

# TABLE OF CONTENTS

[TABLE OF CONTENTS i](#_Toc107330927)

[LIST OF TABLES ii](#_Toc107330928)

[LIST OF FIGURES iii](#_Toc107330929)

[LIST OF DEFINITIONS AND ABBREVIATIONS iv](#_Toc107330930)

[OVERVIEW 5](#_Toc107330931)

[MONITORING SUMMARY 7](#_Toc107330932)

[Performance Monitoring Stations 7](#_Toc107330933)

[Monitoring Methods 7](#_Toc107330934)

[NATA Accreditation Status 8](#_Toc107330935)

[ASSESSMENT OF COMPLIANCE WITH STANDARDS AND GOAL 9](#_Toc107330936)

[Carbon monoxide 11](#_Toc107330937)

[Nitrogen dioxide 12](#_Toc107330938)

[Ozone 14](#_Toc107330939)

[PM10 16](#_Toc107330940)

[PM2.5 18](#_Toc107330941)

[ANALYSIS OF AIR QUALITY MONITORING 20](#_Toc107330942)

[Carbon monoxide 20](#_Toc107330943)

[Nitrogen dioxide 20](#_Toc107330944)

[Ozone 20](#_Toc107330945)

[PM10 21](#_Toc107330946)

[PM2.5 21](#_Toc107330947)

[ASSESSMENT OF PROGRESS TOWARDS ACHIEVING THE GOAL 23](#_Toc107330948)

[APPENDIX A: STATISTICAL SUMMARY AND TRENDS 25](#_Toc107330949)

[Carbon monoxide 25](#_Toc107330950)

[Nitrogen dioxide 27](#_Toc107330951)

[Ozone 30](#_Toc107330952)

[PM10 33](#_Toc107330953)

[PM2.5 37](#_Toc107330954)

# LIST OF TABLES

[Table 1: Summary of stations’ siting compliance with AS 3580.1.1:2016 7](#_Toc107330955)

[Table 2: Methods used for monitoring AAQ NEPM pollutants 8](#_Toc107330956)

[Table 3: AAQ NEPM standards in 2021 10](#_Toc107330957)

[Table 4: 2021 compliance summary for CO 11](#_Toc107330958)

[Table 5: 2021 compliance summary for NO2 12](#_Toc107330959)

[Table 6: 2021 compliance summary for O3 14](#_Toc107330960)

[Table 7: 2021 compliance summary for PM10 16](#_Toc107330961)

[Table 8: 2021 compliance summary for PM2.5 18](#_Toc107330962)

[Table 9: 2021 summary statistics for daily peak 8-hour CO 20](#_Toc107330963)

[Table 10: 2021 summary statistics for daily peak 1-hour NO2 20](#_Toc107330964)

[Table 11: 2021 summary statistics for daily peak 8-hour O3 21](#_Toc107330965)

[Table 12: 2021 summary statistics for daily PM10 21](#_Toc107330966)

[Table 13: 2021 summary statistics for daily PM2.5 22](#_Toc107330967)

[Table 14: 2021 PM2.5 exceedances 22](#_Toc107330968)

[Table 15: Statistical summary for daily maximum 8-hour CO Monash 2012 – 2021 25](#_Toc107330969)

[Table 16: Statistical summary for daily maximum 8-hour CO Florey 2014 – 2021 26](#_Toc107330970)

[Table 17: Statistical summary for daily maximum 1-hour NO2 Monash 2012 – 2021 27](#_Toc107330971)

[Table 18: Statistical summary for daily maximum 1-hour NO2 Florey 2014 – 2021 28](#_Toc107330972)

[Table 19: Statistical summary for daily maximum 8-hour O3 Monash 2012 – 2021 30](#_Toc107330973)

[Table 20: Statistical summary for daily maximum 8-hour O3 Civic 2012 – 2021 31](#_Toc107330974)

[Table 21: Statistical summary for daily maximum 8-hour O3 Florey 2014 – 2021 32](#_Toc107330975)

[Table 22: Statistical summary for daily maximum daily PM10 Monash 2012 – 2021 33](#_Toc107330976)

[Table 23: Statistical summary for daily maximum daily PM10 Civic 2012 – 2021 34](#_Toc107330977)

[Table 24: Statistical summary for daily maximum daily PM10 Florey 2014 – 2021 36](#_Toc107330978)

[Table 25: Statistical summary for daily maximum daily PM2.5 Monash 2012 – 2021 37](#_Toc107330979)

[Table 26: Statistical summary for daily maximum daily PM2.5 Civic 2016 – 2021 39](#_Toc107330980)

[Table 27: Statistical summary for daily maximum daily PM2.5 Florey 2014 – 2021 40](#_Toc107330981)

# LIST OF FIGURES

[Figure 1: Daily maximum for CO 8-hour average – Monash 11](#_Toc107330982)

[Figure 2: Daily maximum for CO 8-hour average – Florey 12](#_Toc107330983)

[Figure 3: Daily maximum for NO2 1-hour average – Monash 13](#_Toc107330984)

[Figure 4: Daily maximum for NO2 1-hour average – Florey 13](#_Toc107330985)

[Figure 5: Daily maximum for O3 8-hour average – Monash 14](#_Toc107330986)

[Figure 6: Daily maximum for O3 8-hour average – Civic 15](#_Toc107330987)

[Figure 7: Daily maximum for O3 8-hour average – Florey 15](#_Toc107330988)

[Figure 8: Daily maximum for PM10 – Monash 16](#_Toc107330989)

[Figure 9: Daily maximum for PM10 – Civic 17](#_Toc107330990)

[Figure 10: Daily maximum for PM10 – Florey 17](#_Toc107330991)

[Figure 11: Daily maximum for PM2.5 – Monash 18](#_Toc107330992)

[Figure 12: Daily maximum for PM2.5 – Civic 19](#_Toc107330993)

[Figure 13: Daily maximum for PM2.5 – Florey 19](#_Toc107330994)

[Figure 14: Statistical summary for daily maximum 8-hour CO Monash 2012 – 2021 25](#_Toc107330995)

[Figure 15: Statistical summary for daily maximum 8-hour CO Florey 2014 – 2021 26](#_Toc107330996)

[Figure 16: Statistical summary for daily maximum 1-hour NO2 Monash 2012 – 2021 27](#_Toc107330997)

[Figure 17: Annual average 1-hour NO2 Monash 2012 – 2021 28](#_Toc107330998)

[Figure 18: Statistical summary for daily maximum 1-hour NO2 Florey 2014 – 2021 29](#_Toc107330999)

[Figure 19: Annual average 1-hour NO2 Florey 2014 – 2021 29](#_Toc107331000)

[Figure 20: Statistical summary for daily maximum 8-hour O3 Monash 2012 – 2021 30](#_Toc107331001)

[Figure 21: Statistical summary for daily maximum 8-hour O3 Civic 2012 – 2021 31](#_Toc107331002)

[Figure 22: Statistical summary for daily maximum 1-hour O3 Florey 2014 – 2021 32](#_Toc107331003)

[Figure 23: Statistical summary for daily PM10 Monash 2012 – 2021 33](#_Toc107331004)

[Figure 24: Annual average daily PM10 Monash 2012 – 2021 34](#_Toc107331005)

[Figure 25: Statistical summary for daily PM10 Civic 2012 – 2021 35](#_Toc107331006)

[Figure 26: Annual average daily PM10 Civic 2012 – 2021 35](#_Toc107331007)

[Figure 27: Statistical summary for daily PM10 Florey 2014 – 2021 36](#_Toc107331008)

[Figure 28: Annual average daily PM10 Florey 2014 – 2021 37](#_Toc107331009)

[Figure 29: Statistical summary for daily PM2.5 Monash 2012 – 2021 38](#_Toc107331010)

[Figure 30: Annual average daily PM2.5 Monash 2012 – 2021 38](#_Toc107331011)

[Figure 31: Statistical summary for daily PM2.5 Civic 2016 – 2021 39](#_Toc107331012)

[Figure 32: Annual average daily PM2.5 Civic 2016 – 2021 40](#_Toc107331013)

[Figure 33: Statistical summary for daily PM2.5 Florey 2014 – 2021 41](#_Toc107331014)

[Figure 34: Annual average daily PM2.5 Florey 2014 – 2021 41](#_Toc107331015)

# 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 one (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

The ACT Air Quality Report 2021 (‘the Report’) presents the results of ambient air quality monitoring in the ACT for 2021 and assesses the results in accordance with the requirements of the National Environment Protection (Ambient Air Quality) Measure[[1]](#footnote-1) (AAQ NEPM) made by the National Environment Protection Council on 26 June 1998.

On 18 May 2021 the AAQ NEPM was amended to update the ambient air quality pollutant concentration standards for nitrogen dioxide, sulfur dioxide and ozone. Several other changes were also made during this variation. The key amendments are detailed in the Section on “ASSESSMENT OF COMPLIANCE WITH STANDARDS AND GOAL”.

Air quality in this Report is assessed against the revised 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 (PM10) against a lower standard of an annual average of 20 μg/m3 rather than the 25 μg/m3 standard. This means that it is reporting against a more stringent target than in the published national standard.

The ACT monitors four of the six NEPM pollutants:

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

The ACT does not monitor sulfur dioxide (SO2) as is primarily an industrial pollutant and the ACT does not have much heavy industry. In 2002, lead monitoring ceased with the phase out of leaded petrol.

A summary of the 2021 Report is:

* Canberra's air quality dramatically improved in 2021 compared to 2019 and 2020 due to the absence of bushfires and reduction of dust storms. There were no exceedances of the AAQ NEPM standards for carbon monoxide, nitrogen dioxide and ozone at any of the ACT's monitoring stations;
* Without the impacts from prolonged drought and unprecedented bushfires, the daily PM10 standard was not exceeded in 2021, compared to 27 exceedance days in 2020 and 29 exceedance days in 2019;
* Annual average levels for particulate matter (PM10 and PM2.5) were at some of the lowest levels experienced in the past 10 years; and
* PM2.5 was the only pollutant that exceeded the national standard. This was exceeded for 5 days in 2021, which were related to controlled burns in NSW and wood heater emissions in the ACT and occurred between late April and early July:
  + Two exceedances (29 April and 30 April) were likely attributable to smoke from hazard reduction burns in NSW;
  + One exceedance (1 May) was likely attributable to a combination of smoke from hazard reduction burns in NSW and wood heater use; and
  + Two exceedances (21 May and 8 July) were likely attributable to smoke from wood heater use.

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

The ACT monitoring network consists of three monitoring stations located at:

* Monash – approximately 300 metres west of Cockcroft Avenue in open urban space area;
* 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 3580.1.1:2016 are listed in Table 1 below.

Table 1: Summary of stations’ siting compliance with AS 3580.1.1:2016

| **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 | 🗹 | 🗹 | 🗹 | 🗹 | 🗹 | 🗹 | 🗹 |

Monash and Florey stations are the ACT’s two performance monitoring stations as per the requirements under Section 14 of the AAQ NEPM and they fully comply with relevant standards.

In addition, the ACT Government carries out key pollutants monitoring at Civic station to better inform the community concerning ambient air quality and support formation of government policy.

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 selected, key pollutants, including 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 3580.6.1-2016 | Methods for sampling and analysis of ambient air - Determination of ozone - Direct-reading instrumental method | Non-dispersive ultraviolet |
| 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 |
| 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 | Beta Attenuation Monitor |

## 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 GOAL

For the purpose of this Report, air quality is assessed against the AAQ NEPM standards as specified in Schedule 2 of the AAQ NEPM and ACT policy position. 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 4).

On 18 May 2021, the AAQ NEPM was amended to introduce the new national standards for NO2, SO2 and O3[[2]](#footnote-2). The amendment, taking into account the latest scientific evidence about the health impacts, primarily includes:

* significantly strengthen NO2 reporting standards for 1-hour and 1-year averaging periods;
* establish a new O3 standard with an 8-hour averaging period that reflects the health evidence;
* significantly strengthen SO2 reporting standards for 1-hour and 24-hour averaging periods;
* remove annual SO2 and 1-hour and 4-hour O3 averaging periods to align the standards with the recent health evidence;
* remove single day exceedances allowed for all gaseous pollutants; and
* apply the existing exceptional events rule O3 given the linkages between elevated O3 levels and fire events.

While the amended AAQ NEPM took effect partway through the year during 2021, air quality in this Report is assessed against the new and more stringent national standards for the whole year. The goal of the AAQ NEPM is to achieve the NEPM standards specified in Schedule 2 of the AAQ NEPM.

Table 3: AAQ NEPM standards in 2021

| **Pollutant** | **Averaging Period** | **Old NEPM Standards** | **New NEPM Standards** | **Change** |
| --- | --- | --- | --- | --- |
| Carbon monoxide | 8 hours | 9.0 ppm | **9.0 ppm** | No change |
| Nitrogen dioxide | 1 hour  1 year | 0.12 ppm  0.03 ppm | **0.08 ppm**  **0.015 ppm** | Strengthened  Strengthened |
| Photochemical oxidants (as ozone) | 1 hour  4 hours  8 hours | 0.10 ppm  0.08 ppm | **-**  **-**  **0.065 ppm** | Removed  Removed  Established |
| Sulfur dioxide | 1 hour  1 day  1 year | 0.20 ppm  0.08 ppm  0.02 ppm | **0.10 ppm**  **0.02 ppm** | Strengthened  Strengthened  Removed |
| Lead | 1 year | 0.50 μg/m3 | **0.50 μg/m3** | No change |
| Particles as PM10 | 1 day  1 year | 50 μg/m3  25 μg/m3 | **50 μg/m3**  **25 μg/m3** | No change  No change |
| Particles as PM2.5 | 1 day  1 year | 25 μg/m3  8 μg/m3 | **25 μg/m3**  **8 μg/m3** | No change  No change |

In accordance with its agreed policy position, the ACT assesses its compliance for the annual average for PM10 against a lower standard of 20 μg/m3 rather than the AAQ NEPM standard of 25 μg/m3. There is an additional goal to further reduce PM2.5 concentrations to below a daily concentration of 20 μg/m3 and an annual concentration of 7 μg/m3 by 2025.

Table 4 to Table 8 summarise compliance with the standards of the AAQ NEPM and ACT policy position. For each pollutant, the data availability (quarterly and annual), the number of days when standards were exceeded, the annual average (where an annual standard exists) and an assessment of compliance, are given for each monitoring station. Although Civic station is not a NEPM performance monitoring station, measured data from this station is included in this Report to better understand ambient air quality in the ACT, especially in the city area.

Air quality is assessed as complying with the AAQ NEPM (i.e. ‘*MET’*) if the maximum recorded concentration is no more than the standard specified in Table 3 and data availability was at least 75 percent in each quarter of the year.

Air quality is assessed as not complying with the AAQ NEPM (i.e. ‘*NOT MET’*) if the maximum recorded concentration is more than the standard specified in Table 3.

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.

For the purpose of reporting compliance against PM10 and PM2.5 daily average standards, monitoring data that has been determined as being directly associated with an exceptional event has been excluded in accordance with the AAQ NEPM.

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

## Carbon monoxide

During 2021, no exceedances of the carbon monoxide standard were recorded and compliance was demonstrated at Florey. Due to instrument failure, there was insufficient data collected in the fourth quarter at Monash. As a result, compliance was not demonstrated at Monash.

Table 4: 2021 compliance summary for CO

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

| **Monitoring station** | **Data availability rates**  **(% of hours)** | | | | | **Number of exceedances**  **(days)** | **NEPM goal compliance** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Q1** | **Q2** | **Q3** | **Q4** | **Annual** |
| Monash  Florey | 95.7  95.8 | 95.7  95.8 | 95.6  95.7 | 66.0  93.4 | 88.2  95.2 | 0  0 | ND  MET |

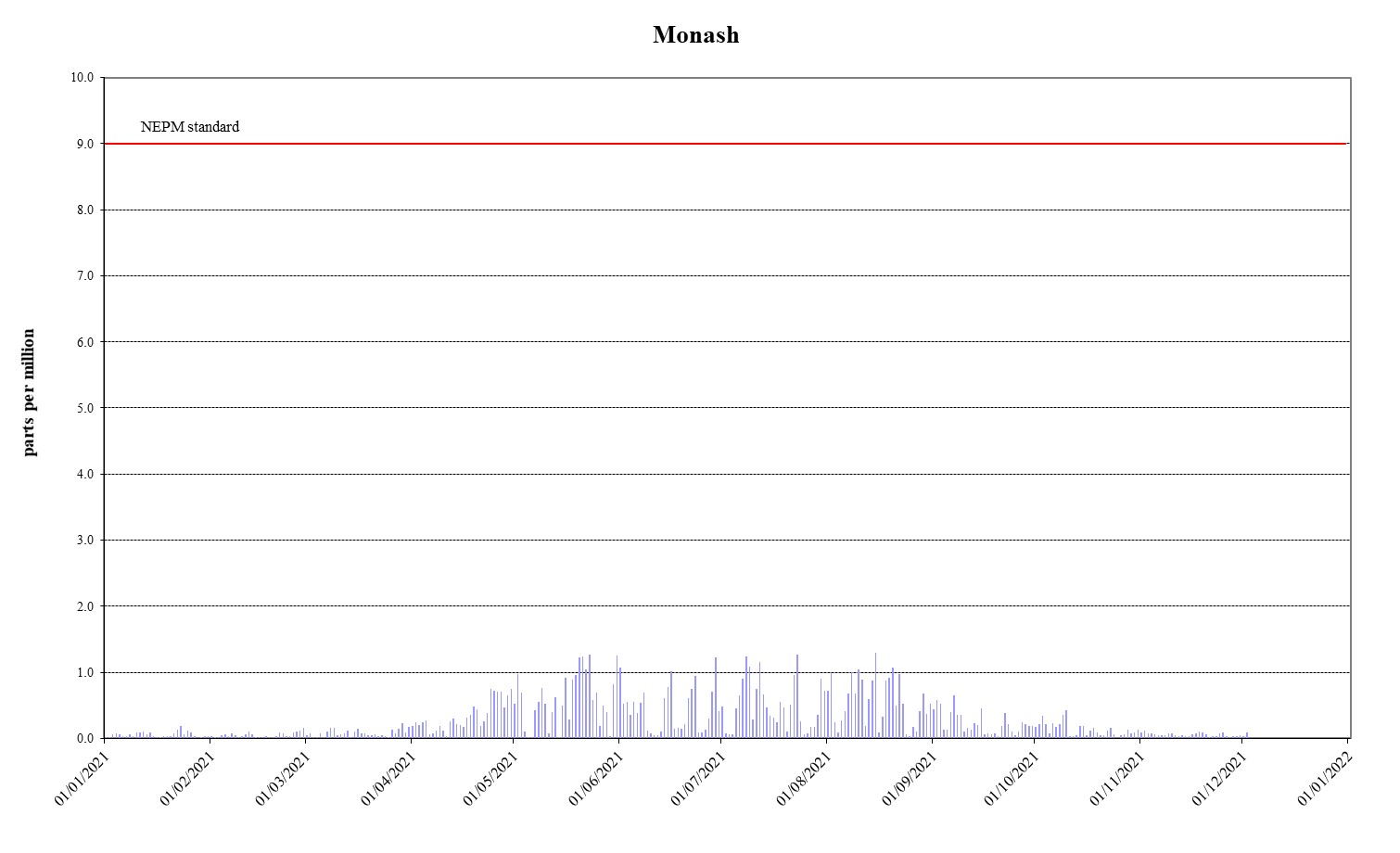


Figure 1: Daily maximum for CO 8-hour average – Monash

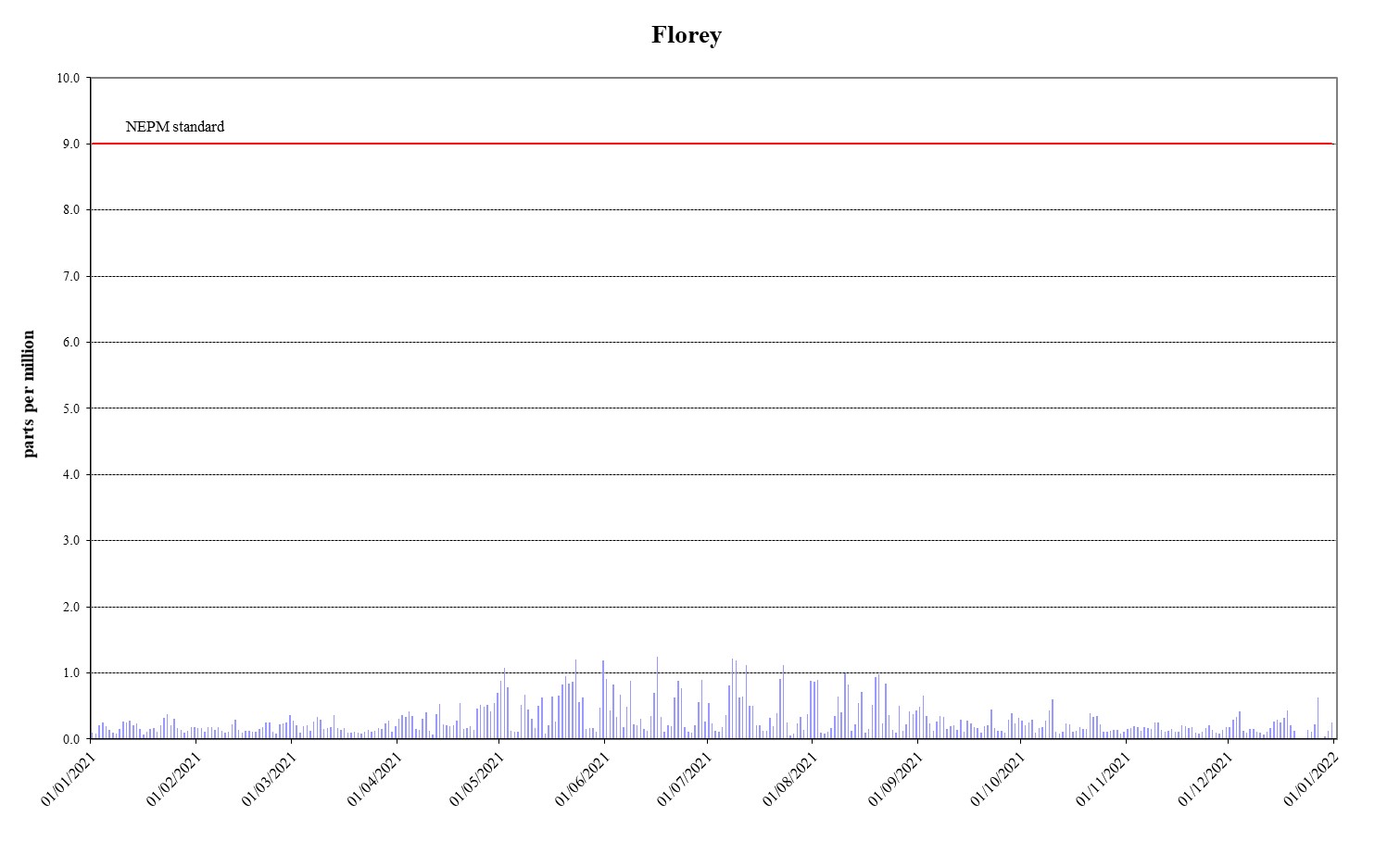
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Figure 2: Daily maximum for CO 8-hour average – Florey

## Nitrogen dioxide

During 2021, no exceedances of the nitrogen dioxide standards were recorded and compliance was demonstrated at Monash and Florey.

The annual average levels remained low and met the standard at Monash and Florey.

Table 5: 2021 compliance summary for NO2

AAQ NEPM standard – 0.08 ppm (1-hour average), 0.015 ppm (1-year average)

| **Monitoring station** | **Data availability rates**  **(% of hours)** | | | | | **1 Hour** | | **1 Year** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Q1** | **Q2** | **Q3** | **Q4** | **Annual** | **Number of exceedances** | **NEPM goal compliance** | **Annual average**  **(ppm)** | **NEPM goal compliance** |
| Monash  Florey | 95.7  92.1 | 95.7  92.3 | 95.6  91.9 | 95.7  90.2 | 95.7  91.6 | 0  0 | MET  MET | 0.003 0.004 | MET  MET |

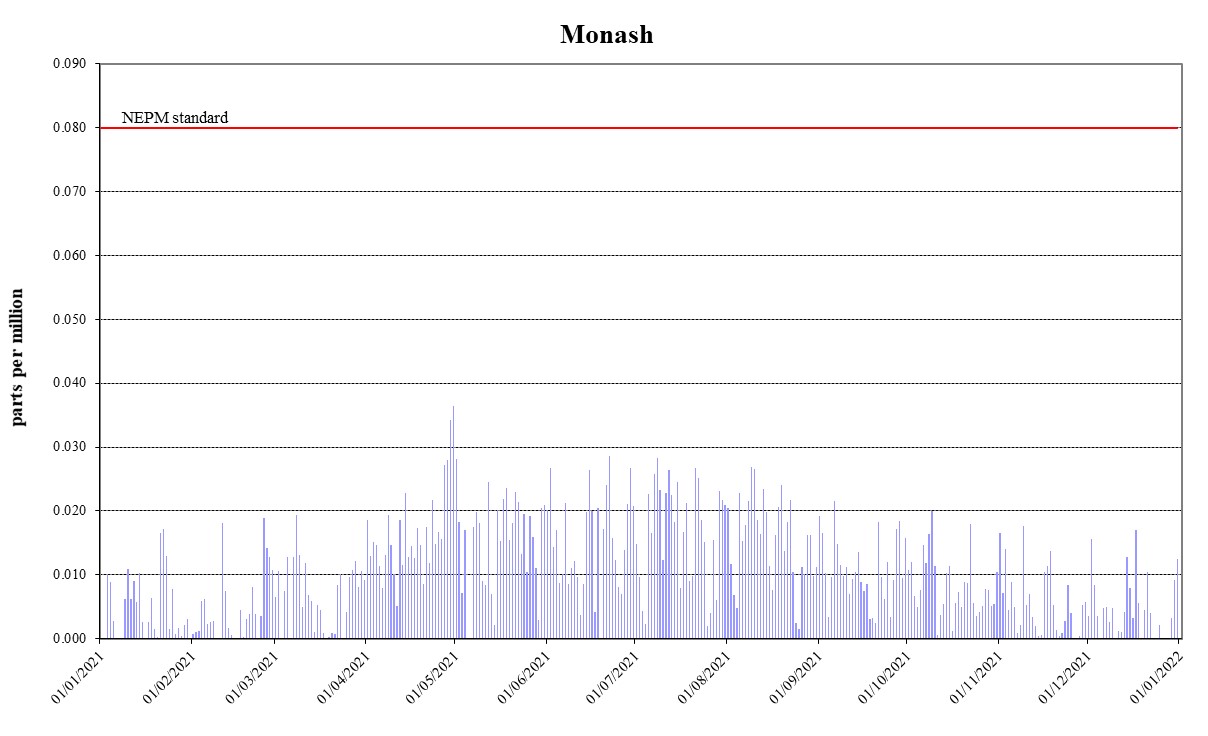


Figure 3: Daily maximum for NO2 1-hour average – Monash

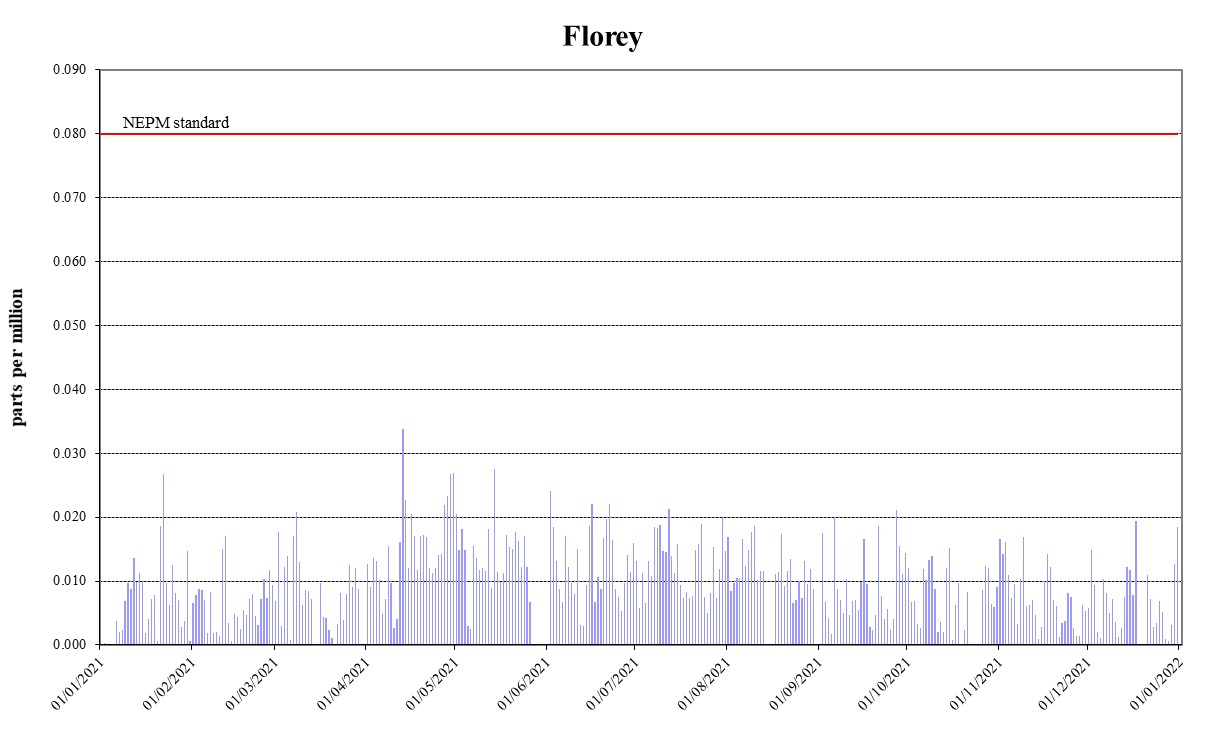


Figure 4: Daily maximum for NO2 1-hour average – Florey

## Ozone

During 2021, no exceedances of the 8-hour standard for ozone were recorded and compliance was demonstrated at all monitoring stations.

Table 6: 2021 compliance summary for O3

AAQ NEPM standard – 0.065 ppm (8-hour average)

| **Monitoring station** | **Data availability rates**  **(% of hours)** | | | | | **Number of exceedances** | **NEPM goal compliance** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Q1** | **Q2** | **Q3** | **Q4** | **Annual** |
| Monash  Civic  Florey | 95.7  95.8  95.8 | 95.7  95.8  95.8 | 95.8  95.8  95.8 | 95.7  94.6  95.8 | 95.7  95.5  95.8 | 0  0  0 | MET  MET  MET |

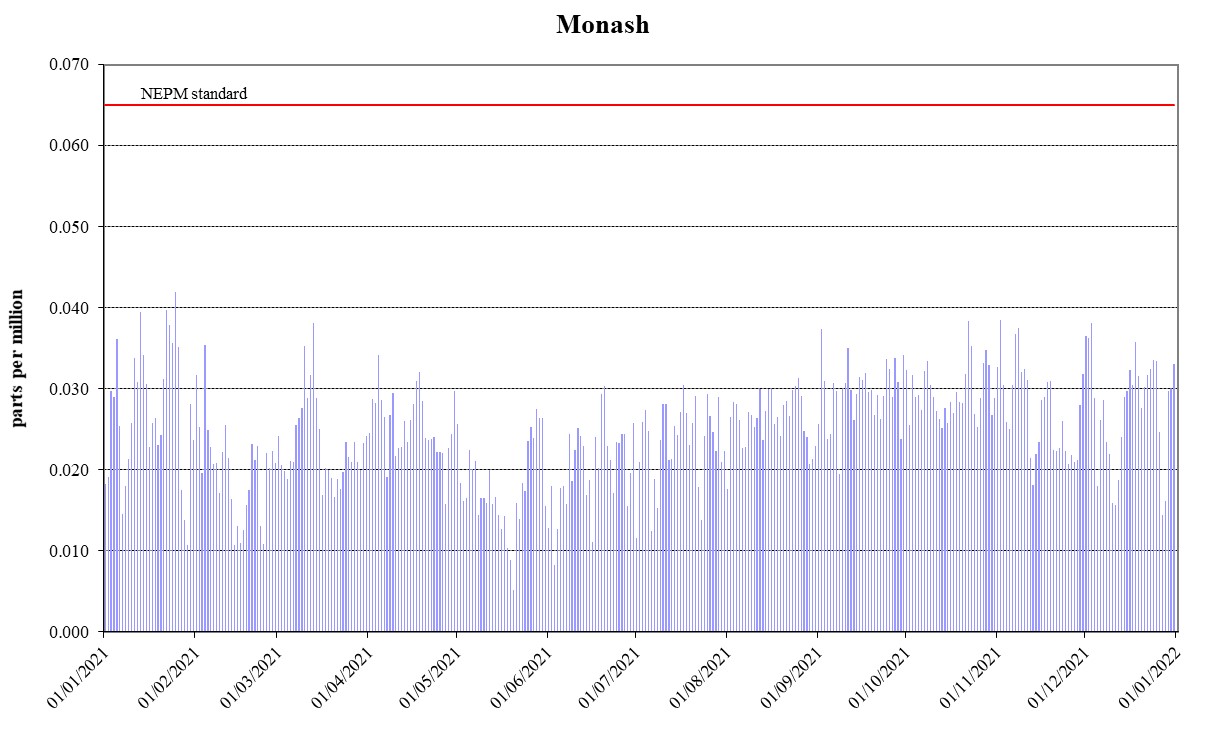


Figure 5: Daily maximum for O3 8-hour average – Monash

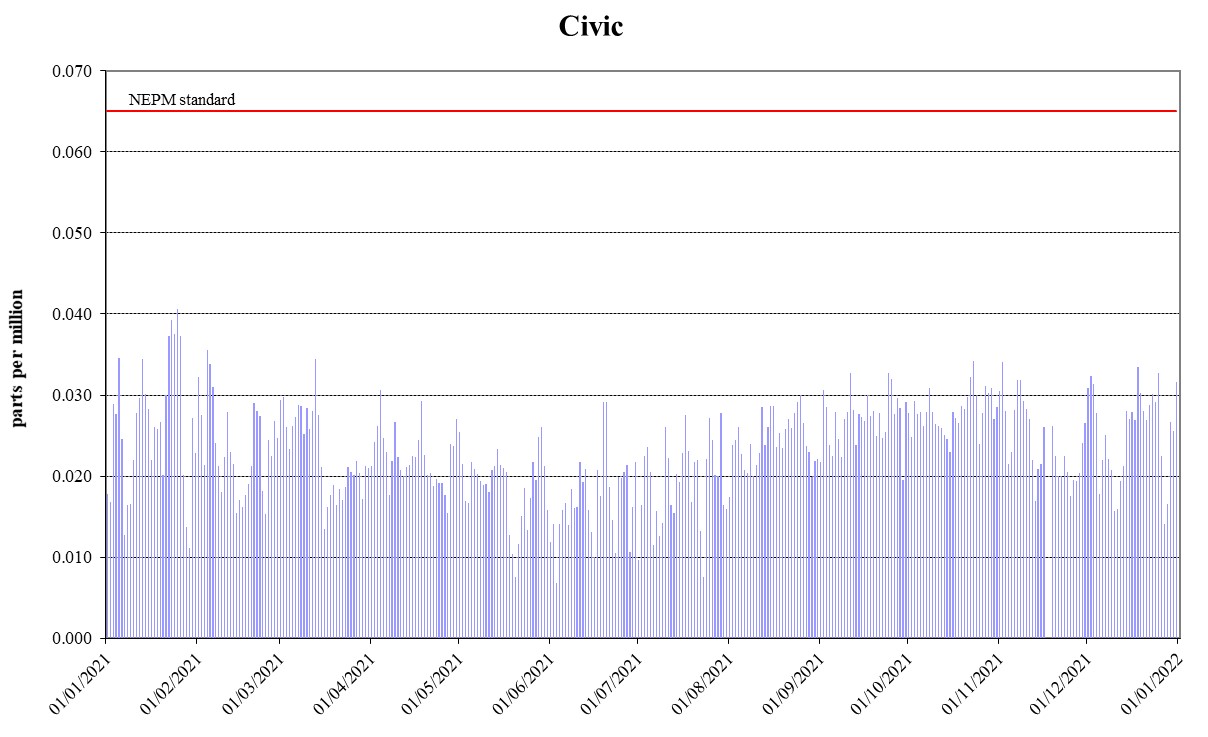


Figure 6: Daily maximum for O3 8-hour average – Civic

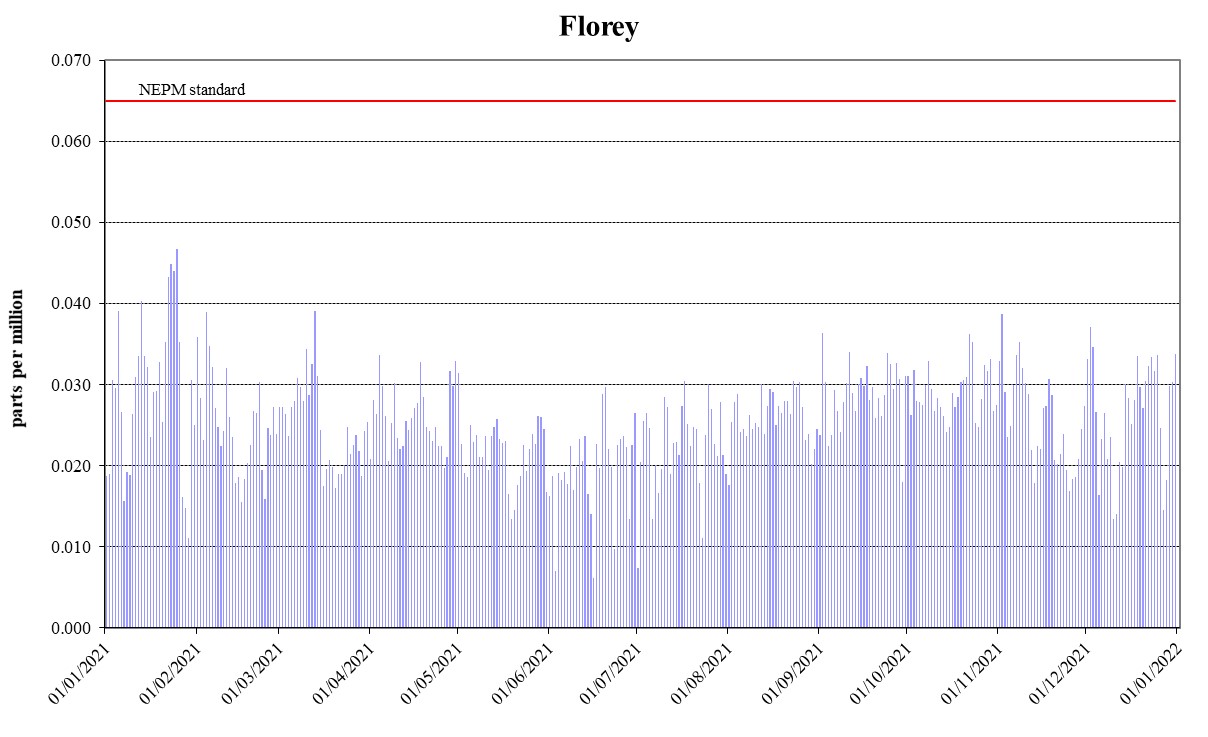


Figure 7: Daily maximum for O3 8-hour average – Florey

## PM10

During 2021, no exceedances of the daily PM10 standard were recorded and compliance was demonstrated at all monitoring stations.

The annual average PM10 levels at all stations met the ACT policy position of 20 μg/m3.

Table 7: 2021 compliance summary for PM10

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

| **Monitoring station** | **Data availability rates**  **(% of days)** | | | | | **1 Day** | | **1 Year** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Q1** | **Q2** | **Q3** | **Q4** | **Annual** | **Number of exceedances** | **NEPM goal compliance** | **Annual average**  **(μg/m3)** | **ACT goal compliance** |
| Monash  Civic  Florey | 100  92.2  97.8 | 100  100  100 | 97.8  100  97.8 | 100  82.6  100 | 99.5  93.7  99.5 | 0  0  0 | MET  MET  MET | 10.3  8.7  9.6 | MET  MET  MET |

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

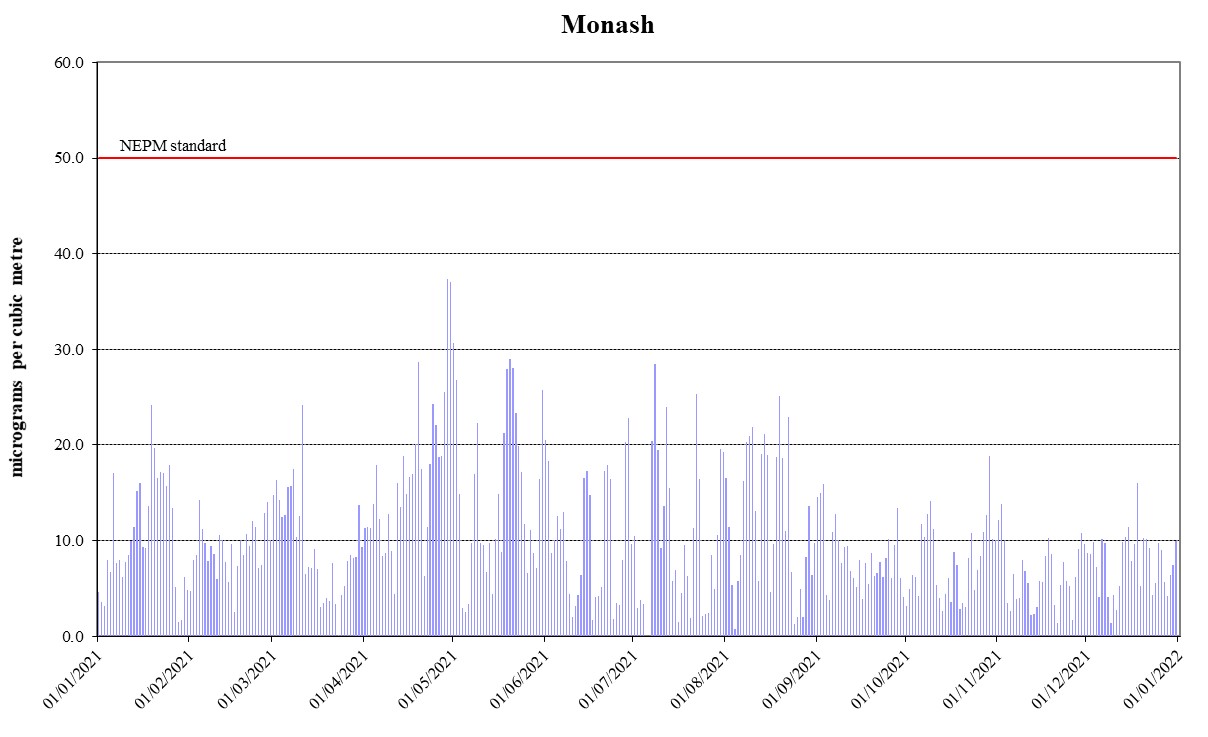


Figure 8: Daily maximum for PM10 – Monash

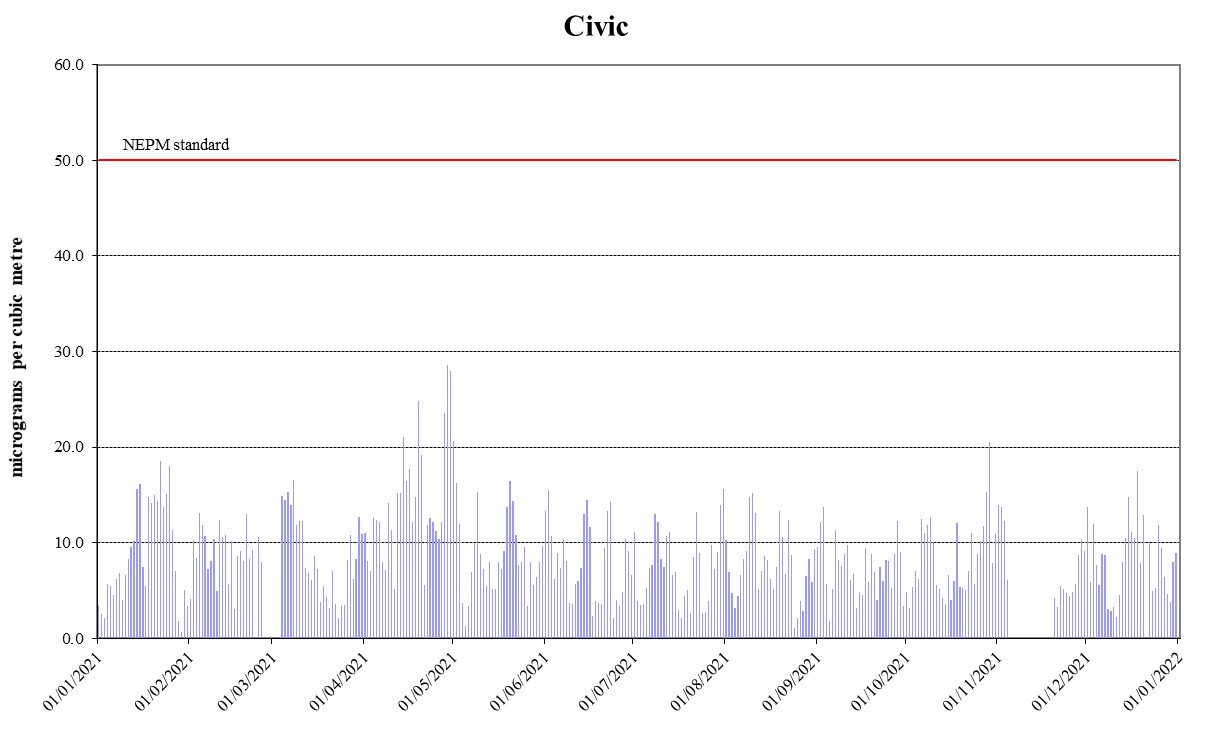


Figure 9: Daily maximum for PM10 – Civic

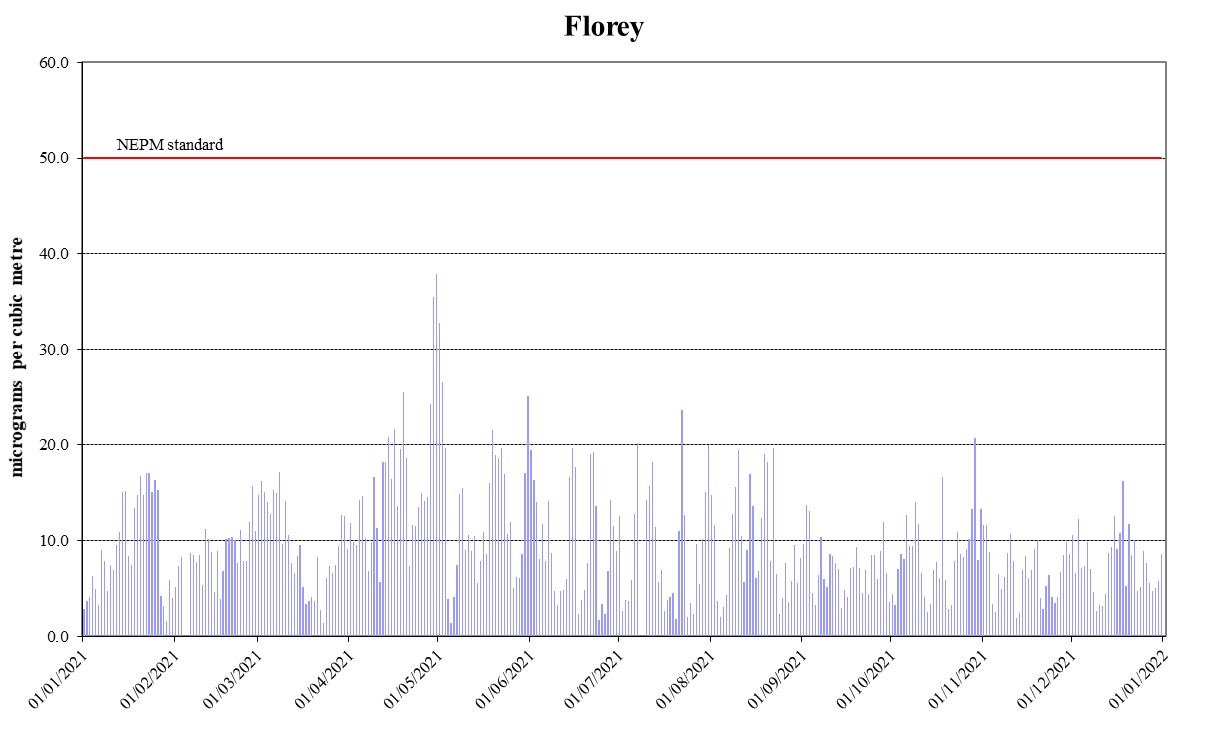


Figure 10: Daily maximum for PM10 – Florey

## PM2.5

During 2021, there were exceedances of daily PM2.5 standard on 5 days at Monash (5 days) and Florey (3 days). Two exceedance days (April 29 and 30 April) were likely attributable to smoke from hazard reduction burns in NSW. Under the exceptional event rule they have been excluded when assessing compliance against the daily standard. Compliance against the daily PM2.5 standard was not met at Monash and Florey. No daily exceedances against the daily PM2.5 standard were recorded at Civic. Annual average PM2.5 data at all stations met the 8 μg/m3 AAQ NEPM standard.

Table 8: 2021 compliance summary for PM2.5

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

| **Monitoring station** | **Data availability rates**  **(% of days)** | | | | | **1 Day** | | **1 Year** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Q1** | **Q2** | **Q3** | **Q4** | **Annual** | **Number of exceedances\*** | **NEPM goal compliance** | **Annual average**  **(μg/m3)** | **NEPM goal compliance** |
| Monash  Civic  Florey | 97.8  93.3  98.9 | 100  97.8  100 | 100  100  98.9 | 96.7  95.7  95.7 | 98.6  96.7  98.4 | **3**  0  **1** | **NOT MET**  MET  **NOT MET** | 6.8  5.0  6.2 | MET  MET  MET |

\* the number excludes exceptional events.

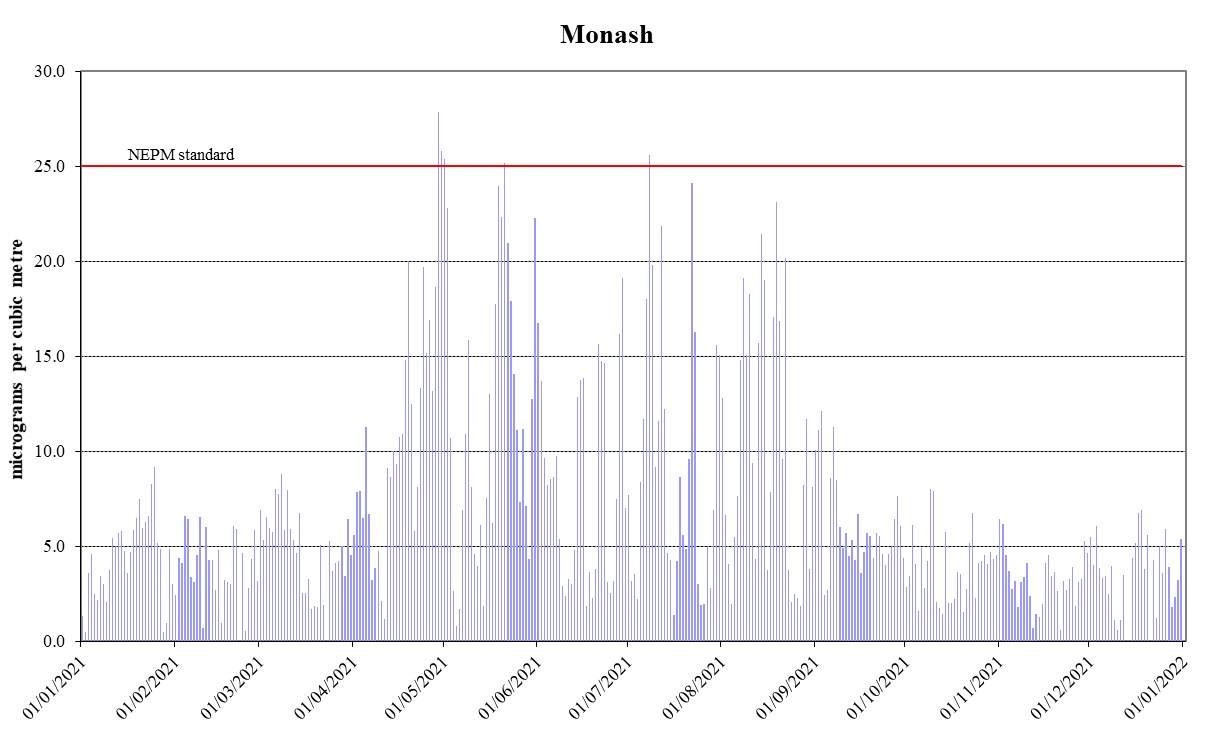
55

Figure 11: Daily maximum for PM2.5 – Monash

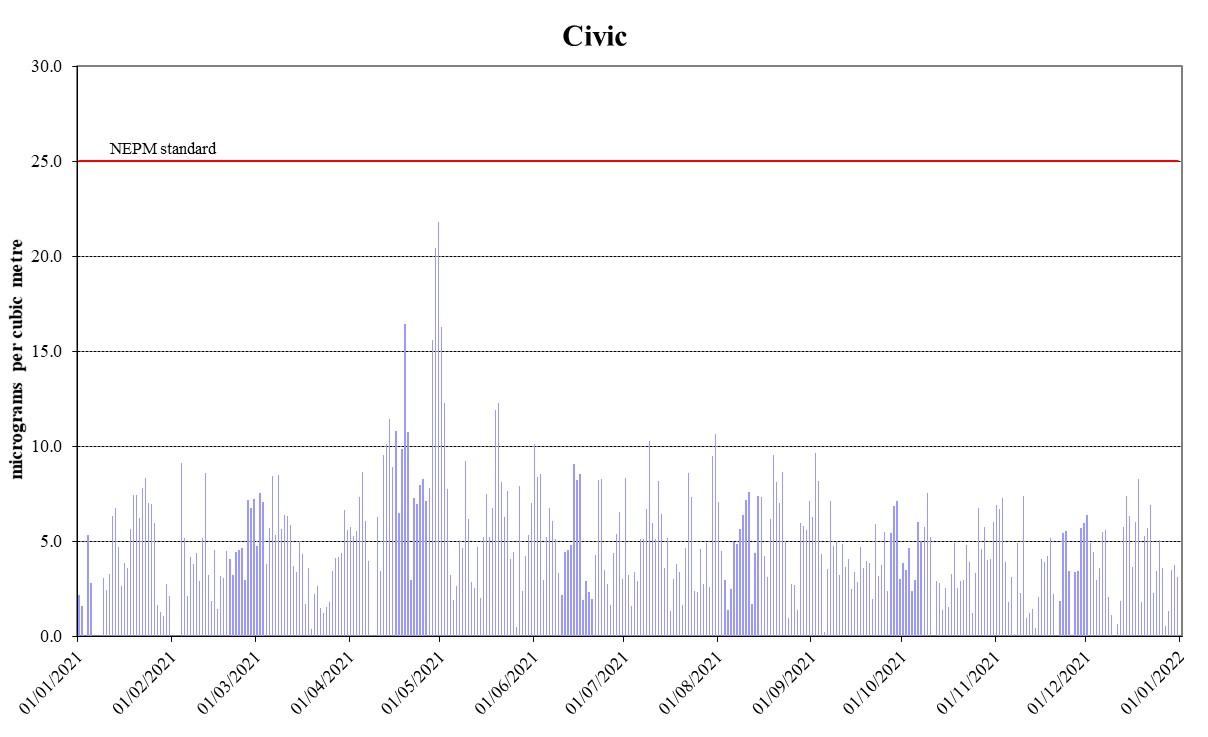


Figure 12: Daily maximum for PM2.5 – Civic

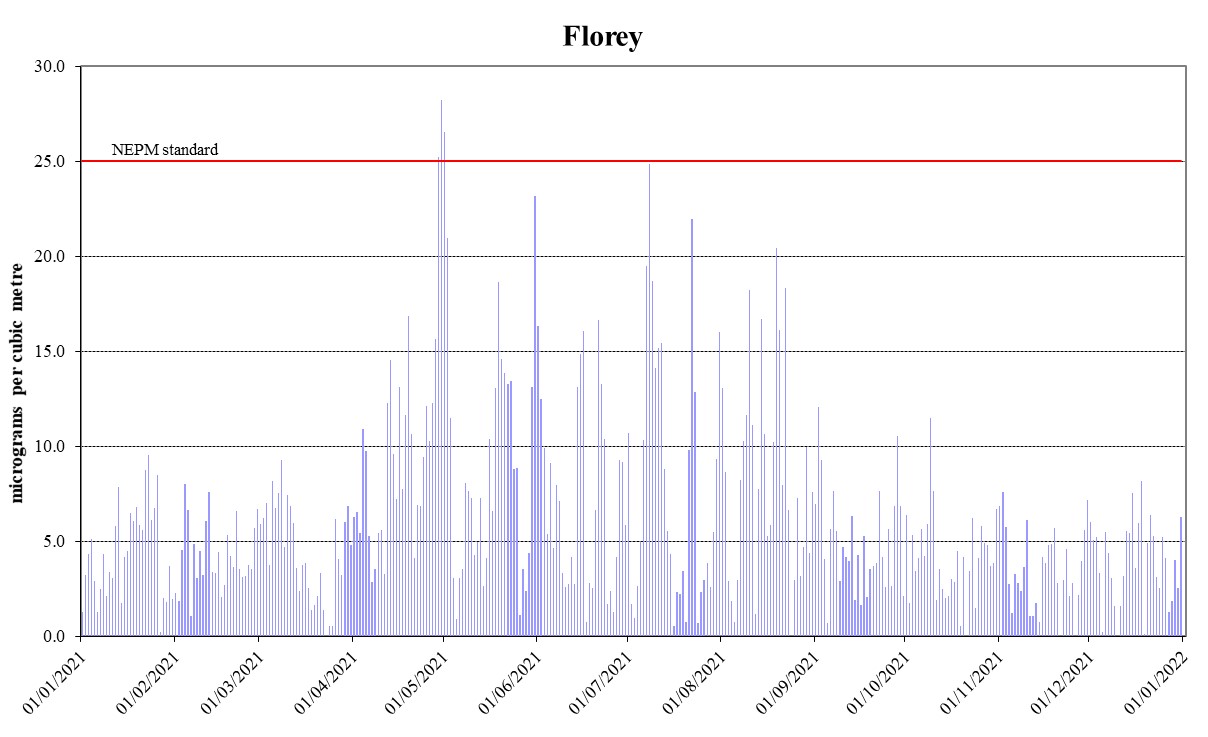


Figure 13: Daily maximum for PM2.5 – Florey

# ANALYSIS OF AIR QUALITY MONITORING

Annual summary statistics contained in Table 9 to Table 13 below assess air quality against the standards and the extent of compliance with the goal. In each case a result of ‘below the standard’ indicates that compliance is achieved. Instances where the standard has been exceeded are highlighted in bold.

## Carbon monoxide

Carbon monoxide levels in 2021 dropped back to a level well below the standard at all monitoring stations, compared to 2019 and 2020. The highest recorded value in the ACT during 2021 was 1.3 ppm at Monash, which was the lowest level in the past ten years.

Table 9: 2021 summary statistics for daily peak 8-hour CO

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

| **Monitoring station** | **Number of valid days** | **Highest**  **(ppm)** | **Highest**  **(date/time)** |
| --- | --- | --- | --- |
| Monash  Florey | 336  362 | 1.3  1.2 | 15 Aug 07:00  16 Jun 09:00 |

## Nitrogen dioxide

Similar to carbon monoxide, nitrogen dioxide levels dropped back to a level well below the standard. The highest recorded 1-hour value during 2021 was 0.036 ppm at Monash, which is only 45% of the new standard. The highest recorded annual average in 2021 was 0.004ppm at Florey (refer to Table 5). This is 27% of the new annual standard 0.015ppm.

Table 10: 2021 summary statistics for daily peak 1-hour NO2

AAQ NEPM standard 0.08 ppm (1-hour average)

| **Monitoring station** | **Number of valid days** | **Highest**  **(ppm)** | **Highest**  **(date/time)** |
| --- | --- | --- | --- |
| Monash  Florey | 365  339 | 0.036  0.034 | 30 Apr 19:00  13 Apr 10:00 |

## Ozone

Ozone levels in 2021 were below the new 8-hour standard. The highest recorded value in the ACT during 2021 was 0.047 ppm at Florey, which is 72% of the standard.

Table 11: 2021 summary statistics for daily peak 8-hour O3

AAQ NEPM standard 0.065 ppm (8-hour average)

| **Monitoring station** | **Number of valid days** | **Highest**  **(ppm)** | **Highest**  **(date/time)** |
| --- | --- | --- | --- |
| Monash  Civic  Florey | 365  363  365 | 0.042  0.041  0.047 | 25 Jan 20:00  25 Jan 20:00  25 Jan 19:00 |

## PM10

PM10 levels were significantly reduced in 2021 without the impacts from prolonged drought and unprecedented bushfires. The highest daily PM10 level was recorded at Florey on 30 April 2021, with the concentration of 37.9μg/m3. The highest recorded annual average in 2021 was 10.3μg/m3 at Monash (refer to Table 7), which is 52% of the ACT policy standard of 20μg/m3.

Table 12: 2021 summary statistics for daily PM10

AAQ NEPM daily standard 50 μg/m3

| **Monitoring station** | **Number of valid days** | **Highest**  **(μg/m3)** | **Highest**  **(date)** |
| --- | --- | --- | --- |
| Monash  Civic  Florey | 363  342  361 | 37.3  28.6  37.9 | 29 April  29 April  30 April |

## PM2.5

The daily standard for PM2.5 was only exceeded on 5 days in 2021 at one or more of the monitoring stations, compared to 29 days in 2019 and 39 days in 2020.

Two exceedance days in April were likely attributable to smoke from hazard reduction burns in NSW. One exceedance (1 May) was likely attributable to a combination of smoke from hazard reduction burns in NSW and wood heater use at night. Two exceedances (21 May and 8 July) were likely attributable to smoke from wood heater use.

The highest daily PM2.5 level was 28.2μg/m3 which was recorded at Florey on 30 April 2021. The highest recorded annual average in 2021 was 6.8μg/m3 at Monash (refer to Table 8).

Table 13: 2021 summary statistics for daily PM2.5

AAQ NEPM daily standard 25 μg/m3

| **Monitoring station** | **Number of valid days** | **Highest**  **(μg/m3)** | **Highest**  **(date)** |
| --- | --- | --- | --- |
| Monash  Civic  Florey | 360  353  359 | **27.9**  21.8  **28.2** | 29 April  30 April  30 April |

Table 14: 2021 PM2.5 exceedances

| **Date** | **Monitoring Station** | | | **Inferred Cause** | **Exceptional Event** |
| --- | --- | --- | --- | --- | --- |
| **Monash**  **(μg/m3)** | **Civic**  **(μg/m3)** | **Florey**  **(μg/m3)** |
| 29 April 2021 | **27.9** |  | **25.2** | Controlled Burn | Yes |
| 30 April 2021 | **25.8** |  | **28.2** | Controlled Burn | Yes |
| 01 May 2021 | **25.4** |  | **26.6** | Controlled Burn Wood Heater | No |
| 21 May 2021 | **25.2** |  |  | Wood Heater | No |
| 08 July 2021 | **25.6** |  |  | Wood Heater | No |

# ASSESSMENT OF PROGRESS TOWARDS ACHIEVING THE GOAL

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. In more recent years, especially 2018 to 2020, exceedances of the particulate matter standards have also been attributed to smoke from hazard reduction burns, bushfires and dust storms.

Compared to 2019 and 2020, carbon monoxide, nitrogen dioxide and ozone concentrations dropped back to pre-bushfire levels. The AAQ NEPM standards for these pollutants were met during the whole year. PM10 levels were also significantly reduced in 2021 in the absence of prolonged drought and bushfires.

PM2.5 levels increase significantly during the cooler months of the year which can be seen in Figure 11 to Figure 13. PM2.5 is the pollutant most affected by woodsmoke as the majority of combustion particles are less than 1 micron in diameter.

The ACT Government acknowledges that wood heater emissions have an adverse effect on air quality during winter, and continue to implement an integrated program to address this including:

* Provides public information on air quality levels in the ACT through the online Air Quality Index[[3]](#footnote-3) and AirRater App;
* The annual 'Burn Right Tonight' community education campaign which reminds ACT residents how to use wood heaters correctly to minimise air pollution[[4]](#footnote-4);
* The regulation of firewood merchants to ensure only seasoned wood is sold[[5]](#footnote-5);
* The regulation of wood heaters sold in the ACT to ensure they meet the current Australian Standards for emissions and efficiency;
* The prohibition of wood heaters in new developments where planning studies show that they would have an adverse impact on air quality. The ACT Government has taken this approach for the development of the Molonglo Valley (except Wright)[[6]](#footnote-6), and previously with the suburbs of Dunlop and East O'Malley;
* Compliance and enforcement activities for wood heater emissions with a focus on correct wood heater operation[[7]](#footnote-7);
* Administering the Wood Heater Replacement Program to replace old inefficient wood heaters with high efficiency alternatives[[8]](#footnote-8); and
* Releasing the “*Bushfire Smoke and Air Quality Strategy 2021-25”* which will guide the ACT Government’s approach to prevent, prepare for, respond to, and recover from significant bushfire smoke events and management of the smoke from wood heaters[[9]](#footnote-9).

# APPENDIX A: STATISTICAL SUMMARY AND TRENDS

The following section provides a basic statistical summary, using percentiles, for Monash, Civic and Florey stations and for each standard in the past ten years. While the 8-hour O3 standard was only established in 2021, the long-term data for this new standard is back-calculated and present below. Daily maximum values are also presented in the following tables.

## Carbon monoxide

Table 15: Statistical summary for daily maximum 8-hour CO Monash 2012 – 2021

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (ppm) | 95th  percentile  (ppm) | 75th  percentile  (ppm) | 50th  percentile  (ppm) |
| --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 2018 | 92.3 | 0 | 1.5 | 1.2 | 0.5 | 0.2 |
| 2019 | 72.1 | 1 | 12.4 | 1.1 | 0.4 | 0.1 |
| 2020 | 94.9 | 2 | 22.0 | 1.5 | 0.6 | 0.2 |
| 2021 | 88.2 | 0 | 1.3 | 1.0 | 0.4 | 0.1 |

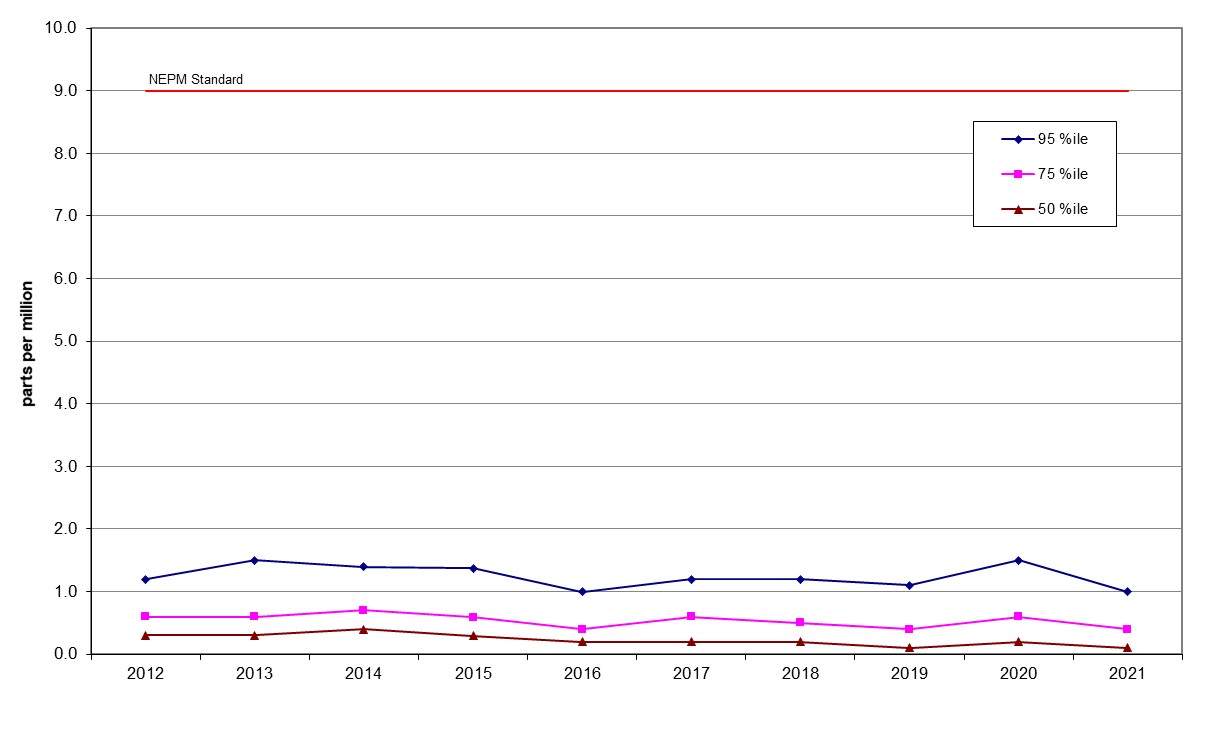


Figure 14: Statistical summary for daily maximum 8-hour CO Monash 2012 – 2021

Table 16: Statistical summary for daily maximum 8-hour CO Florey 2014 – 2021

| 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 |
| 2018 | 94.7 | 0 | 1.5 | 1.1 | 0.5 | 0.3 |
| 2019 | 95.3 | 0 | 8.6 | 1.2 | 0.6 | 0.3 |
| 2020 | 94.7 | 2 | 14.6 | 1.3 | 0.6 | 0.3 |
| 2021 | 95.2 | 0 | 1.2 | 0.9 | 0.4 | 0.2 |

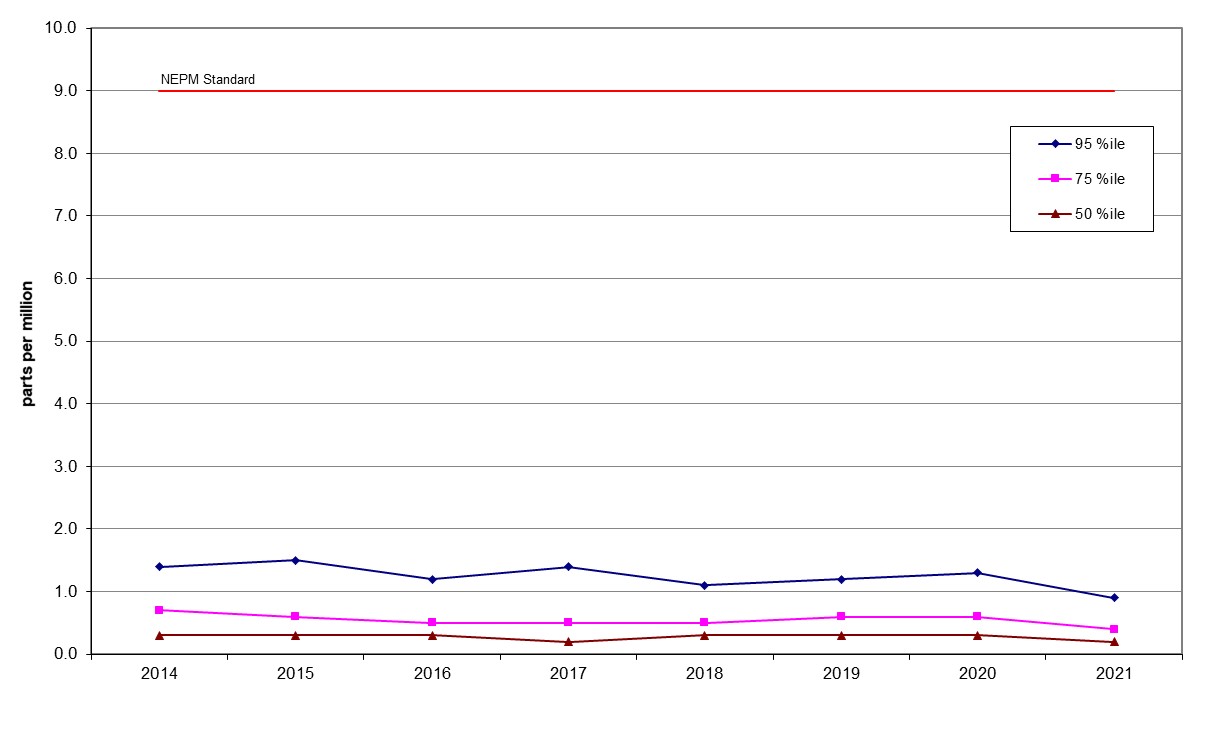


Figure 15: Statistical summary for daily maximum 8-hour CO Florey 2014 – 2021

## Nitrogen dioxide

Table 17: Statistical summary for daily maximum 1-hour NO2 Monash 2012 – 2021

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (ppm) | Annual average  (ppm) | 95th  percentile  (ppm) | 75th  percentile  (ppm) | 50th  percentile  (ppm) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 2018 | 95.5 | 0 | 0.039 | 0.004 | 0.028 | 0.020 | 0.014 |
| 2019 | 94.9 | 0 | 0.084 | 0.005 | 0.027 | 0.021 | 0.014 |
| 2020 | 95.7 | 0 | 0.116 | 0.004 | 0.027 | 0.019 | 0.011 |
| 2021 | 95.7 | 0 | 0.036 | 0.003 | 0.024 | 0.016 | 0.010 |

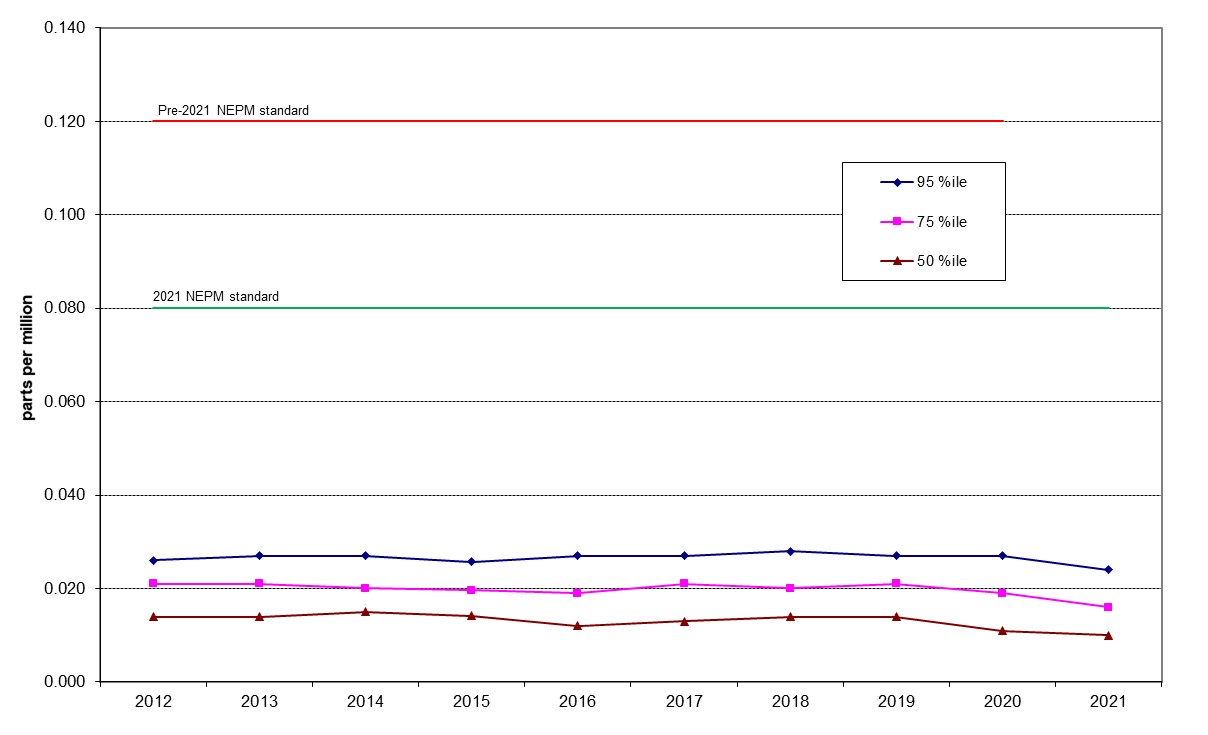


Figure 16: Statistical summary for daily maximum 1-hour NO2 Monash 2012 – 2021

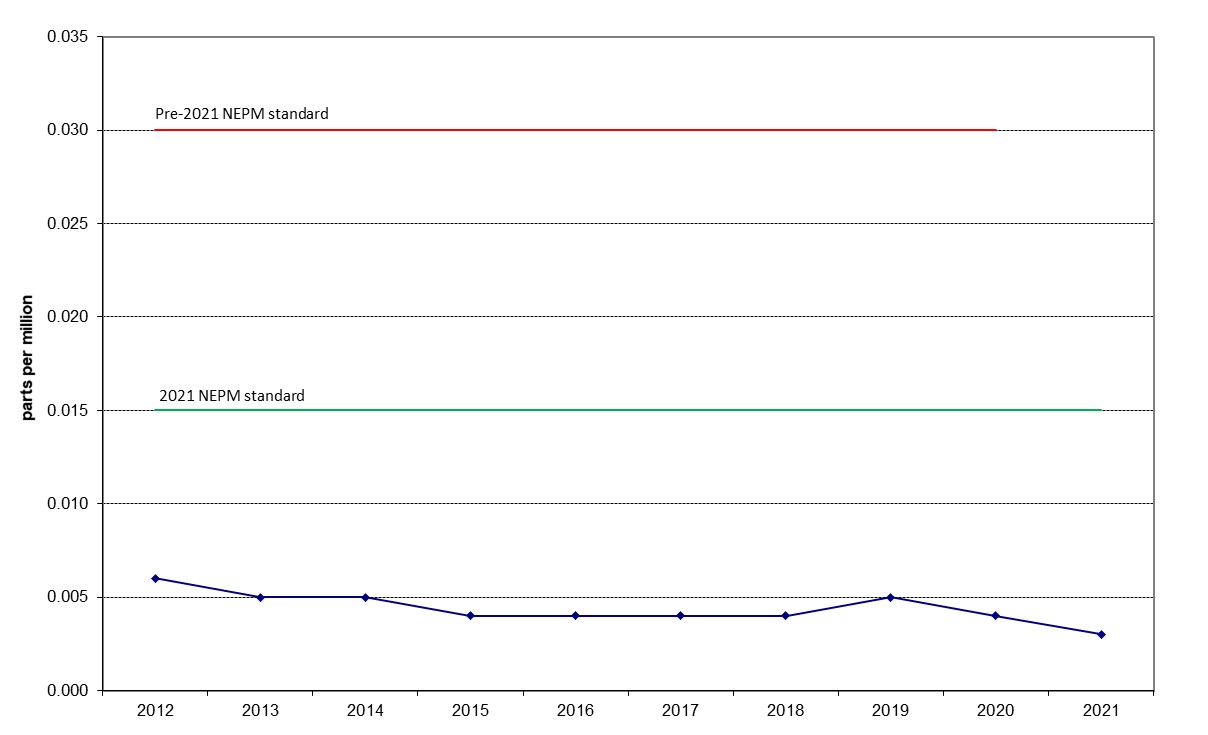


Figure 17: Annual average 1-hour NO2 Monash 2012 – 2021

Table 18: Statistical summary for daily maximum 1-hour NO2 Florey 2014 – 2021

| 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 |
| 2018 | 93.3 | 0 | 0.039 | 0.005 | 0.028 | 0.022 | 0.015 |
| 2019 | 92.4 | 0 | 0.062 | 0.005 | 0.027 | 0.020 | 0.014 |
| 2020 | 94.1 | 2 | 0.171 | 0.004 | 0.024 | 0.017 | 0.011 |
| 2021 | 91.6 | 0 | 0.034 | 0.004 | 0.020 | 0.013 | 0.009 |

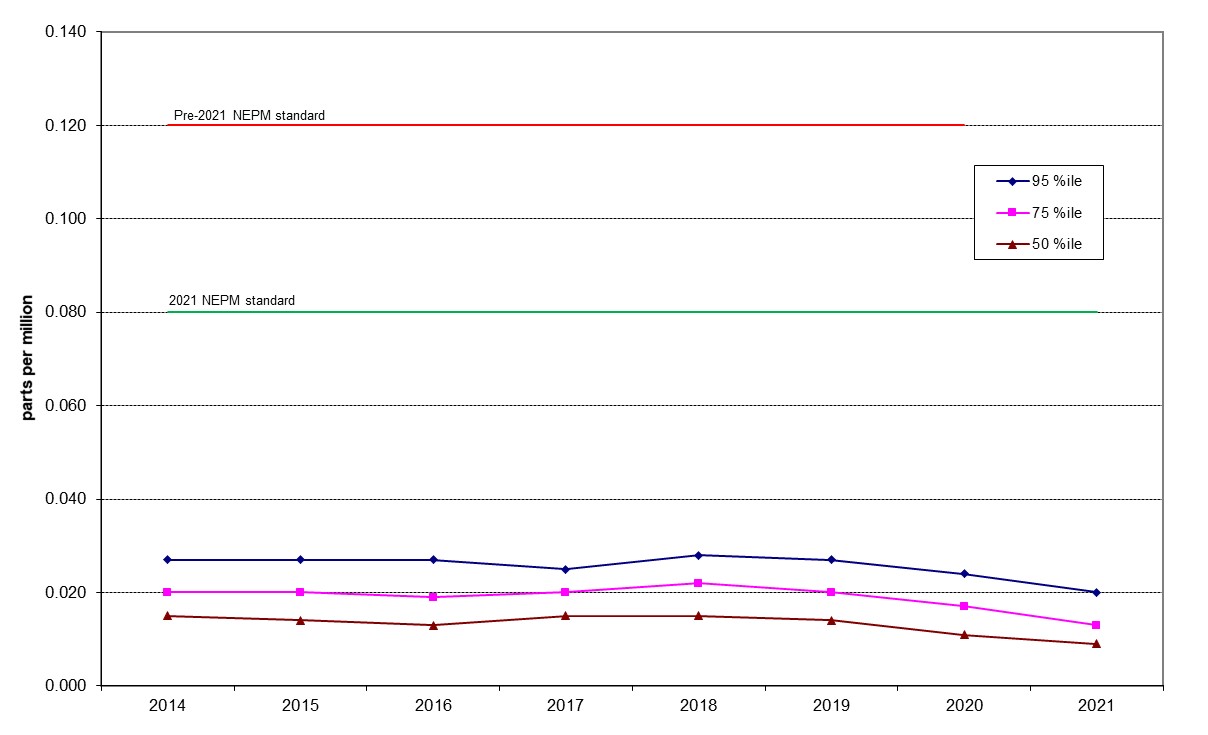


Figure 18: Statistical summary for daily maximum 1-hour NO2 Florey 2014 – 2021

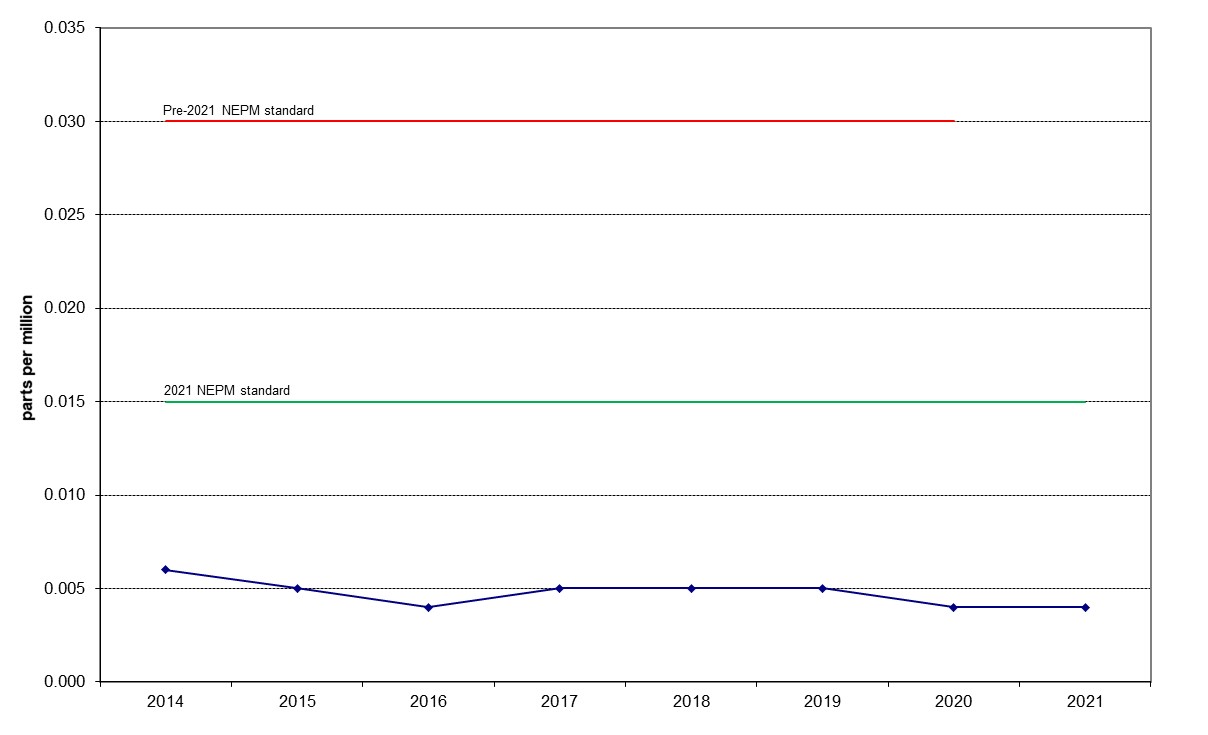


Figure 19: Annual average 1-hour NO2 Florey 2014 – 2021

## Ozone

Table 19: Statistical summary for daily maximum 8-hour O3 Monash 2012 – 2021

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (ppm) | 95th  percentile  (ppm) | 75th  percentile  (ppm) | 50th  percentile  (ppm) |
| --- | --- | --- | --- | --- | --- | --- |
| 2012 | 100 | 0 | 0.050 | 0.032 | 0.023 | 0.016 |
| 2013 | 97.8 | 0 | 0.054 | 0.032 | 0.025 | 0.018 |
| 2014 | 94.8 | 0 | 0.057 | 0.035 | 0.025 | 0.019 |
| 2015 | 92.8 | 0 | 0.047 | 0.032 | 0.022 | 0.014 |
| 2016 | 95.2 | 0 | 0.049 | 0.031 | 0.022 | 0.017 |
| 2017 | 95.5 | 0 | 0.052 | 0.036 | 0.027 | 0.020 |
| 2018 | 95.8 | 0 | 0.053 | 0.036 | 0.028 | 0.022 |
| 2019 | 95.8 | 10 | 0.107 | 0.042 | 0.029 | 0.022 |
| 2020 | 95.8 | 6 | 0.093 | 0.036 | 0.026 | 0.020 |
| 2021 | 95.7 | 0 | 0.042 | 0.030 | 0.023 | 0.017 |

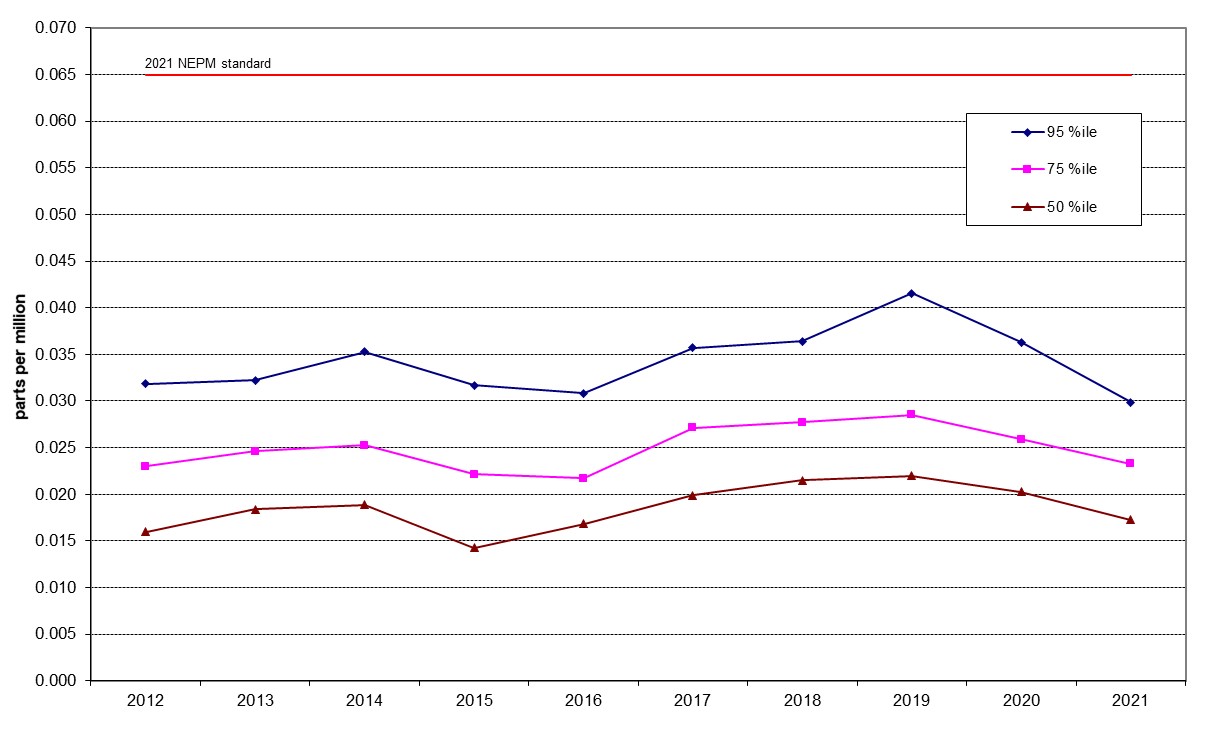


Figure 20: Statistical summary for daily maximum 8-hour O3 Monash 2012 – 2021

Table 20: Statistical summary for daily maximum 8-hour O3 Civic 2012 – 2021

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (ppm) | 95th  percentile  (ppm) | 75th  percentile  (ppm) | 50th  percentile  (ppm) |
| --- | --- | --- | --- | --- | --- | --- |
| 2012 | 100 | 0 | 0.040 | 0.023 | 0.016 | 0.011 |
| 2013 | 92.1 | 0 | 0.050 | 0.026 | 0.019 | 0.013 |
| 2014 | 94.0 | 0 | 0.044 | 0.028 | 0.017 | 0.012 |
| 2015 | 89.0 | 0 | 0.040 | 0.025 | 0.018 | 0.013 |
| 2016 | 95.8 | 0 | 0.042 | 0.027 | 0.020 | 0.015 |
| 2017 | 95.8 | 0 | 0.046 | 0.032 | 0.023 | 0.017 |
| 2018 | 95.2 | 0 | 0.050 | 0.032 | 0.024 | 0.018 |
| 2019 | 95.8 | 4 | 0.088 | 0.039 | 0.026 | 0.020 |
| 2020 | 95.8 | 3 | 0.076 | 0.032 | 0.023 | 0.018 |
| 2021 | 95.5 | 0 | 0.041 | 0.028 | 0.022 | 0.017 |

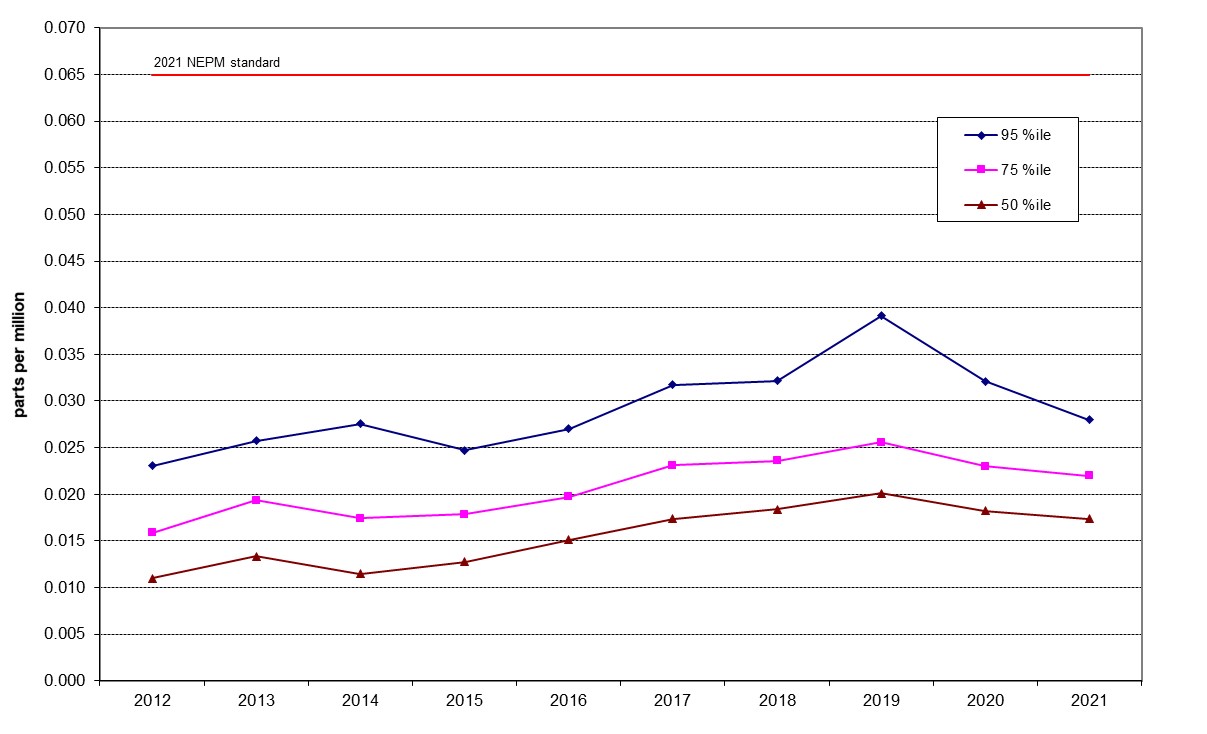


Figure 21: Statistical summary for daily maximum 8-hour O3 Civic 2012 – 2021

Table 21: Statistical summary for daily maximum 8-hour O3 Florey 2014 – 2021

| Year | Data  Availability  (%) | No. of  Exceedances  (days) | Max  conc.  (ppm) | 95th  percentile  (ppm) | 75th  percentile  (ppm) | 50th  percentile  (ppm) |
| --- | --- | --- | --- | --- | --- | --- |
| 2014 | 79.4 | 0 | 0.037 | 0.024 | 0.017 | 0.010 |
| 2015 | 94.2 | 0 | 0.034 | 0.023 | 0.016 | 0.010 |
| 2016 | 95.8 | 0 | 0.046 | 0.029 | 0.022 | 0.016 |
| 2017 | 95.5 | 0 | 0.052 | 0.036 | 0.026 | 0.020 |
| 2018 | 95.2 | 0 | 0.054 | 0.036 | 0.027 | 0.021 |
| 2019 | 95.3 | 10 | 0.099 | 0.042 | 0.027 | 0.021 |
| 2020 | 92.0 | 6 | 0.089 | 0.037 | 0.026 | 0.020 |
| 2021 | 95.8 | 0 | 0.047 | 0.030 | 0.023 | 0.018 |

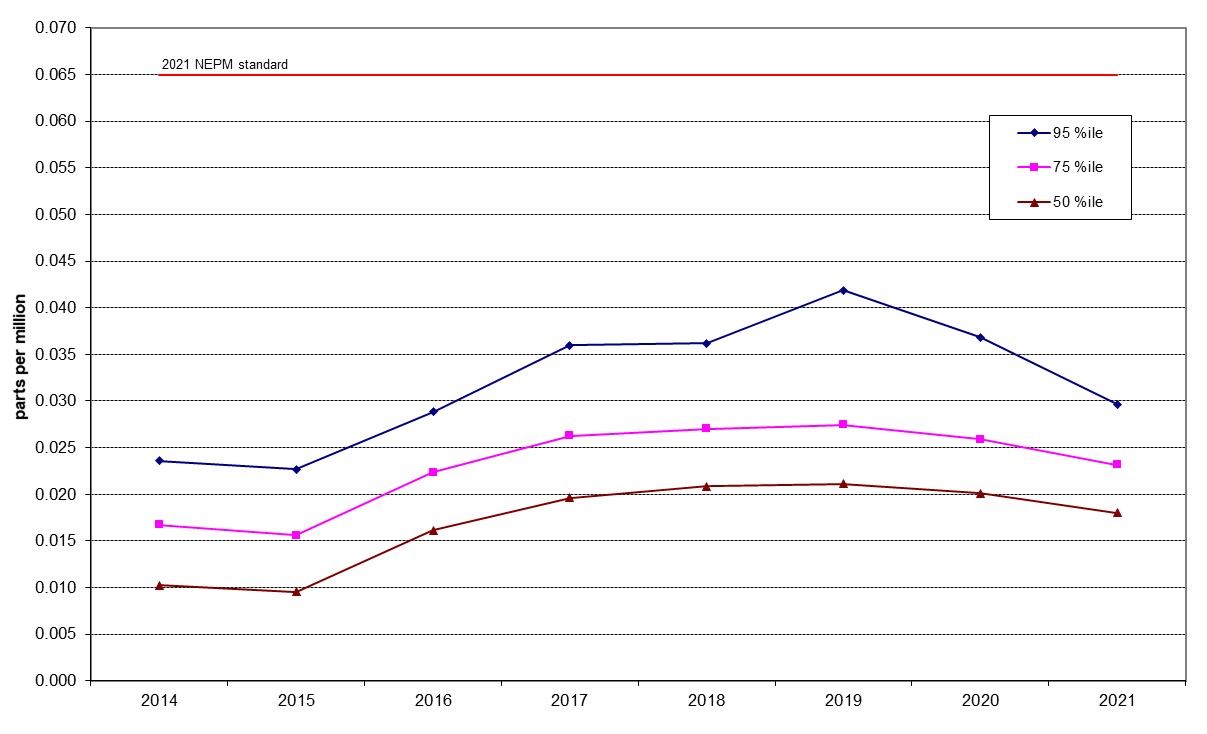


Figure 22: Statistical summary for daily maximum 1-hour O3 Florey 2014 – 2021

## PM10

Table 22: Statistical summary for daily maximum daily PM10 Monash 2012 – 2021

| 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) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 2018 | 99.2 | 4 | 139.2 | 11.8 | 23.0 | 14.8 | 10.4 |
| 2019 | 98.4 | 22 | 385.7 | 19.1 | 61.1 | 17.8 | 11.4 |
| 2020 | 99.2 | 21 | 1046.1 | 22.4 | 54.3 | 17.8 | 10.4 |
| 2021 | 99.5 | 0 | 37.3 | 10.3 | 22.9 | 13.7 | 9.1 |

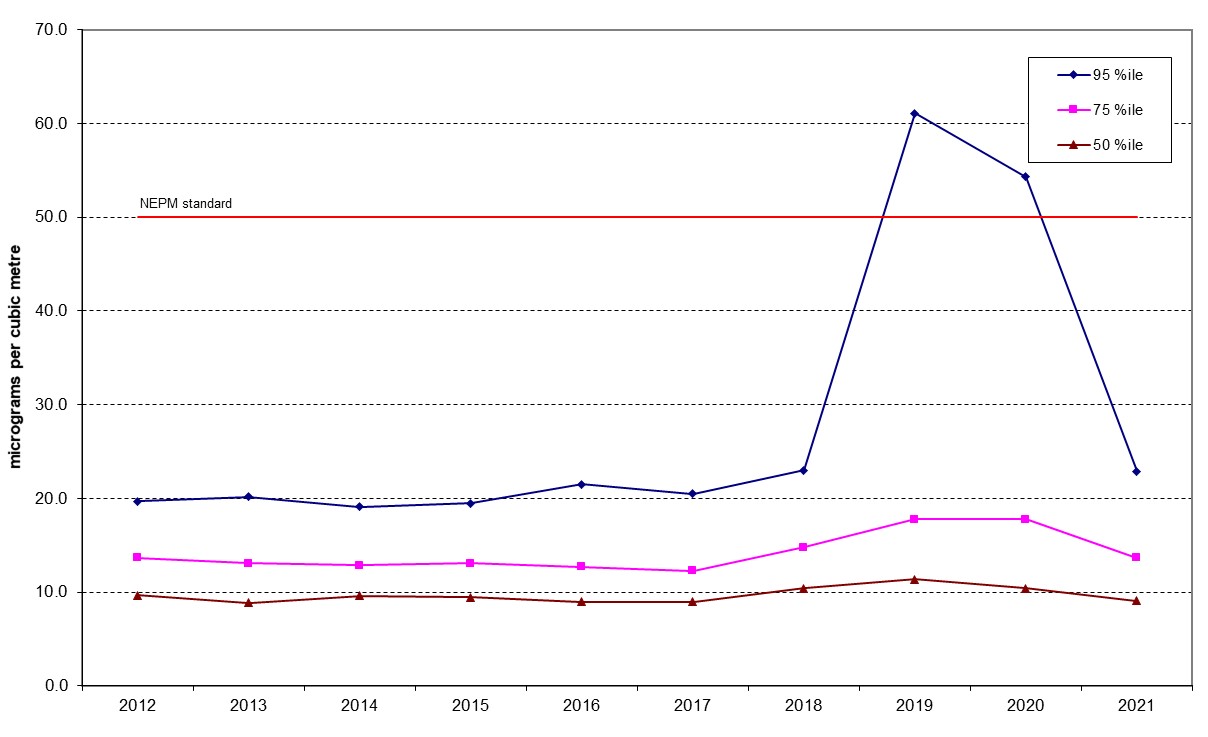


Figure 23: Statistical summary for daily PM10 Monash 2012 – 2021

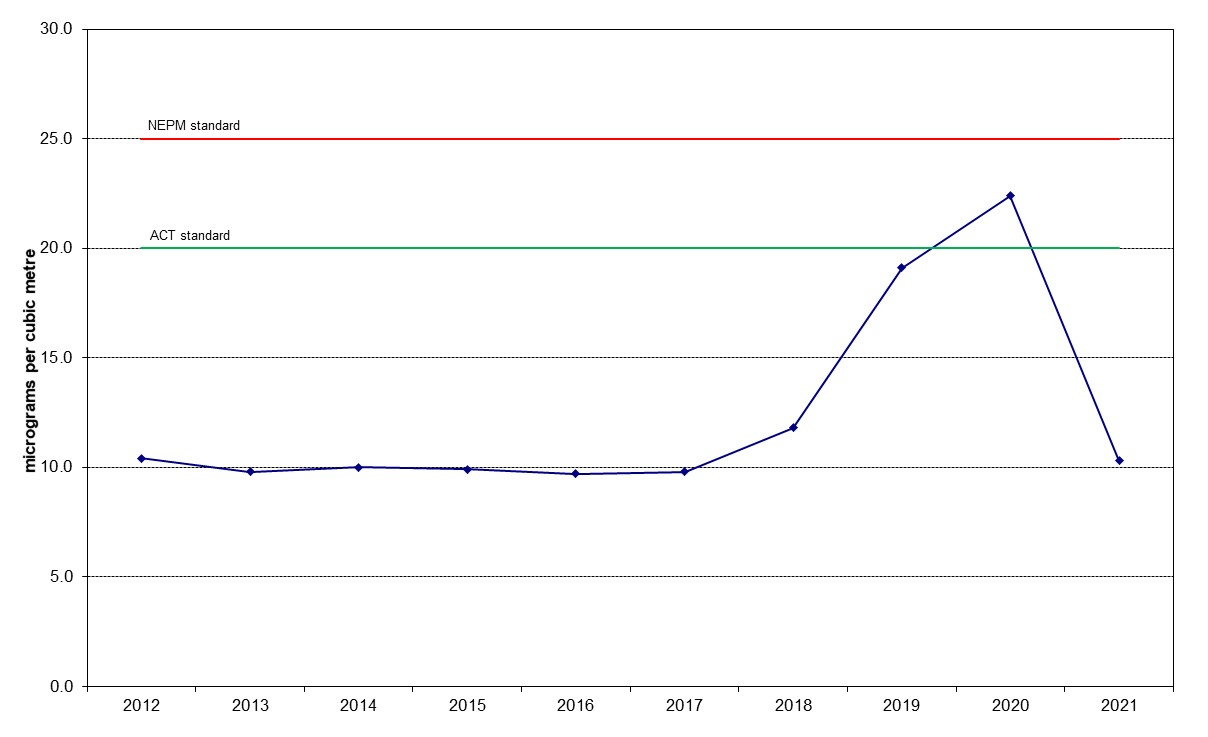


Figure 24: Annual average daily PM10 Monash 2012 – 2021

Table 23: Statistical summary for daily maximum daily PM10 Civic 2012 – 2021

| 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) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 2018 | 97.8 | 1 | 179.8 | 13.5 | 24.1 | 16.1 | 11.3 |
| 2019 | 97.3 | 29 | 390.2 | 22.9 | 82.5 | 19.5 | 12.7 |
| 2020 | 98.4 | 24 | 994.9 | 21.7 | 56.7 | 15.2 | 10.0 |
| 2021 | 93.7 | 0 | 28.6 | 8.7 | 15.6 | 11.5 | 8.1 |

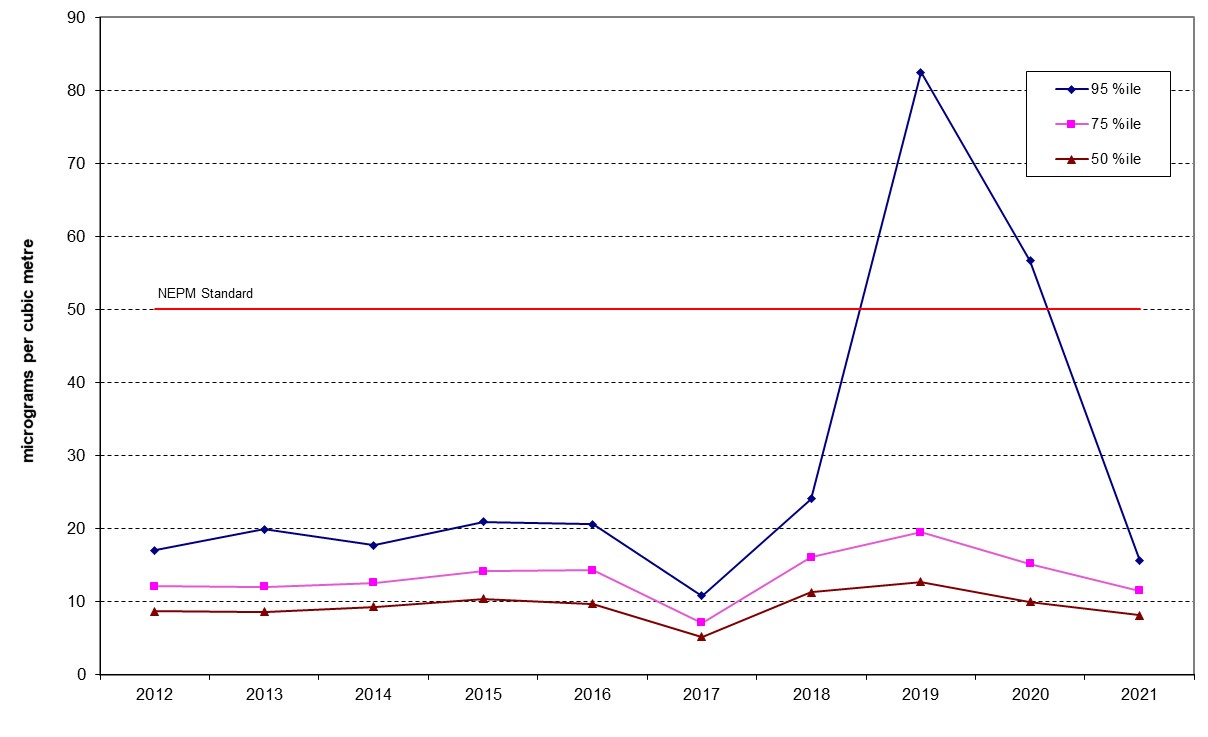


Figure 25: Statistical summary for daily PM10 Civic 2012 – 2021

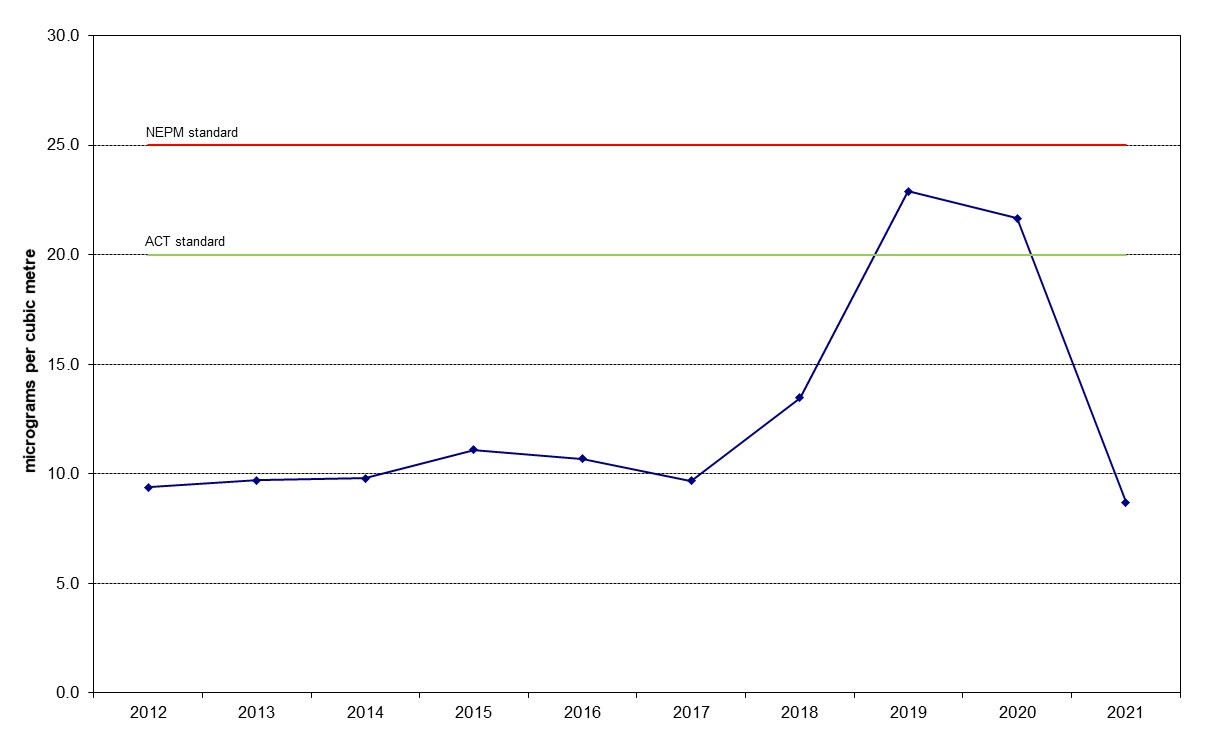


Figure 26: Annual average daily PM10 Civic 2012 – 2021

Table 24: Statistical summary for daily maximum daily PM10 Florey 2014 – 2021

| 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 |
| 2018 | 89.9 | 3 | 158.6 | 12.0 | 23.8 | 15.3 | 10.1 |
| 2019 | 98.1 | 28 | 379.7 | 23.8 | 96.8 | 20.6 | 13.4 |
| 2020 | 99.5 | 21 | 1075.5 | 22.8 | 57.5 | 17.9 | 10.9 |
| 2021 | 99.5 | 0 | 37.9 | 9.6 | 19.6 | 12.7 | 8.5 |

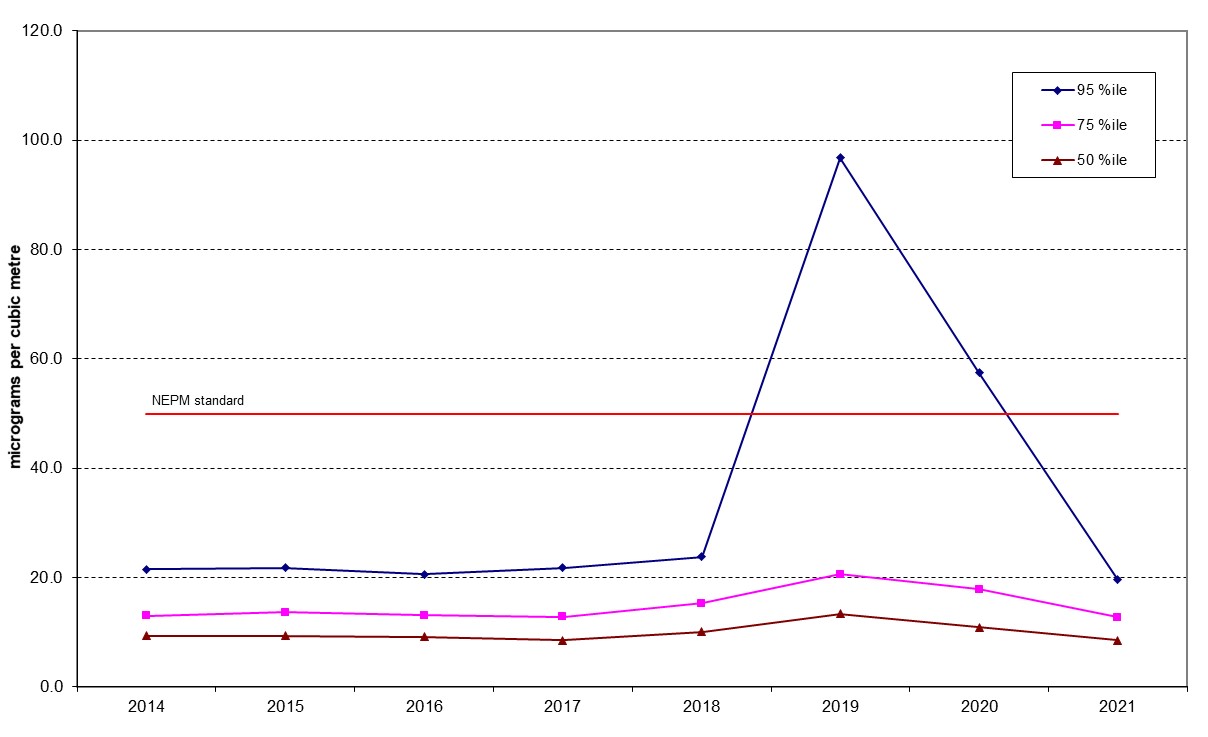


Figure 27: Statistical summary for daily PM10 Florey 2014 – 2021

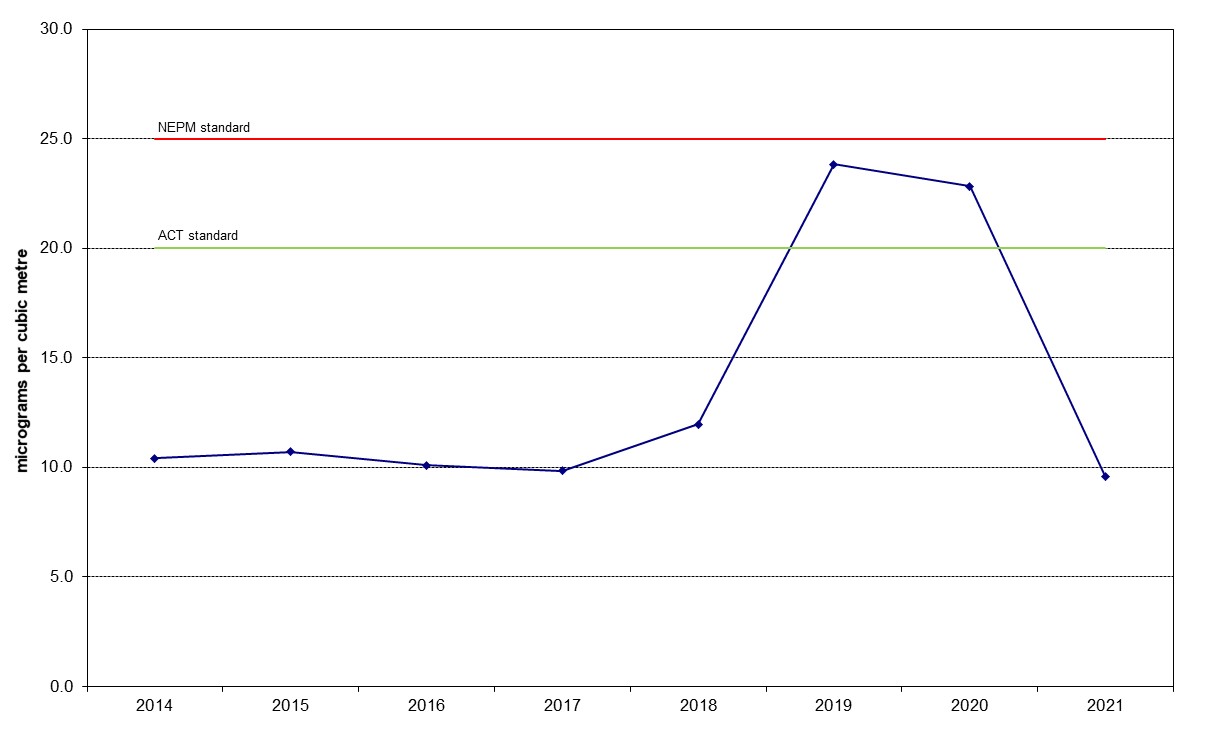


Figure 28: Annual average daily PM10 Florey 2014 – 2021

## PM2.5

Table 25: Statistical summary for daily maximum daily PM2.5 Monash 2012 – 2021

| 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) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 2018 | 99.2 | 2 | 32.0 | 6.8 | 19.2 | 8.6 | 5.3 |
| 2019 | 98.9 | 28 | 307.9 | 14.1 | 42.7 | 12.5 | 7.2 |
| 2020 | 98.6 | 37 | 1146.5 | 17.9 | 38.4 | 11.3 | 5.7 |
| 2021 | 98.6 | 5 | 27.9 | 6.8 | 19.2 | 8.1 | 4.9 |

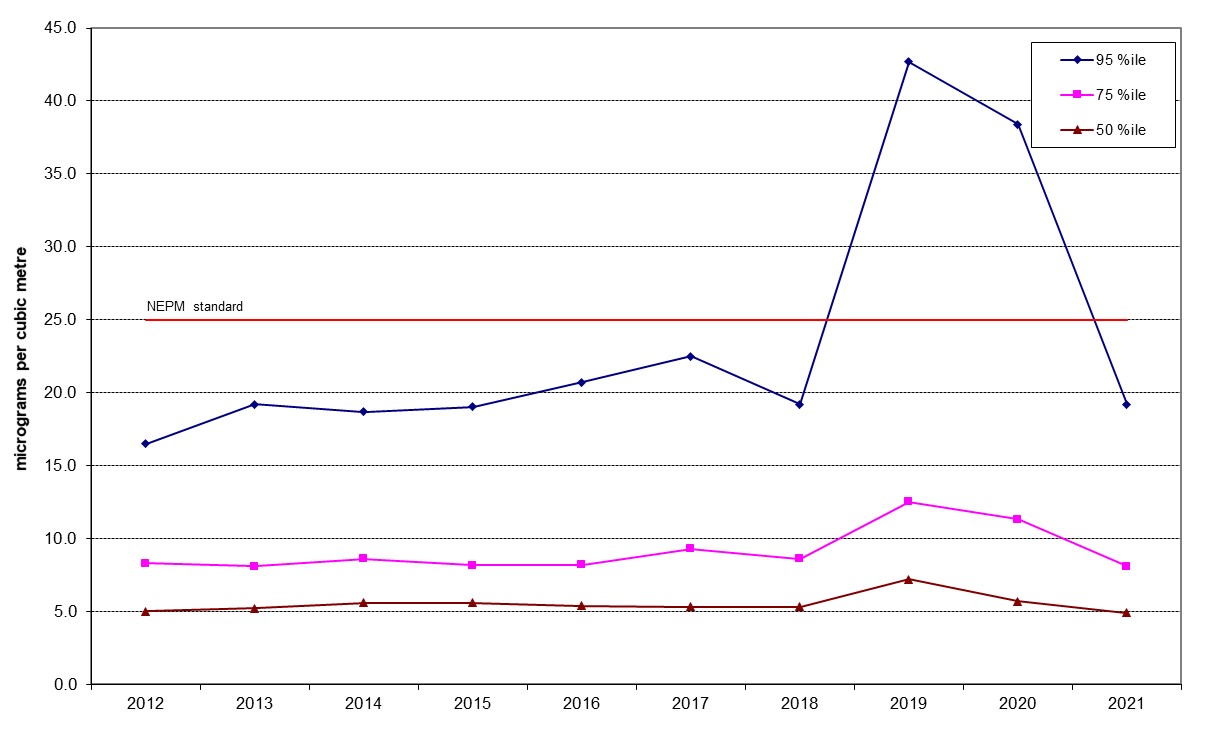


Figure 29: Statistical summary for daily PM2.5 Monash 2012 – 2021

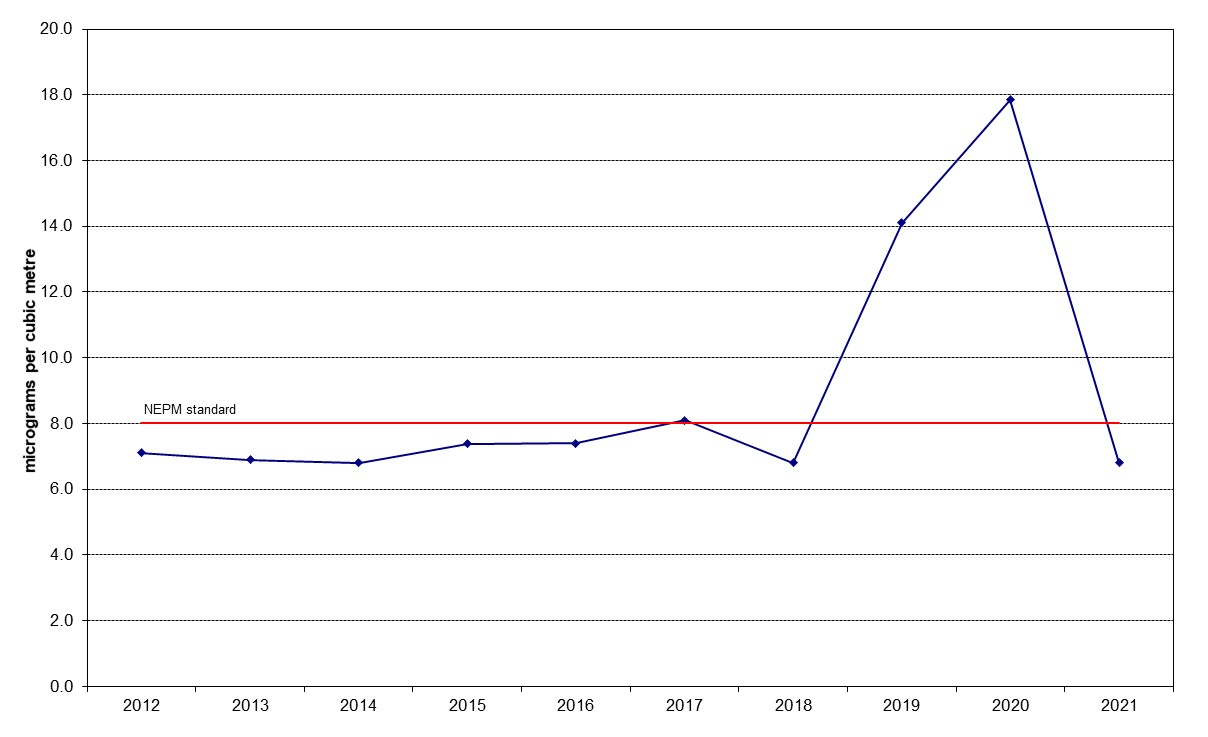


Figure 30: Annual average daily PM2.5 Monash 2012 – 2021

Table 26: Statistical summary for daily maximum daily PM2.5 Civic 2016 – 2021

| 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 |
| 2018 | 98.6 | 1 | 36.1 | 6.5 | 12.1 | 8.1 | 6.1 |
| 2019 | 96.4 | 29 | 390.2 | 22.9 | 82.5 | 19.5 | 12.7 |
| 2020 | 99.2 | 18 | 872.6 | 12.9 | 24.8 | 7.6 | 5.1 |
| 2021 | 96.7 | 0 | 21.8 | 5.0 | 9.5 | 6.6 | 4.6 |

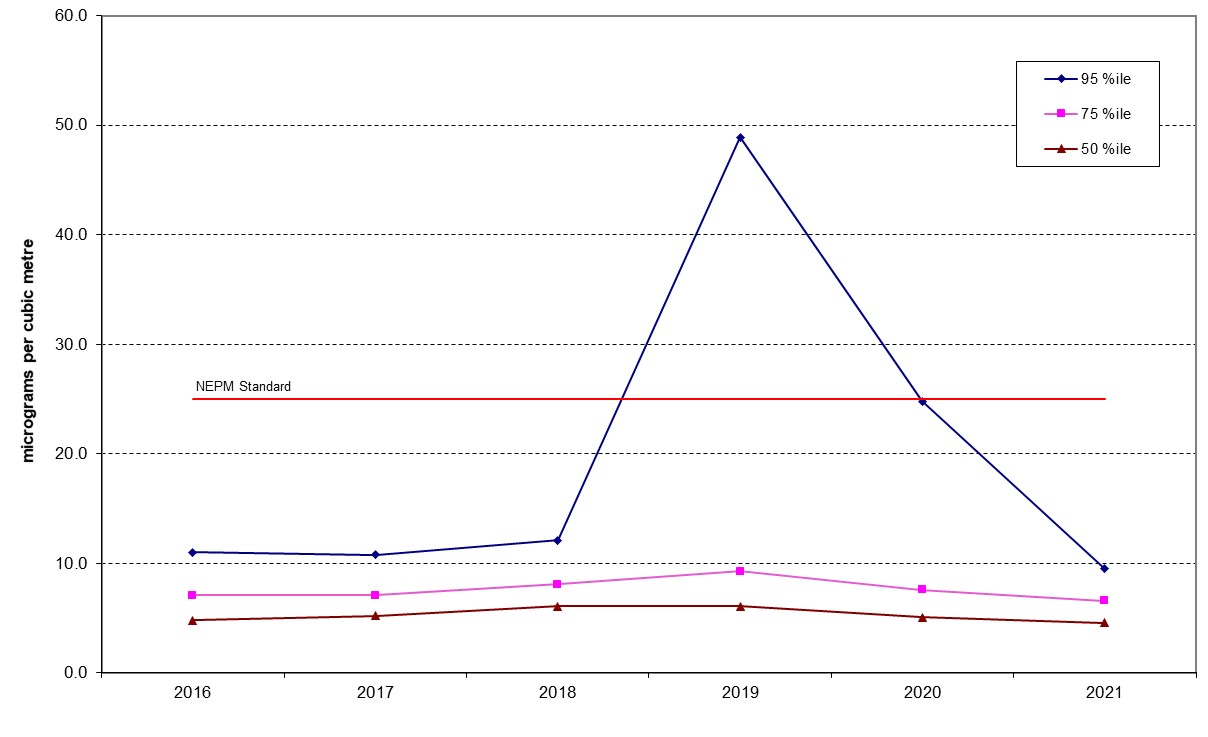


Figure 31: Statistical summary for daily PM2.5 Civic 2016 – 2021

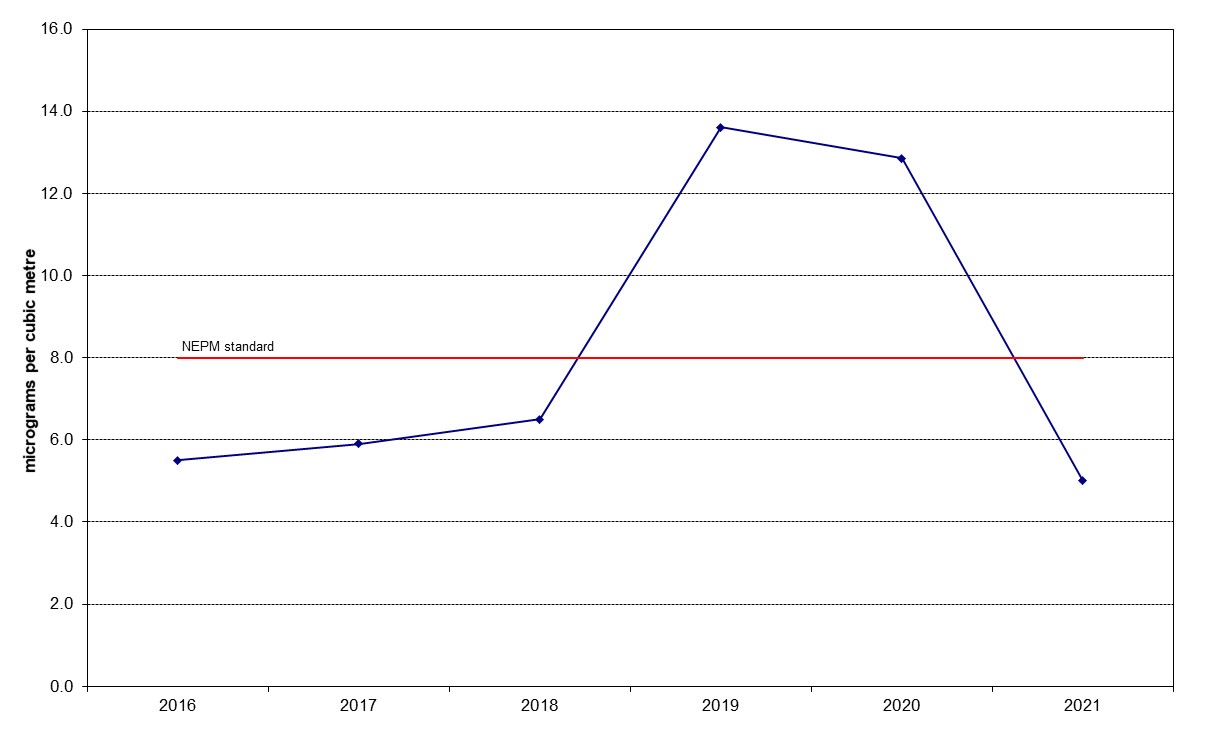


Figure 32: Annual average daily PM2.5 Civic 2016 – 2021

Table 27: Statistical summary for daily maximum daily PM2.5 Florey 2014 – 2021

| 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 |
| 2018 | 97.3 | 2 | 26.4 | 7.4 | 17.0 | 8.7 | 5.9 |
| 2019 | 98.4 | 29 | 319.6 | 14.8 | 46.9 | 12.3 | 7.2 |
| 2020 | 97.3 | 25 | 983.4 | 16.9 | 28.8 | 12.2 | 5.9 |
| 2021 | 98.4 | 3 | 28.2 | 6.2 | 16.0 | 7.6 | 4.9 |

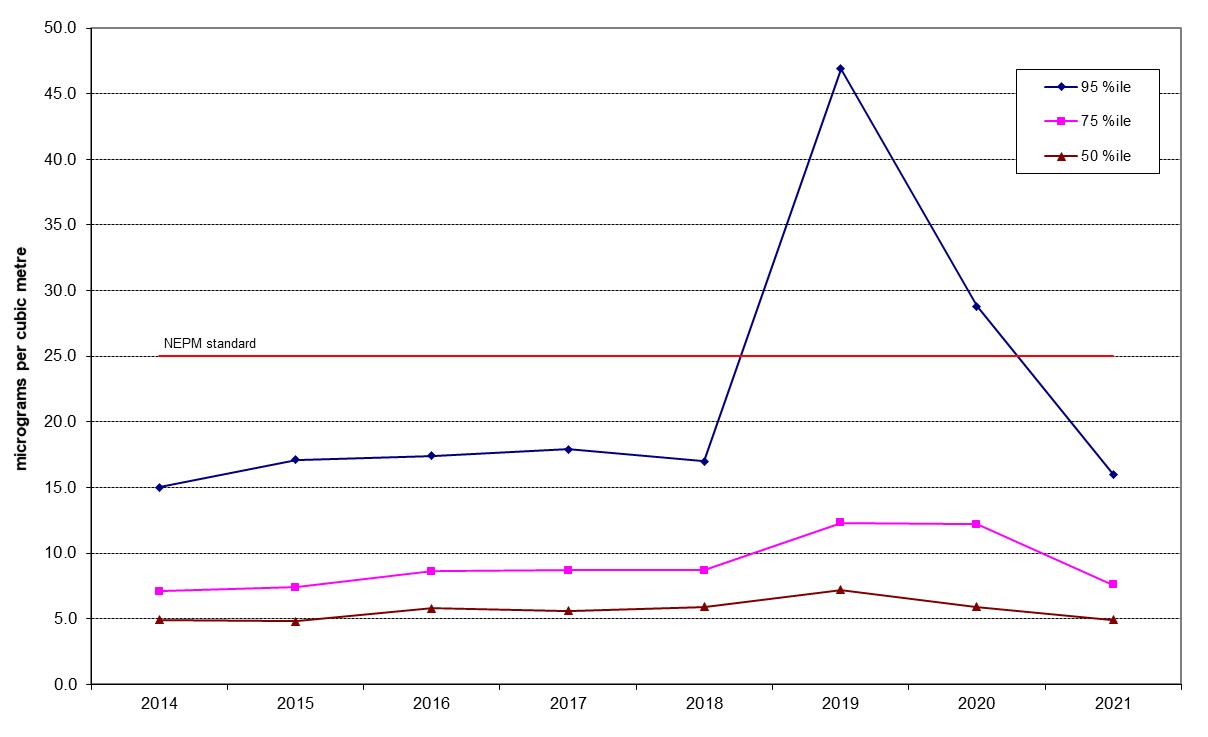


Figure 33: Statistical summary for daily PM2.5 Florey 2014 – 2021

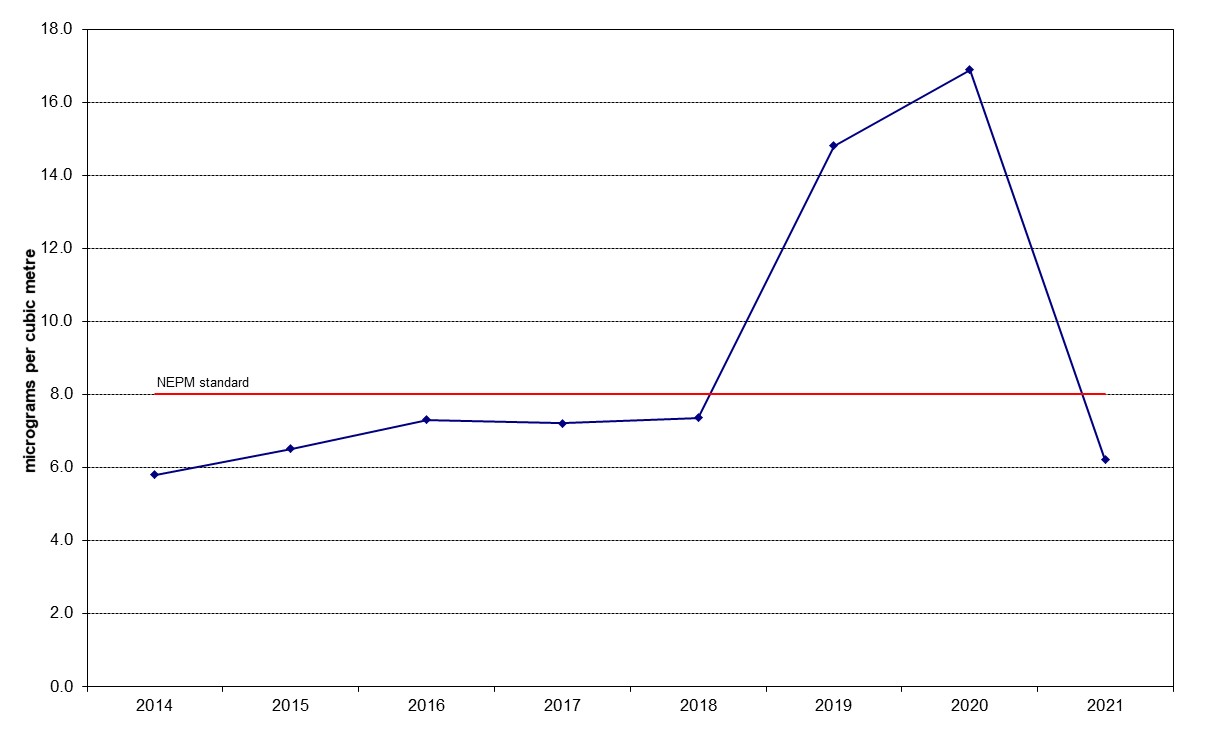


Figure 34: Annual average daily PM2.5 Florey 2014 – 2021

1. <http://www.nepc.gov.au/nepms/ambient-air-quality> [↑](#footnote-ref-1)
2. <http://www.nepc.gov.au/nepms/ambient-air-quality/variation-ambient-air-quality-nepm-ozone-nitrogen-dioxide-and-sulfur> [↑](#footnote-ref-2)
3. <https://www.health.act.gov.au/about-our-health-system/population-health/environmental-monitoring/monitoring-and-regulating-air> [↑](#footnote-ref-3)
4. <https://www.accesscanberra.act.gov.au/s/article/air-pollution-tab-domestic> [↑](#footnote-ref-4)
5. <https://www.accesscanberra.act.gov.au/s/article/air-pollution-tab-business-and-industry> [↑](#footnote-ref-5)
6. <https://files.accesscanberra.act.gov.au/legacy/3224/Molonglo%20Valley%20air%20quality%20assessment.pdf> [↑](#footnote-ref-6)
7. <https://files.accesscanberra.act.gov.au/legacy/3371/Your-guide-to-using-a-wood-heater.pdf> [↑](#footnote-ref-7)
8. <https://www.climatechoices.act.gov.au/policy-programs/wood-heater-replacement-program> [↑](#footnote-ref-8)
9. <https://www.act.gov.au/bushfire-smoke-and-air-quality-strategy> [↑](#footnote-ref-9)