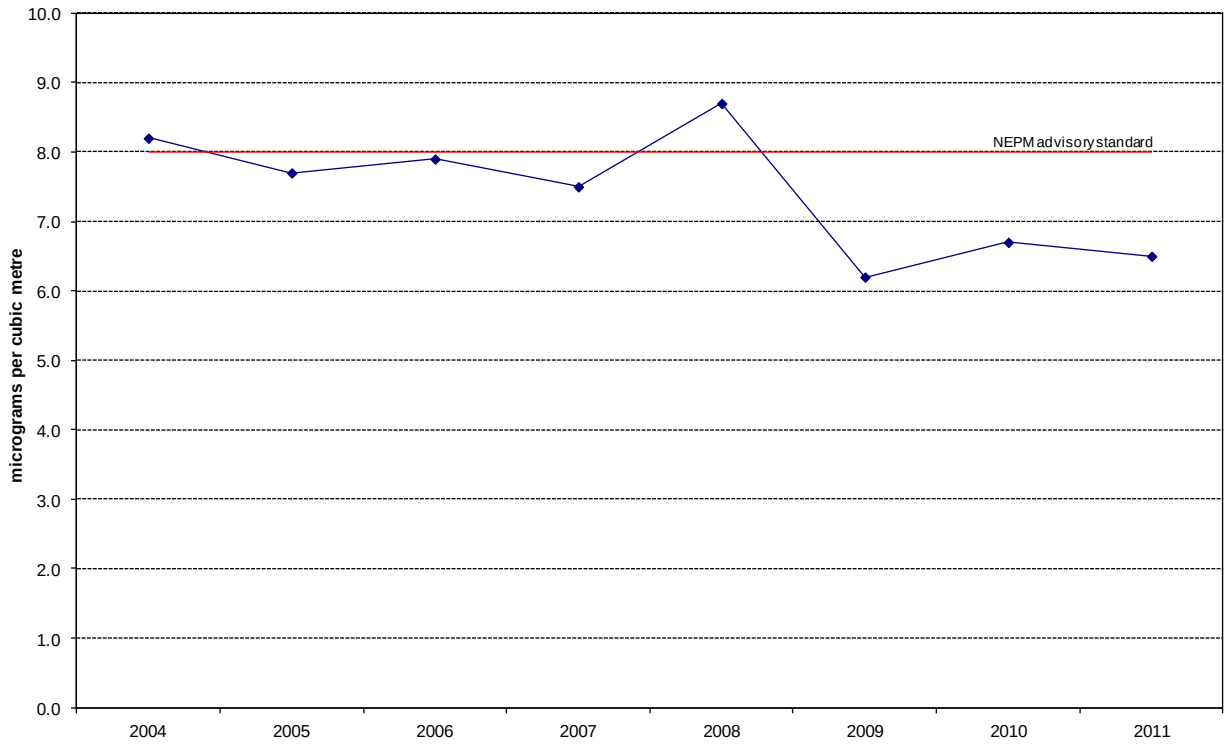

Figure 25: Annual average 24-hour $PM_{2.5}$ Monash 2004 - 2011