ACT AIR QUALITY REPORT 2017

Environment Protection Authority | June 2018

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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 |
| Exceptional event | Exceptional event means a fire or dust occurrence that adversely affects air quality at a particular location, and causes an exceedance of 1 day average standards in excess of normal historical fluctuations and background levels, and is directly related to: bushfire; jurisdiction authorised hazard reduction burning; or continental scale windblown dust |
| NATA | National Association of Testing Authorities |
| ND | Not Demonstrated |
| NO2 | Nitrogen Dioxide |
| O3 | Ozone |
| PMS | Performance Monitoring Station |
| PM2.5 | Particles with an equivalent aerodynamic diameter less than or equal to 2.5 micrometres |
| PM10 | Particles with an equivalent aerodynamic diameter less than or equal to 10 micrometres |
| 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) |
| SO2 | Sulfur Dioxide |
| µg/m3 | micrograms per cubic metre |
|  |  |
|  |  |

# OVERVIEW

This report presents the results of ambient air quality monitoring in the ACT for 2017 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 on 26 June 1998.

The AAQ NEPM establishes:

* requirements for monitoring air quality;
* air quality standards that are levels of specified pollutants against which air quality can be assessed; and
* a goal that air quality standards be met to the extent specified in the NEPM. Recognising that certain events can impact on air quality, the NEPM specifies a maximum number of days on which it is permissible to exceed the standard.

Air quality in this report is assessed against the AAQ NEPM standards shown in Table 3. In accordance with its agreed policy position, the ACT assesses its compliance for the annual average for particulate matter less than 10 microns (μg) (PM10) against a lower standard of 20 μg/m3 rather than the AAQ NEPM standard of 25 μg/m3 from 2016.

The ACT monitors four of the six NEPM pollutants:

* carbon monoxide (CO);
* nitrogen dioxide (NO2);
* photochemical oxidants as ozone (O3); and
* particulate matter (particles less than 10 microns in diameter – PM10 and particles less than 2.5 microns in diameter – PM2.5).

Due to a lack of heavy industry, the ACT has never monitored sulfur dioxide (SO2) as it is primarily an industrial pollutant, and lead monitoring ceased in 2002 with the phase out of leaded petrol.

Monitoring in the ACT 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 results in 2017 demonstrate that Canberra’s air quality is generally good, with no exceedances of the AAQ NEPM standards for carbon monoxide, nitrogen dioxide and ozone. There was one exceedance of the 24-hour PM10 standard recorded at Civic. There were 13 exceedances of the daily PM2.5 standard recorded at Monash and Civic. The daily reporting standard for PM2.5 and PM10 were both exceeded at Civic on 30 August 2017 due to smoke coming from a hazard reduction burn but have not been included for compliance purposes under the exceptional event rule.

There were 12 days when PM2.5 exceeded the daily standard at Monash. These exceedances, which occurred between May and July, can be linked to increased domestic wood heater emissions during the cold winter months.

The major impacts on Canberra’s air quality in 2017, as in 2016, came from the accumulation of combustion particles from hazard reduction burns and wood heaters. Noting there is no safe level of particle pollution, the EPA is concerned about the increase in the number of exceedances and levels of PM2.5. Annual average levels in Florey and Monash are now very close to national standards. Given this trend and the comment in the Australia State of the Environment Report, 2016 that:

*“Air quality is generally good to very good in Australian urban areas. However, evidence about the adverse impact of air pollution on human health has increased since 2011, and health effects have been observed at lower pollutant concentrations than those on which [national] guidelines are based*”

The EPA, in conjunction with the Environment, Planning and Sustainable Development Directorate, will:

* undertake a review of the efficacy of the Government’s woodsmoke programs; and
* look to establish tighter controls on the installation of solid fuelled heaters to drive the installation of lower emission models.

# MONITORING SUMMARY

## 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 Protection Authority (EPA) within the Chief Minister, Treasury and Economic Development Directorate is responsible for annual reporting under the AAQ NEPM.

The AAQ NEPM monitoring network in the ACT consists of three monitoring stations located at:

* Monash - approximately 300 metres west of Cockcroft Avenue in the Monash district playing fields;
* Civic - at the northern end of the carpark on the western side of the Olympic swimming pool adjacent to Allara Street; and
* Florey at the end of Neumann Place, on public land.

The compliance and non-compliance criteria for the monitoring stations against the siting standard AS/NZS 3580.1.1:2008 are listed in Table 1 below.

Table 1: Summary of stations’ siting compliance with AS 3580.1.1:2008

| **Station** | **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 | 🗹 | 🗹 | 🗹 | 🗹 | 🗹 | 🗹 | 🗹 |
| Civic | 🗹 | 🗷 | 🗷 | 🗷 | 🗹 | 🗹 | 🗹 |
| Florey | 🗹 | 🗹 | 🗹 | 🗹 | 🗹 | 🗹 | 🗹 |

The Monash and Florey stations contain instrumentation that continuously monitors carbon monoxide, nitrogen dioxide, ozone and particles as PM10 and PM2.5.  Following the establishment of the Florey station on 28 February 2014, the Civic station only monitors ozone and particles as PM10 and PM2.5.

## Monitoring Methods

The ACT monitoring is conducted in accordance with the relevant Australian Standards as shown in Table 2. Data not meeting the requirements of these Standards are identified as invalid and not included in this report.

Table 2: Methods used for monitoring AAQ NEPM pollutants

| **Pollutant** | **Standard** | **Title** | **Method Used** |
| --- | --- | --- | --- |
| Carbon Monoxide | AS 3580.7.1-2011 | Methods for sampling and analysis of ambient air - Determination of carbon monoxide - Direct-reading instrumental method | Gas filter correlation/  Infrared. |
| Nitrogen dioxide | AS 3580.5.1-2011 | Methods for sampling and analysis of ambient air - Determination of oxides of nitrogen - Direct-reading instrumental method | Gas phase  chemiluminescence. |
| Photochemical  oxidant (ozone) | AS 3580.6.1-2011 | Methods for sampling and analysis of ambient air - Determination of ozone - Direct-reading instrumental method | Non-dispersive ultraviolet. |
| Particles  PM10 | AS/NZS 3580.9.11-2016 | Method for sampling and analysis of ambient air Method – Determination of suspended particles matter – PM10 beta attenuation monitors | Beta Attenuation Monitor (BAM) |
| PM10 | AS/NZS 3580.9.6-2015 | Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM10 high volume sampler with size-selective inlet - Gravimetric method | Gravimetric reference method |
| PM2.5 | AS/NZS 3580.9.12:2013 | Methods for sampling and analysis of ambient air - Method 9.12: Determination of suspended particulate matter - PM2.5 beta attenuation monitors | BAM |

## NATA Accreditation Status

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

# ASSESSMENT OF COMPLIANCE WITH STANDARDS AND GOALS

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/m3) (refer to Table 3, column 3).

The goal of the AAQ NEPM is to achieve the National Environment Protection Standards as assessed in accordance with the monitoring protocol to the extent specified in Schedule 2 of the AAQ NEPM.

The extent is expressed as a maximum allowable number of exceedances for each standard (shown in column 4, Table 3). For PM2.5, there is an additional goal to further reduce concentrations to below a daily concentration of 20 μg /m3 and an annual concentration of 7 μg /m3 by 2025.

Table 3: AAQ NEPM standards and goals

| **Pollutant** | **Averaging Period** | **Maximum concentration** | **Maximum allowable exceedances** | **Monitoring Station** |
| --- | --- | --- | --- | --- |
| Carbon monoxide | 8 hours | 9.0 ppm | 1 day a year | Monash  Florey |
| Nitrogen dioxide | 1 hour  1 year | 0.12 ppm  0.03 ppm | 1 day a year  None | Monash  Florey |
| Photochemical oxidants | 1 hour  4 hours | 0.10 ppm  0.08 ppm | 1 day a year  1 day a year | Monash  Florey  Civic |
| 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 | Not monitored |
| Lead | 1 year | 0.50 μg/m3 | None | Not monitored |
| Particles as PM10 | 1 day  1 year | 50 μg/m3  25 μg/m3 | None  None | Monash  Florey  Civic |
| Particles as PM2.5 | 1 day  1 year | 25 μg/m3  8 μg/m3 | None  None | Monash  Florey  Civic |

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

Air quality 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.

Air quality 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. For the purpose of reporting compliance against PM10 and PM2.5 1 day average standards, monitoring data that has been determined as being directly associated with an exceptional event has been excluded.

Air quality is assessed as ‘*NOT DEMONSTRATED’* (i.e. *‘ND’*) if there has been insufficient data collected to demonstrate that the standards and goal have been met or not met.

These categories (i.e. MET, NOT MET and ND) are used in Tables 4 to 8 on the following pages.

## Carbon monoxide

During 2017, no exceedances of the carbon monoxide standard were recorded and compliance was demonstrated at Monash and Florey.

Table 4: 2017 compliance summary for CO

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

| **Performance monitoring station** | **Data availability rates**  **(% of hours)** | | | | | **Number of exceedances**  **(days)** | **Performance against the standards and goal** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Q1** | **Q2** | **Q3** | **Q4** | **Annual** |
| Monash  Florey | 95.6  94.4 | 95.7  95.8 | 94.6  92.7 | 95.8  95.8 | 95.4  94.7 | 0  0 | MET  MET |



Figure 1: Daily max for CO 8-hour average – Monash



Figure 2: Daily max for CO 8-hour average – Florey

## Nitrogen dioxide

During 2017, no exceedances of the nitrogen dioxide standards were recorded and compliance was demonstrated at Monash and Florey.

Table 5: 2017 compliance summary for NO2

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 exceedances**  **(days)** | **Performance against the standards and goal** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **1 hour** | **1 year** |
| **Q1** | **Q2** | **Q3** | **Q4** | **Annual** |
| Monash  Florey | 95.1  87.5 | 95.7  95.5 | 95.7  95.7 | 95.8  95.8 | 95.6  93.7 | 0.004 0.005 | 0  0 | MET  MET | MET  MET |



Figure 3: Daily max for NO2 – Monash



Figure 4: Daily max for NO2 – Florey

## Ozone

During 2017, no exceedances of the 1-hour and 4-hour standards for ozone were recorded and compliance was demonstrated at all monitoring stations.

Table 6: 2017 compliance summary for O3

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 exceedances**  **(days)** | | **Performance against the standards and goal** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Q1** | **Q2** | **Q3** | **Q4** | **Annual** | **1 hour** | **4 hours** | **1 hour** | **4 hours** |
| Monash  Civic  Florey | 95.8  95.8  94.4 | 94.6  95.8  95.8 | 95.7  95.8  95.8 | 95.8  95.8  95.8 | 95.5  95.8  95.5 | 0  0  0 | 0  0  0 | MET  MET  MET | MET  MET  MET |



Figure 5: Daily max for 1 hour O3 – Monash



Figure 6: Daily max for 1 hour O3 – Civic



Figure 7: Daily max for 1 hour O3 – Florey



Figure 8: Daily max for 4 hours O3 - Monash



Figure 9: Daily max for 4 hours O3 – Civic



Figure 10: Daily max for 4 hours O3 – Florey

## PM10

During 2017, there was one exceedance of the 24-hour PM10 standard recorded at Civic. No exceedances of the daily and annual average PM10 standards were recorded at Monash and Florey and compliance was demonstrated at both monitoring stations.

Compliance against the AAQ NEPM PM10 standard was met at Monash, Florey and Civic, when the exceedance of 30 August 2017 is removed as an exceptional event.

Table 7: 2017 compliance summary for PM10

AAQ NEPM standard 50 μg/m3 1-day average, 20 μg/m3 (1-year average)\*

| **Performance monitoring station** | **Data availability rates**  **(% of days)** | | | | | **Annual mean**  **Concentration**  **(μg/m3)\*** | **Number of exceedances**  **(days)** | **Performance against the standards and goal** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Q1** | **Q2** | **Q3** | **Q4** | **Annual** |
| Monash  Civic  Florey | 98.9  100  95.6 | 100  100  100 | 98.9  81.5  97.8 | 97.8  53.3  100 | 98.9  83.6  98.4 | 9.8  9.7  9.8 | 0  1  0 | MET  ND  MET |

\* ACT policy position 20 µg/m3 not AAQ NEPM standard of 25 µg/m3



Figure 11: Daily max for PM10 – Monash



Figure 12: Daily max for PM10 – Civic



Figure 13: Daily max for PM10 – Florey

## PM2.5

During 2017, while no exceedances of the annual average PM2.5 standard were recorded in the ACT, 13 exceedances of the daily PM2.5 standard were recorded at Monash and Civic. Compliance against the AAQ NEPM PM2.5 standard was met at Florey and Civic when the exceedance of 30 August 2017 is removed as an exceptional event.

Table 8: 2017 compliance summary for PM2.5

AAQ NEPM standard – 25 μg/m3 (1-day), 8 μg/m3 (1-year)

| **Performance monitoring station** | **Data availability rates**  **(% of days)** | | | | | **Annual mean**  **Concentration**  **(μg/m3)** | **Number of exceedances**  **(days)** | **Performance against the standards and goal** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Q1** | **Q2** | **Q3** | **Q4** | **Annual** |
| Monash  Civic  Florey | 97.8  100  92.2 | 100  79.1  93.4 | 98.9  100  91.3 | 97.8  91.3  100 | 98.6  92.6  94.2 | 7.7  5.8  7.1 | 12  1  0 | NOT MET  MET  MET |



Figure 14: Daily max for PM2.5 – Monash



Figure 15: Daily max for PM2.5 – Civic



Figure 16: Daily max for PM2.5 – Florey

# ANALYSIS OF AIR QUALITY MONITORING

Annual summary statistics contained in Table 9 to Table 14 below assess air quality against the standards and the extent of compliance with the goal. Instances where the standard has been exceeded are highlighted in bold.

## Carbon monoxide

Table 9: 2017 summary statistics for daily peak 8-hour CO

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

| **Performance monitoring station** | **Number of valid days** | **Highest**  **(ppm)** | **Highest**  **(date/time)** | **2nd Highest**  **(ppm)** | **2nd Highest**  **(date/time)** |
| --- | --- | --- | --- | --- | --- |
| Monash  Florey | 365  365 | 1.6  1.8 | 26 May 03:00  27 May 05:00 | 1.5  1.8 | 16 Jun 03:00  22 Jun 04:00 |

Carbon monoxide levels are well below the AAQ NEPM standard at all monitoring stations. The highest recorded value in the ACT during 2017 was 1.8 ppm at Florey, which is 20% of the standard.

## Nitrogen dioxide

Table 10: 2017 summary statistics for daily peak 1-hour NO2

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  Florey | 365  365 | 0.031  0.033 | 22 Feb 21:00  24 Oct 20:00 | 0.031  0.032 | 16 Feb 21:00  13 Dec 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 2017 was 0.033 ppm at Florey, which is only 27.5% of the standard. The highest recorded annual average in 2017 was 0.005ppm at Florey (refer to Table 5). This is 17% of the annual standard 0.03ppm.

## Ozone

Table 11: 2017 summary statistics for daily peak 1-hour O3

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  Civic  Florey | 363  365  363 | 0.060  0.053  0.057 | 11 Feb 11:00  11 Feb 11:00  19 Dec 11:00 | 0.058  0.052  0.056 | 17 Jan 10:00  19 Dec 11:00  29 Mar 17:00 |

Table 12: 2017 summary statistics for daily peak 4-hour O3

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  Civic  Florey | 363  365  363 | 0.055  0.049  0.054 | 25 Nov 14:00  22 Jan 19:00  19 Dec 13:00 | 0.054  0.048  0.053 | 19 Dec 13:00  25 Nov 14:00  25 Nov 13:00 |

Ozone levels are below the AAQ NEPM standard. The highest recorded 1-hour value in the ACT during 2017 was 0.060 ppm at Monash, which is 60% of the standard. The highest recorded 4-hour value in the ACT during 2017 was 0.055 ppm at Monash, which is 69% of the standard.

## PM10

Table 13: 2017 summary statistics for daily peak PM10

AAQ NEPM daily standard 50 μg/m3

| **Performance monitoring station** | **Number of valid days** | **Highest**  **(μg/m3)** | **Highest**  **(date)** |
| --- | --- | --- | --- |
| Monash  Civic  Florey | 361  305  359 | 28.3  **53.0**  28.1 | 02 July  30 August  15 June |

PM10 levels at Monash and Florey are below the AAQ NEPM standard. The only exceedance recorded during 2017 was 53.0μg/m3 at Civic on 30 August 2017due to hazard reduction burns. Excluding this exceedance under the exceptional event rule, PM10 levels at Civic are well below the standard. The highest recorded annual average in 2017 was 9.8μg/m3 at Florey (refer to Table 7). This is 49% of the ACT policy standard annual of 20μg/m3.

## PM2.5

Table 14: 2017 summary statistics for daily peak PM2.5

AAQ NEPM daily standard 25 μg/m3

| **Performance monitoring station** | **Number of valid days** | **Highest**  **(μg/m3)** | **Highest**  **(date)** |
| --- | --- | --- | --- |
| Monash  Civic  Florey | 360  338  344 | **35.2**  **53.8**  23.8 | 02 July  30 August  16 June |

The daily reporting standard for PM2.5 was exceeded 12 times at Monash and once at Civic. The exceedances at Monash, occurred between May and July, and are a result of increased domestic wood heater emissions during the winter months.

The daily reporting standard for PM2.5 was exceeded at Civic on 30 August 2017 due to smoke coming from hazard reduction burns. The highest recorded annual average in 2017 was 7.7μg/m3 at Monash (refer to Table 8). This is 95% of the annual standard 8μg/m3.

# ASSESSMENT OF PROGRESS TOWARDS ACHIEVING THE GOAL

The goals and standards have been consistently met in the ACT for carbon monoxide, nitrogen dioxide, and ozone since the commencement of the AAQ NEPM in 1998.

Historical monitoring results indicate that the only AAQ NEPM pollutant of concern in the ACT air shed is particulate matter, which increases significantly during winter because of emissions from domestic wood heaters, especially in the Tuggeranong Valley where levels are also exacerbated by the topography of the valley which is subject to temperature inversions and poor pollution dispersion.

In more recent years exceedances of the particulate matter standards have also been attributed to dust storms and smoke from controlled burns.

PM2.5 is the pollutant that is the most affected by wood smoke as the majority of particles are less than 1 micron in diameter. Figures 14 and 16 clearly show that PM2.5 levels increase significantly during the cooler months of the year. In the last few years the annual average PM2.5 readings for Monash and Florey have also increased and are now approaching the NEPM standard. Excluding temporal variation, this rise is more than likely because of an increase in wood heater use and or installation as a result of the increasing cost of gas and electricity.

The ACT Government acknowledges that woodsmoke is a problem and will continue to implement an integrated program to address woodsmoke. This will involve public education and enforcement activities, the implementation of the ‘Burn Right Tonight Campaign’, the regulation of the sale of firewood and the on-going administration of the Wood Heater Replacement Program.

Noting there is no safe level of particle pollution, the EPA is concerned about the increase in the number of exceedances and levels of PM2.5. Annual average levels in Florey and Monash are now very close to national standards. Given this trend the EPA, in conjunction with the Environment, Planning and Sustainable Development Directorate, will:

* undertake a review of the efficacy of the Government’s wood smoke programs
* look to establish tighter controls on the installation of solid fuelled heaters to drive the installation of lower emission models.

# APPENDIX A: STATISTICAL SUMMARY AND TRENDS

The following section provides a basic statistical summary, using percentiles, for Monash, Florey and Civic stations and for each standard in the past ten years. Percentiles for daily maximum values are presented.

## Carbon monoxide

Table 15: Statistical summary for daily maximum 8-hour CO Monash 2008 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (ppm) | 95th  percentile  (ppm) | 75th  percentile  (ppm) | 50th  percentile  (ppm) |
| --- | --- | --- | --- | --- | --- | --- |
| 2008 | 88.0 | 0 | 2.4 | 1.8 | 0.8 | 0.3 |
| 2009 | 96.4 | 0 | 2.0 | 1.4 | 0.6 | 0.3 |
| 2010 | 99.2 | 0 | 1.8 | 1.4 | 0.6 | 0.3 |
| 2011 | 98.6 | 0 | 2.2 | 1.5 | 0.5 | 0.2 |
| 2012 | 99.7 | 0 | 1.8 | 1.2 | 0.6 | 0.3 |
| 2013 | 95.9 | 0 | 2.1 | 1.5 | 0.6 | 0.3 |
| 2014 | 94.0 | 0 | 1.8 | 1.4 | 0.7 | 0.4 |
| 2015 | 94.8 | 0 | 1.9 | 1.4 | 0.6 | 0.3 |
| 2016 | 95.8 | 0 | 1.7 | 1.0 | 0.4 | 0.2 |
| 2017 | 95.4 | 0 | 1.6 | 1.2 | 0.6 | 0.2 |



Figure 17: Statistical summary for daily maximum 8-hour CO Monash 2008 – 2017

Table 16: Statistical summary for daily maximum 8-hour CO Florey 2014 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (ppm) | 95th  percentile  (ppm) | 75th  percentile  (ppm) | 50th  percentile  (ppm) |
| --- | --- | --- | --- | --- | --- | --- |
| 2014 | 79.2 | 0 | 2.2 | 1.4 | 0.7 | 0.3 |
| 2015 | 94.9 | 0 | 2.0 | 1.5 | 0.6 | 0.3 |
| 2016 | 95.5 | 0 | 1.9 | 1.2 | 0.5 | 0.3 |
| 2017 | 94.7 | 0 | 1.8 | 1.4 | 0.5 | 0.2 |



Figure 18: Statistical summary for daily maximum 8-hour CO Florey 2014 – 2017

## Nitrogen dioxide

Table 17: Statistical summary for daily maximum 1-hour NO2 Monash 2008 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (ppm) | Annual average  (ppm) | 95th  percentile  (ppm) | 75th  percentile  (ppm) | 50th  percentile  (ppm) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2008 | 86.5 | 0 | 0.103 | 0.007 | 0.031 | 0.025 | 0.019 |
| 2009 | 92.6 | 0 | 0.041 | 0.008 | 0.029 | 0.023 | 0.019 |
| 2010 | 89.1 | 0 | 0.037 | 0.006 | 0.025 | 0.021 | 0.017 |
| 2011 | 96.7 | 0 | 0.043 | 0.005 | 0.029 | 0.022 | 0.015 |
| 2012 | 97.5 | 0 | 0.033 | 0.006 | 0.026 | 0.021 | 0.014 |
| 2013 | 97.5 | 0 | 0.037 | 0.005 | 0.027 | 0.021 | 0.014 |
| 2014 | 94.1 | 0 | 0.036 | 0.005 | 0.027 | 0.020 | 0.015 |
| 2015 | 94.8 | 0 | 0.032 | 0.004 | 0.026 | 0.020 | 0.014 |
| 2016 | 95.6 | 0 | 0.036 | 0.004 | 0.027 | 0.019 | 0.012 |
| 2017 | 95.6 | 0 | 0.031 | 0.004 | 0.027 | 0.021 | 0.013 |



Figure 19: Statistical summary for daily maximum 1-hour NO2 Monash 2008 – 2017



Figure 20: Annual average 1-hour NO2 Monash 2008 – 2017

Table 18: Statistical summary for daily maximum 1-hour NO2 Florey 2014 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (ppm) | Annual average  (ppm) | 95th  percentile  (ppm) | 75th  percentile  (ppm) | 50th  percentile  (ppm) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2014 | 78.3 | 0 | 0.045 | 0.006 | 0.027 | 0.020 | 0.015 |
| 2015 | 91.5 | 0 | 0.033 | 0.005 | 0.027 | 0.020 | 0.014 |
| 2016 | 94.7 | 0 | 0.034 | 0.004 | 0.027 | 0.019 | 0.013 |
| 2017 | 93.7 | 0 | 0.033 | 0.005 | 0.025 | 0.020 | 0.015 |



Figure 21: Statistical summary for daily maximum 1-hour NO2 Florey 2014 – 2017



Figure 22: Annual average 1-hour NO2 Florey 2014 – 2017

## Ozone

Table 19: Statistical summary for daily maximum 1-hour O3 Monash 2008 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (ppm) | 95th  percentile  (ppm) | 75th  percentile  (ppm) | 50th  percentile  (ppm) |
| --- | --- | --- | --- | --- | --- | --- |
| 2008 | 84.2 | 0 | 0.065 | 0.047 | 0.031 | 0.026 |
| 2009 | 96.4 | 0 | 0.073 | 0.052 | 0.038 | 0.030 |
| 2010 | 86.6 | 0 | 0.051 | 0.042 | 0.033 | 0.030 |
| 2011 | 99.2 | 0 | 0.056 | 0.044 | 0.033 | 0.028 |
| 2012 | 100 | 0 | 0.055 | 0.043 | 0.034 | 0.029 |
| 2013 | 97.8 | 0 | 0.062 | 0.045 | 0.035 | 0.029 |
| 2014 | 94.8 | 0 | 0.087 | 0.050 | 0.036 | 0.030 |
| 2015 | 92.8 | 0 | 0.065 | 0.044 | 0.034 | 0.026 |
| 2016 | 95.2 | 0 | 0.057 | 0.044 | 0.032 | 0.026 |
| 2017 | 95.5 | 0 | 0.060 | 0.049 | 0.038 | 0.032 |



Figure 23: Statistical summary for daily maximum 1-hour O3 Monash 2008 – 2017

Table 20: Statistical summary for daily maximum 1-hour O3 Civic 2008 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (ppm) | 95th  percentile  (ppm) | 75th  percentile  (ppm) | 50th  percentile  (ppm) |
| --- | --- | --- | --- | --- | --- | --- |
| 2008 | 91.4 | 0 | 0.052 | 0.039 | 0.028 | 0.023 |
| 2009 | 97.8 | 0 | 0.060 | 0.044 | 0.031 | 0.024 |
| 2010 | 99.2 | 0 | 0.058 | 0.040 | 0.029 | 0.025 |
| 2011 | 96.4 | 0 | 0.052 | 0.041 | 0.030 | 0.026 |
| 2012 | 100 | 0 | 0.053 | 0.034 | 0.024 | 0.020 |
| 2013 | 92.1 | 0 | 0.060 | 0.036 | 0.028 | 0.024 |
| 2014 | 94.0 | 0 | 0.060 | 0.039 | 0.028 | 0.022 |
| 2015 | 89.0 | 0 | 0.042 | 0.034 | 0.026 | 0.022 |
| 2016 | 95.8 | 0 | 0.047 | 0.036 | 0.028 | 0.024 |
| 2017 | 95.8 | 0 | 0.053 | 0.045 | 0.034 | 0.028 |



Figure 24: Statistical summary for daily maximum 1-hour O3 Civic 2008 – 2017

Table 21: Statistical summary for daily maximum 1-hour O3 Florey 2014 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (ppm) | 95th  percentile  (ppm) | 75th  percentile  (ppm) | 50th  percentile  (ppm) |
| --- | --- | --- | --- | --- | --- | --- |
| 2014 | 79.4 | 0 | 0.074 | 0.034 | 0.027 | 0.023 |
| 2015 | 94.2 | 0 | 0.040 | 0.032 | 0.025 | 0.021 |
| 2016 | 95.8 | 0 | 0.050 | 0.040 | 0.031 | 0.027 |
| 2017 | 95.5 | 0 | 0.057 | 0.048 | 0.038 | 0.032 |



Figure 25: Statistical summary for daily maximum 1-hour O3 Florey 2014 – 2017

Table 22: Statistical summary for daily maximum 4-hour O3 Monash 2008 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (ppm) | 95th  percentile  (ppm) | 75th  percentile  (ppm) | 50th  percentile  (ppm) |
| --- | --- | --- | --- | --- | --- | --- |
| 2008 | 84.2 | 0 | 0.061 | 0.045 | 0.030 | 0.025 |
| 2009 | 96.2 | 0 | 0.068 | 0.048 | 0.036 | 0.029 |
| 2010 | 86.6 | 0 | 0.049 | 0.040 | 0.032 | 0.029 |
| 2011 | 98.9 | 0 | 0.054 | 0.041 | 0.032 | 0.027 |
| 2012 | 99.7 | 0 | 0.052 | 0.043 | 0.034 | 0.029 |
| 2013 | 97.8 | 0 | 0.059 | 0.042 | 0.033 | 0.028 |
| 2014 | 94.8 | 0 | 0.060 | 0.046 | 0.034 | 0.029 |
| 2015 | 92.8 | 0 | 0.050 | 0.041 | 0.033 | 0.025 |
| 2016 | 95.2 | 0 | 0.055 | 0.042 | 0.030 | 0.025 |
| 2017 | 95.5 | 0 | 0.055 | 0.047 | 0.036 | 0.031 |



Figure 26: Statistical summary for daily maximum 4-hour O3 Monash 2008 – 2017

Table 23: Statistical summary for daily maximum 4-hour O3 Civic 2008 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (ppm) | 95th  percentile  (ppm) | 75th  percentile  (ppm) | 50th  percentile  (ppm) |
| --- | --- | --- | --- | --- | --- | --- |
| 2008 | 91.4 | 0 | 0.051 | 0.036 | 0.027 | 0.022 |
| 2009 | 97.8 | 0 | 0.059 | 0.041 | 0.030 | 0.023 |
| 2010 | 99.2 | 0 | 0.056 | 0.037 | 0.028 | 0.024 |
| 2011 | 96.4 | 0 | 0.050 | 0.038 | 0.029 | 0.025 |
| 2012 | 100 | 0 | 0.042 | 0.032 | 0.023 | 0.019 |
| 2013 | 91.8 | 0 | 0.057 | 0.034 | 0.027 | 0.023 |
| 2014 | 94.0 | 0 | 0.047 | 0.036 | 0.026 | 0.020 |
| 2015 | 89.0 | 0 | 0.041 | 0.031 | 0.025 | 0.021 |
| 2016 | 95.8 | 0 | 0.045 | 0.035 | 0.027 | 0.023 |
| 2017 | 95.8 | 0 | 0.049 | 0.042 | 0.033 | 0.027 |



Figure 27: Statistical summary for daily maximum 4-hour O3 Civic 2008 – 2017

Table 24: Statistical summary for daily maximum 4-hour O3 Florey 2014 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (ppm) | 95th  percentile  (ppm) | 75th  percentile  (ppm) | 50th  percentile  (ppm) |
| --- | --- | --- | --- | --- | --- | --- |
| 2014 | 79.4 | 0 | 0.040 | 0.031 | 0.026 | 0.022 |
| 2015 | 94.2 | 0 | 0.037 | 0.031 | 0.025 | 0.020 |
| 2016 | 95.8 | 0 | 0.050 | 0.038 | 0.029 | 0.026 |
| 2017 | 95.5 | 0 | 0.054 | 0.046 | 0.037 | 0.031 |



Figure 28: Statistical summary for daily maximum 4-hour O3 Florey 2014 – 2017

## PM10

Table 25: Statistical summary for daily maximum daily PM10 Monash 2008 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (μg/m3) | Annual average  (μg/m3) | 95th  percentile  (μg/m3) | 75th  percentile  (μg/m3) | 50th  percentile  (μg/m3) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2008 | 82 | 3 | 96.6 | 16.4 | 29.9 | 20.1 | 14.8 |
| 2009 | 42.3 | 9 | 210.0 | 20.3 | 50.5 | 25.5 | 15.2 |
| 2010 | 95.4 | 0 | 48.4 | 11.1 | 23.5 | 14.7 | 10.0 |
| 2011 | 99.2 | 0 | 40.0 | 10.4 | 22.8 | 13.2 | 8.7 |
| 2012 | 98.6 | 0 | 41.0 | 10.4 | 19.7 | 13.7 | 9.7 |
| 2013 | 95.6 | 0 | 43.5 | 9.8 | 20.2 | 13.1 | 8.9 |
| 2014 | 97.8 | 0 | 39.3 | 10 | 19.1 | 12.9 | 9.6 |
| 2015 | 98.4 | 0 | 49.4 | 9.9 | 19.5 | 13.1 | 9.5 |
| 2016 | 99.5 | 0 | 31.9 | 9.7 | 21.5 | 12.7 | 9.0 |
| 2017 | 98.9 | 0 | 28.3 | 9.8 | 20.5 | 12.3 | 9.0 |



Figure 29: Statistical summary for daily maximum daily PM10 Monash 2008 – 2017

**Note:** 2009 data has not been included in Figure 29 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.



Figure 30: Annual average daily PM10 Monash 2008 – 2017

Table 26: Statistical summary for daily maximum daily PM10 Civic 2008 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (μg/m3) | Annual average  (μg/m3) | 95th  percentile  (μg/m3) | 75th  percentile  (μg/m3) | 50th  percentile  (μg/m3) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2008 | 12.0 | 1 | 53.3 | 14.3 | 26.1 | 17.3 | 11.9 |
| 2009 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| 2010 | 57.6 | 0 | 23.8 | 8.5 | 14.7 | 11.1 | 8.4 |
| 2011 | 97.0 | 0 | 29.2 | 8.7 | 16.9 | 11.0 | 7.9 |
| 2012 | 95.1 | 0 | 49.5 | 9.4 | 17.0 | 12.1 | 8.7 |
| 2013 | 92.9 | 1 | 57.8 | 9.7 | 19.9 | 12.0 | 8.6 |
| 2014 | 95.1 | 0 | 31.4 | 9.8 | 17.7 | 12.6 | 9.3 |
| 2015 | 97.5 | 1 | 64.3 | 11.1 | 20.9 | 14.1 | 10.4 |
| 2016 | 100 | 0 | 36.6 | 10.7 | 20.6 | 14.3 | 9.7 |
| 2017 | 83.6 | 1 | 53.0 | 9.68 | 10.8 | 7.1 | 5.2 |



Figure 31: Statistical summary for daily maximum daily PM10 Civic 2008 – 2017

**Note:** No PM10 monitoring was conducted at Civic in 2009.



Figure 32: Annual average daily PM10 Civic 2008 – 2017

Table 27: Statistical summary for daily maximum daily PM10 Florey 2014 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (μg/m3) | Annual average  (μg/m3) | 95th  percentile  (μg/m3) | 75th  percentile  (μg/m3) | 50th  percentile  (μg/m3) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2014 | 83.3 | 0 | 30.2 | 10.4 | 21.5 | 13.0 | 9.4 |
| 2015 | 95.6 | 0 | 70.8 | 10.7 | 21.8 | 13.7 | 9.4 |
| 2016 | 98.9 | 0 | 28.8 | 10.1 | 20.6 | 13.1 | 9.2 |
| 2017 | 98.4 | 0 | 28.1 | 9.84 | 21.8 | 12.8 | 8.5 |



Figure 33: Statistical summary for daily maximum daily PM10 Florey 2014 – 2017



Figure 34: Annual average daily PM10 Florey 2008 – 2017

## PM2.5

Table 28: Statistical summary for daily maximum daily PM2.5 Monash 2008 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (μg/m3) | Annual average  (μg/m3) | 95th  percentile  (μg/m3) | 75th  percentile  (μg/m3) | 50th  percentile  (μg/m3) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2008 | 45.4 | 6 | 30.7 | 8.7 | 23.5 | 12.4 | 6.3 |
| 2009 | 64.5 | 2 | 33.5 | 6.2 | 14.6 | 7.6 | 5.0 |
| 2010 | 95.1 | 2 | 52.4 | 6.7 | 17.4 | 7.8 | 4.4 |
| 2011 | 92.1 | 4 | 32.8 | 6.5 | 20.0 | 7.0 | 4.5 |
| 2012 | 95.1 | 3 | 29.2 | 7.1 | 16.5 | 8.3 | 5.0 |
| 2013 | 98.6 | 6 | 38.4 | 6.9 | 19.2 | 8.1 | 5.2 |
| 2014 | 87.7 | 4 | 31.5 | 6.8 | 18.7 | 8.6 | 5.6 |
| 2015 | 96.4 | 6 | 33.8 | 7.4 | 19.0 | 8.2 | 5.6 |
| 2016 | 98.1 | 8 | 32.7 | 7.4 | 20.7 | 8.2 | 5.4 |
| 2017 | 98.6 | 12 | 35.2 | 7.7 | 22.5 | 9.3 | 5.3 |



Figure 35: Statistical summary for daily maximum daily PM2.5 Monash 2008 – 2017



Figure 36: Annual average daily PM2.5 Monash 2008 – 2017

Table 29: Statistical summary for daily maximum daily PM2.5 Civic 2016 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (μg/m3) | Annual average  (μg/m3) | 95th  percentile  (μg/m3) | 75th  percentile  (μg/m3) | 50th  percentile  (μg/m3) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2016 | 98.6 | 0 | 22.1 | 5.5 | 11.0 | 7.1 | 4.8 |
| 2017 | 94.2 | 1 | 53.8 | 5.9 | 10.8 | 7.1 | 5.2 |



Figure 37: Statistical summary for daily maximum daily PM2.5 Civic 2016 – 2017



Figure 38: Annual average daily PM2.5 Civic 2016 – 2017

Table 30: Statistical summary for daily maximum daily PM2.5 Florey 2014 – 2017

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (μg/m3) | Annual average  (μg/m3) | 95th  percentile  (μg/m3) | 75th  percentile  (μg/m3) | 50th  percentile  (μg/m3) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2014 | 74.2 | 0 | 22.8 | 5.8 | 15.0 | 7.1 | 4.9 |
| 2015 | 96.2 | 0 | 24.3 | 6.5 | 17.1 | 7.4 | 4.8 |
| 2016 | 98.6 | 1 | 27.2 | 7.3 | 17.4 | 8.6 | 5.8 |
| 2017 | 94.2 | 0 | 23.8 | 7.2 | 17.9 | 8.7 | 5.6 |



Figure 39: Statistical summary for daily maximum daily PM2.5 Florey 2014 – 2017



Figure 40: Annual average daily PM2.5 Florey 2014 – 2017