Government of **Western Australia**
Department of **Water and Environmental Regulation**

2021 Western Australian air monitoring report

Annual report under the National Environment Protection (Ambient Air Quality) Measure

Department of Water and Environmental Regulation

October 2022

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FIRST 115980

October 2022

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Contents

Summary

Western Australia (WA) is a signatory to the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) and is required to report annually on the results of air quality monitoring undertaken by the Department of Water and Environmental Regulation (the department). This report has been prepared to comply with these AAQ NEPM reporting requirements.

The department is responsible for the operation and maintenance of 16 air quality monitoring sites (AQMS) in WA, with a total capital cost of more than $4 million. Ten of these sites – Armadale, Caversham, Duncraig, Mandurah, Quinns Rocks, Rolling Green, Rockingham, South Lake, Swanbourne and Wattleup – are within the Greater Perth region. The remaining six sites are located regionally in Albany, Bunbury, Busselton, Collie, Geraldton and Kalgoorlie. These sites monitor one or more of a range of pollutants such as ozone (O_3), nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), particles less than 10 micrometres in diameter (PM_{10}) and particles less than 2.5 micrometres in diameter ($PM_{2.5}$)

This report is based on the 2021 AAQ NEPM registered on 26 May 2021 and available at legislation.gov.au.

In October 2021 the Collie PM_{10} site was supplemented with a $PM_{2.5}$ particle instrument. One $PM_{2.5}$ exceedance was recorded at Collie in October and has been included in this report; however, annual and trend statistics have not been included because there are only three months of data for 2021.

In December 2021 the Albany PM_{10} site was supplemented with a $PM_{2.5}$ particle instrument; however, no exceedances were recorded, and annual and trend statistics have not been included.

During calendar year 2021, the AAQ NEPM 8-hour average standard ozone was not met at:

- Caversham
- Quinns Rocks
- Rolling Green
- Swanbourne.

The AAQ NEPM goal for PM_{10} particles was not met at:

- Busselton
- Geraldton
- Mandurah

The AAQ NEPM goal for $PM_{2.5}$ particles was not met at:

- Busselton
- Caversham
- Kalgoorlie
- Mandurah
- Quinns Rocks
- South Lake

The AAQ NEPM annual average standards were met for all other pollutants.

Across all monitoring sites, there were 96 AAQ NEPM standard exceedances in 2021, comprising 42 exceedances of the PM_{10} particles standard (including 19 exceptional events) and 50 of the $PM_{2.5}$ particles standard (including 38 exceptional events).

Of the 35 PM_{10} and $PM_{2.5}$ particle exceedances that were classed as assessable events:

- 17 were due to marine aerosols
- 11 were due to wood heater smoke
- six were due to wind borne dust
- one was due to a local burn off.

Of the 57 PM_{10} and $PM_{2.5}$ particle exceedances that were classed as exceptional events:

- 51 were due to prescribed burning activities
- six were due to bushfires.

These ‘exceptional event’ exceedances are not included in the AAQ NEPM goal assessment, in accordance with AAQ NEPM protocols.

A. Monitoring summary

This section summarises pollution data collected from each air quality monitoring site.

A.1 Current monitoring sites

The department's urban monitoring network shown in Figure A1 was originally designed for the purposes of the Perth Photochemical Smog Study, the Perth Haze Study and the management of pollutants in the Kwinana area.

The then Commonwealth Scientific and Industrial Research Organisation (CSIRO) Division of Atmospheric Research provided advice on monitoring site locations for the two studies. The network's design was based on the knowledge of emissions sources, pollutant chemistry and meteorological features.

More recently, new urban sites have been established at Armadale and Mandurah.

Regional monitoring sites at Bunbury, Busselton, Collie and Albany (as shown in Figure A2) were established to monitor smoke from fuel reduction burns. The Geraldton site (Figure A2) was established in the mid-west of the state to monitor windblown crustal material and smoke from bushfires, prescribed burns, agricultural stubble burning and wood-fired home heaters. The Kalgoorlie monitoring site was established to monitor particles from windblown crustal material and smoke, and sulfur dioxide from industry.

Tables A1 to A8 present summaries of site locations, monitoring methods and other information relating to the monitoring network.

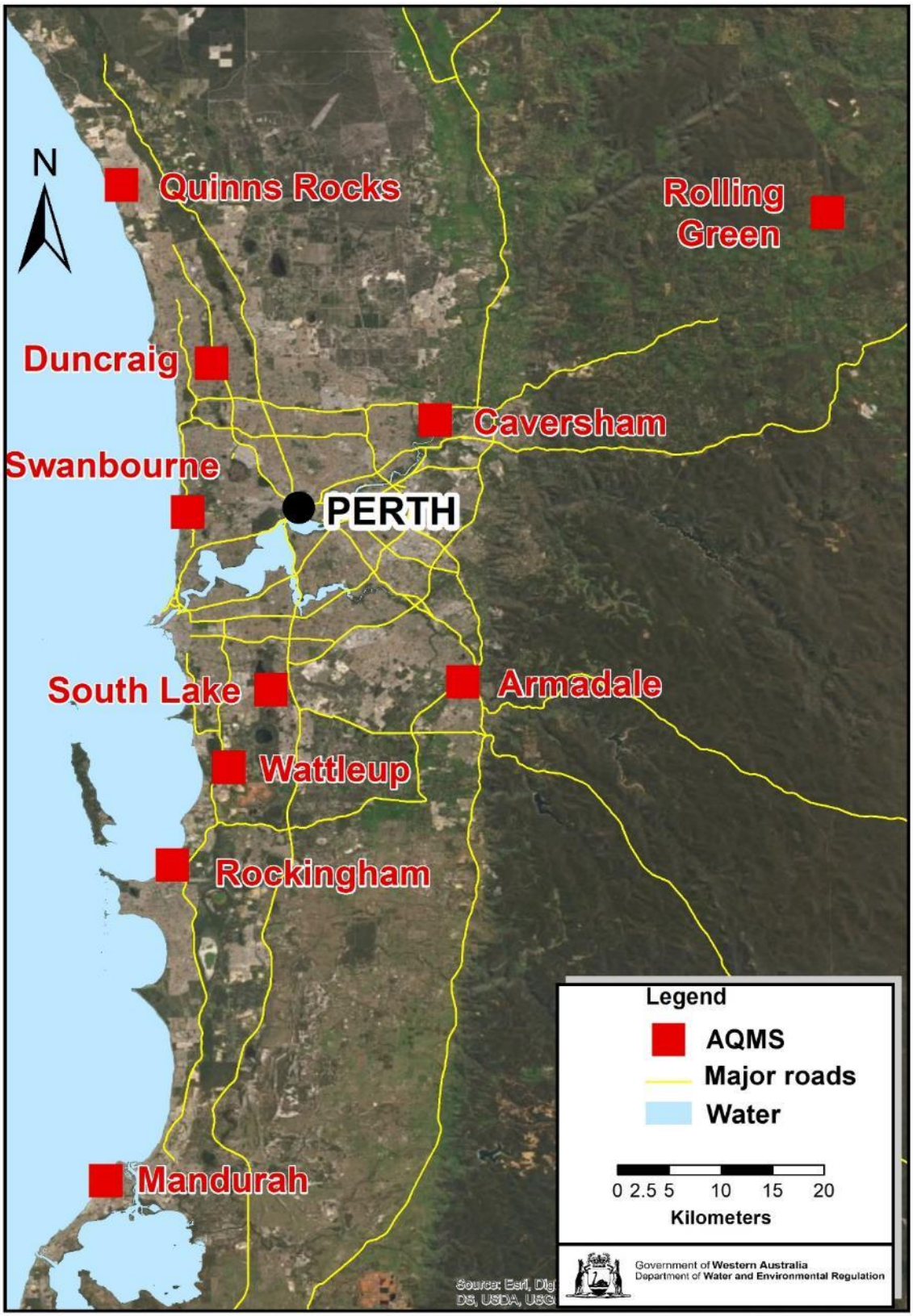


Figure A1 Department air quality monitoring sites in the Perth Metropolitan and Peel Regions.

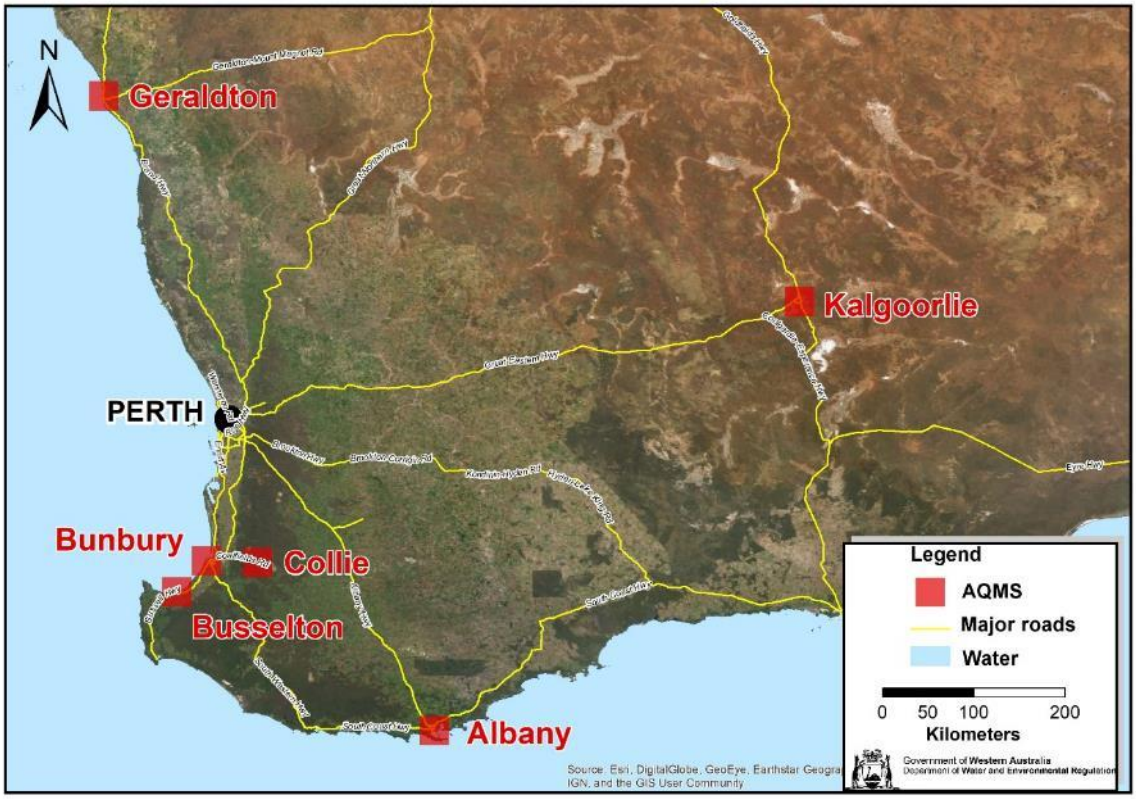


Figure A2 Department air quality monitoring sites in regional WA.

Table A1 Monitoring sites, air pollutants measured and periods of operation

Monitoring site	CO	O_3	NO_2	SO_2	PM_{10}	$PM_{2.5}$
Al Albany					07/2006 to present	12/2021 to present
Ar Armadale					07/2020 to present	07/2020 to present
Bn Bunbury					06/1999 to present	04/1997 to present
Bs Busselton					05/2020 to present	11/2006 to present
Ca Caversham	08/1993 to present	11/1989 to present	09/1990 to present		01/2004 to present	03/1994 to present
Co Collie					02/2008 to present	10/2021 to present
Du Duncraig	08/1995 to present		08/1995 to present		06/1996 to present	01/1995 to present
Ge Geraldton					09/2005 to present	01/2019 to present
Kg Kalgoorlie	12/2017 to present			12/2017 to present	12/2017 to present	12/2017 to present
Ma Mandurah	10/2019 to present	10/2019 to present	10/2019 to present		10/2019 to present	10/2019 to present
QR* Quinns Rocks		11/1992 to present*	11/1992 to present*		04/2020 to present	07/2006 to present*
Ro Rockingham		12/1995 to present	12/1995 to present	07/1988 to present		
RG Rolling Green		01/1993 to present	01/1993 to present			
SL South Lake	03/2000 to present	03/2000 to present	03/2000 to present	03/2000 to present	03/2000 to present	04/2006 to present
Sw Swanbourne		01/1993 to present	03/1993 to present			
Wt Wattleup				01/1988 to present		

* The Quinns Rocks site was decommissioned in March 2017 and re-established at a new location in April 2020

Table A2 Monitoring site descriptions

Site	Description
Albany	Medium rural town 380 km south-south-west of Perth with medium-density housing.
Armadale	South-east metropolitan site 22 km south-east of Perth with medium-density housing and moderate traffic flow. The site is 200 m east of the Tonkin Highway, a main north–south arterial road carrying about 27,000 vehicles daily.
Bunbury	Large regional town 145 km south of Perth with medium-density housing.
Busselton	Medium rural town 185 km south of Perth with medium-density housing.
Caversham	Semi-rural north-east metropolitan suburb in the Swan Valley – a grape-growing region next to the Perth foothills – 14 km north-east of the Perth CBD. The region mainly comprises low-density housing and paddocks. Some brick manufacturing.
Collie	Small rural town within a forested region 152 km south of Perth with medium-density housing and typical traffic flows. Coal mining and power-generation industries.
Duncraig	North metropolitan suburb 16 km north-north-west of the Perth CBD with medium-density housing and moderate-to-high traffic flows. The site is 200 m west of the Mitchell freeway, a main north–south arterial road carrying about 98,000 vehicles daily.
Geraldton	Medium rural town 377 km north of Perth in the mid-west with medium-density housing.
Kalgoorlie	Medium rural town 500 km east-north-east of Perth in the goldfields with a dry climate and medium-density housing.
Mandurah	City on the south-west coast of WA, 70 km south of Perth. It is the state's second-largest city and has a Mediterranean climate. The site is about 100 m from the coast and is affected by marine aerosols during westerly winds.
Quinns Rocks	Outer-north coastal suburb 35 km north of Perth with medium-density housing.
Rolling Green	Outer-east rural suburb 56 km north-east of Perth with low-density rural housing and low traffic flows. The closest road is 80 m east of the site with 3,200 vehicles per day.
Rockingham	South-coastal site 35 km south of Perth with medium-density housing and typical traffic flows, situated adjacent to the southern border of the Kwinana Industrial Area. A major arterial road carrying 34,700 vehicles per day runs 1 km east of the site.
South Lake	South-east metropolitan site 17 km south of Perth with medium-density housing and moderate-to-high traffic flows. The site is 1.6 km west of the Kwinana freeway, a main north–south arterial road carrying about 87,000 vehicles daily and is 4 km north-east of the northern border of the Kwinana Industrial Area.
Swanbourne	An inner-coastal site on coastal sand dunes 9 km west of the Perth CBD, and 150 m west of a major north–south arterial road carrying about 27,200 vehicles per day.
Wattleup	A south metropolitan site 25 km south of Perth within a defined buffer area for the Kwinana Industrial Area. Surrounding land uses are retail outlets and market gardens.

Table A3 Monitoring site classification

Site	CO	O_3	NO_2	SO_2	PM_{10}	$PM_{2.5}$
Albany					P/T	
Armadale					P/T	P/T
Bunbury					P/T	P/T
Busselton					DWER	DWER
Caversham	DWER	P/T	P/T		P/T	P/T
Collie					DWER	DWER
Duncraig	P/T		DWER		P/T	P/T
Geraldton					P/T	P/T
Kalgoorlie	M			P/T	P/T	P/T
Mandurah	P/T	P/T	P/T		P/T	P/T
Quinns Rocks		DWER	DWER		DWER	DWER
Rolling Green		DWER	DWER			
Rockingham		DWER	DWER	DWER		
South Lake	P/T	P/T	P/T	P	P/T	P/T
Swanbourne		P/T	P/T			
Wattleup				DWER		

Key:

P	Performance monitoring site
T	Trend performance monitoring site
M	Campaign monitoring
DWER	Instrument will be maintained by the department for the foreseeable future

Table A4 Screening procedures to demonstrate if monitoring is required

Notation	Screening procedures
A	Campaign monitoring at a generally representative upper bound (GRUB or upper bound) monitoring location (with no significant deterioration expected over 5–10 years).
B	Use of historical data within a region which will contain one or more GRUB monitoring sites to demonstrate the full number of sites is not required, either to detect exceedances or gain a more representative depiction of pollutant distribution.
C	Use of modelling within a region which will contain one or more GRUB monitoring sites to demonstrate the full number of sites is not required, either to detect exceedances or gain a more representative depiction of pollutant distribution.
D	In a region with no performance monitoring, use of validated modelling with detailed and reliable estimates of emissions and meteorological data.
E	In a region with no performance monitoring, and in the absence of emissions and detailed meteorological data, use of generic model results based on gross emissions estimates, ‘worst case’ meteorology estimates and other conservative assumptions.
F	In a region with no performance monitoring, comparison with a NEPM-compliant region with a greater population, emissions and pollution potential.
P	Performance monitoring.
T	Trend monitoring.
M	Campaign monitoring.

Table A5 Screening procedures satisfied at each site

Site	Pop'n*	CO	O_3	NO_2	SO_2	Pb	Particles
Perth and Rockingham	1,944,000	P/T/M	P/T/M	P/T/M	B&C	B	P/T/M
Mandurah	80,800	P/T/M	P/T/M	P/T/M	F	F	P/T
Albany	29,400	F	F	F	F	F	P/T
Bunbury	71,000	A&F	E&F	E&F	D&F	F	P/T
Kalgoorlie-Boulder	29,900	M	E&F	E&F	P/T	F	P/T
Geraldton	32,000	F	E&F	E&F	D&F	F	P/T

* Population based on 2016 data (www.censusdata.abs.gov.au).

Details of screening procedures are given in the monitoring plan available at: www.nepc.gov.au/resource/ephc-archive-ambient-air-quality-nepm.

Table A6 Monitoring methods used

Pollutant	Standard	Method
Carbon monoxide	AS/NZS 3580.7.1 Determination of carbon monoxide – direct-reading instrumental method.	Gas filter correlation spectrophotometry.
Ozone	AS 3580.6.1 Determination of ozone – direct-reading instrumental method.	Ultraviolet absorption.
Nitrogen dioxide	AS 3580.5.1 Determination of oxides of nitrogen – chemiluminescence method.	Chemiluminescence.
Sulfur dioxide	AS 3580.4.1 Determination of sulfur dioxide – direct-reading instrumental method.	Ultraviolet fluorescence.
Particles as PM_{10}	AS 3580.9.8 Determination of suspended particulate matter – PM_{10} continuous direct mass method using a tapered element oscillating microbalance (TEOM) analyser.	Tapered element oscillating microbalance.
Particles as $PM_{2.5}$	AS/NZS 3580.9.13 Determination of suspended particulate matter – $PM_{2.5}$ continuous direct mass method using a tapered element oscillating microbalance analyser.	Tapered element oscillating microbalance.
Particles as $PM_{2.5}$ and PM_{10}	AS/NZS 3580.9.7 Determination of suspended particulate matter – dichotomous sampler (PM_{10}, coarse PM and PM2.5) – gravimetric method.	Dichotomous FDMS
	AS/NZS 3580.9.16 PM_{10} continuous direct mass method using a tapered element oscillating microbalance monitor incorporating a filter dynamic measurement system (FDMS) unit.	Tapered element oscillating microbalance.

Table A7 Site compliance with AS/NZ 3580.1.1

	Height above ground	Minimum distance to support structures	Clear sky angle of 120°	Unrestricted airflow of 270°/360°	20 m from trees	No extraneous sources nearby	Minimum distance from road or traffic	Sample line material	Sample line length	Comments
Perth region										
Armadale	☑	☑	☑	☑	☑	☑	☑	☑	☑	
Caversham	☑	☑	☑	☑	☑	☑	☑	☑	☑	
Duncraig	☑	☑	☒	☑	☒	☑	☑	☑	☑	6 m to medium-sized trees and presence of power pole.
Quinns Rocks	☑	☑	☑	☑	☒	☑	☑	☑	☑	
Rockingham	☑	☑	☑	☑	☒	☑	☑	☑	☑	12 m to trees. Northern vector dominated by grain storage facility.
Rolling Green	☑	☑	☑	☑	☑	☑	☑	☑	☑	
South Lake	☑	☑	☑	☑	☑	☑	☑	☑	☑	
Swanbourne	☑	☑	☑	☑	☑	☑	☑	☑	☑	
Wattleup	☑	☑	☑	☑	☑	☑	☑	☑	☑	
Mandurah region										
Mandurah	☑	☑	☑	☑	☑	☑	☑	☑	☑	
Southwest region										
Albany	☑	☑	☑	☑	☑	☑	☑	☑	☑	
Bunbury	☑	☑	☑	☑	☒	☑	☑	☑	☑	15 m from small to medium-sized eucalyptus trees.
Busselton	☑	☑	☑	☑	☒	☑	☑	☑	☑	5 m from small to medium-sized eucalyptus trees.
Collie	☑	☑	☒	☑	☒	☑	☑	☑	☑	Some trees and shipping containers nearby.
Mid West region										
Geraldton	☑	☑	☑	☑	☑	☑	☑	☑	☑	
Goldfields region										
Kalgoorlie	☑	☑	☑	☑	☑	☑	☑	☑	☑	

Table A8 AAQ NEPM standards for criteria pollutants

Pollutant	Averaging period	Maximum concentration standard
Carbon monoxide	8 hours	9.0 ppm
Nitrogen dioxide	1 hour 1 year	0.08 ppm 0.015 ppm
Photochemical oxidants (as ozone)	8 hours	0.065 ppm
Sulfur dioxide	1 hour 1 day	0.10 ppm 0.02 ppm
Lead	1 year	0.50 µg/m^3
Particles as PM_{10}	1 day 1 year	50 µg/m^3 25 µg/m^3
Particles as $PM_{2.5}$	1 day 1 year	25 µg/m^3 8 µg/m^3

Note: There are no exceedances allowed for carbon monoxide, nitrogen dioxide, sulfur dioxide and lead. Exceedances for particles and ozone are allowed if they result from exceptional events.

A.2 Carbon monoxide

This section summarises carbon monoxide (CO) monitoring performed in WA.

WA maintained performance monitoring of CO at the nominated trend sites of Duncraig and South Lake. CO is also monitored at Mandurah and Caversham.

The Duncraig monitoring site is an upper-bound site for monitoring the combined effects of emissions from vehicles on the nearby Mitchell freeway and from domestic wood fires. The site is 200 m west of the Mitchell freeway and lies in a depression through which the freeway passes. The effect of stable air pooling in the depression is likely to lead to elevated CO concentrations. This geographic feature is found in many other places across the Perth coastal plain. The site is representative of a medium-density suburb.

The South Lake monitoring site is in an urban area and has previously recorded moderate levels of CO from domestic wood fires. It is not as close to major roads as the Duncraig site and is therefore more typical of a population-average site.

The concentration of CO caused by motor vehicles at the Mandurah monitoring site is expected to be low; however, there is likely to be some contribution from wood fires and controlled burns. Data has only been collected from Mandurah since October 2019, and so trend analysis is not possible at this time.

The Caversham monitoring site is in a region of low population density and is therefore not considered a performance monitoring site.

Trend analysis for each site shows that the maximum of the eight-hourly averages has consistently declined between 0.1 and 0.03 ppm per year as shown in Figure A3. Distinct seasonal influences can be seen in Figure A3 with CO concentrations peaking during winter months and falling during summer.

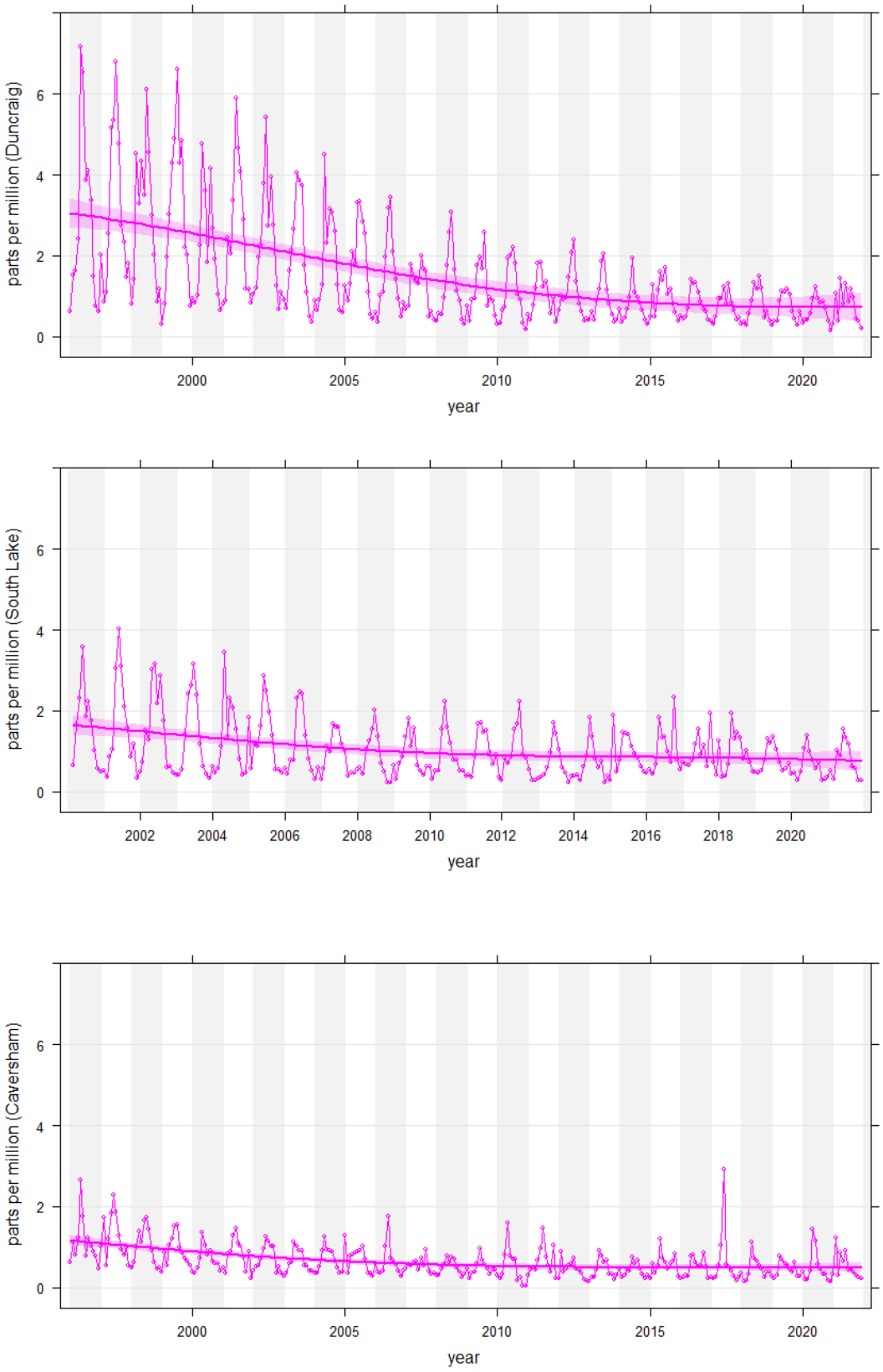


Figure A3 *Smoothed trend (dark lines) for CO at Duncraig (top), South Lake (centre) and Caversham (bottom).*

According to the National Pollutant Inventory, for the 2019–20 reporting year, over 90 per cent of the CO emissions were from motor vehicles (0.25 million tonnes [MT]) and combustion products from fuel-reduction burns and wildfires (1.7 MT). Metal ore mining (0.05 MT) and domestic solid fuel burning (0.041 MT) were the next highest contributors.

The CO maximum (blue), 99th (red) and 95th (green) concentration percentiles for each hour of the day at Duncraig over five-year periods 1997–2001, 2007–11 and 2017–21 is presented in Figure A4. The CO profile shows a marked decrease in overnight concentrations over the 24-year timespan. One possible reason for this is the introduction of the Environmental Protection (Domestic Solid Fuel Burning Appliances and Firewood Supply) Regulations 1998[1]. These required heating appliances (wood heaters) for sale to meet emission standards set out in the relevant Australian and New Zealand Standard (AS/NZS4013:1999) and regulated the moisture content of wood sold as firewood.

Over the same period, motor vehicle engine technologies have also improved, reducing the emissions of harmful exhaust products and further driving the overall reduction of CO concentrations.

[1] Repealed and replaced by the Environmental Protection (Solid Fuel Heater and Firewood) Regulations 2018 on 1 September 2018

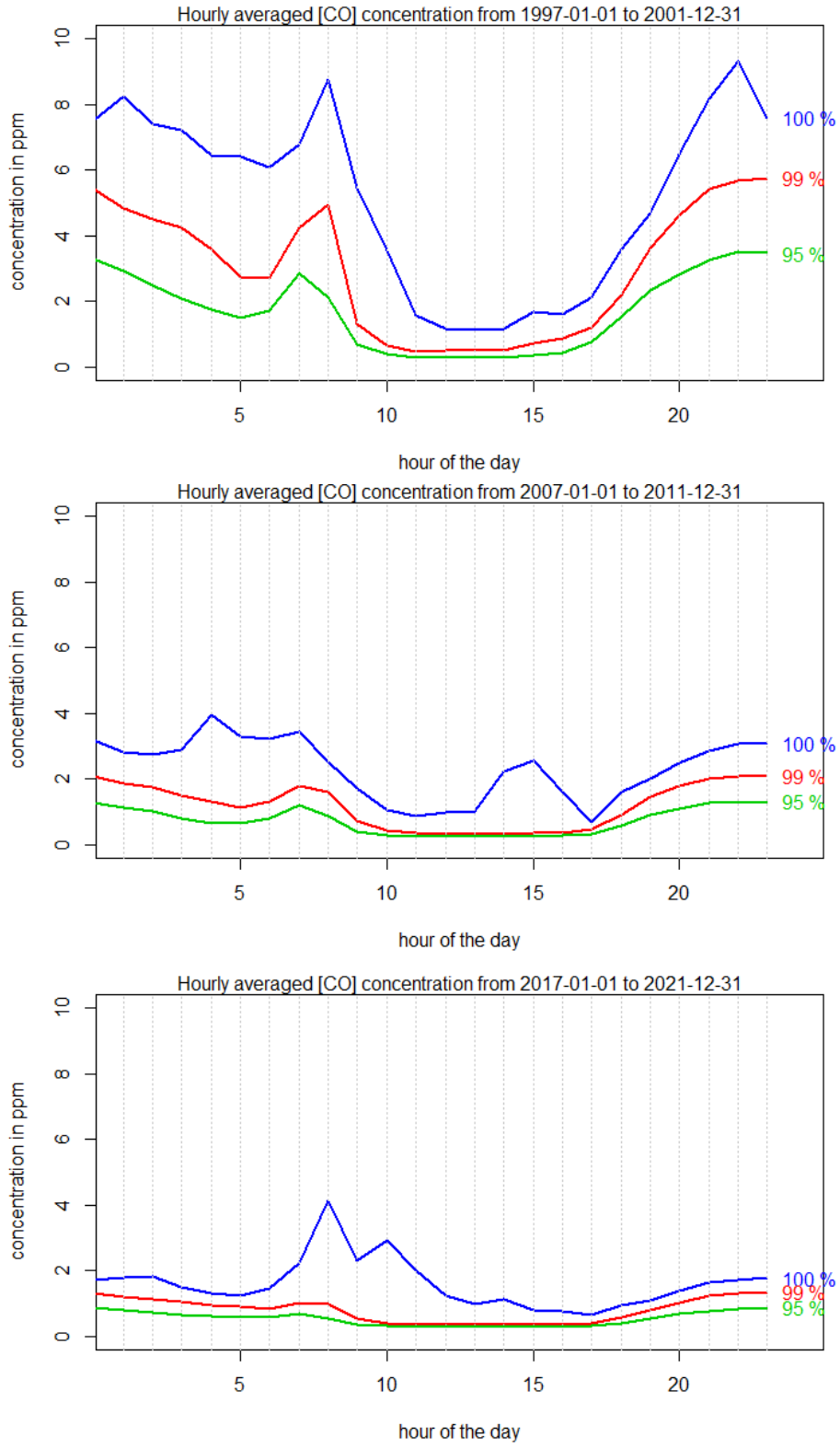


Figure A4 *The CO maximum (blue), 99th (red) and 95th (green) percentiles for each hour of the day at Duncraig over five-year periods 1997–2001 (top), 2007–11 (centre) and 2017–21 (bottom).*

A.3 Photochemical oxidants as ozone

This section describes ozone (O_3) monitoring performed in WA.

O_3 formation in metropolitan Perth occurs due to a complex interaction between nitrogen oxides, organic compounds, prevailing winds and relatively high levels of sunlight. This often occurs with easterly winds during the day, until an afternoon sea breeze pushes an O_3-rich plume back over the city.

Statistics for the coastal sites of Quinns Rocks, Swanbourne and Rockingham indicate there is little difference between O_3 levels at each site over the long term. Swanbourne was selected as a performance monitoring site, while monitoring sites at Quinns Rocks and Rockingham were maintained to provide additional information on O_3 events.

Given its location, the Caversham monitoring site represents an upper-bound, middle-distance inland site. Accordingly, Caversham was selected as a performance monitoring site.

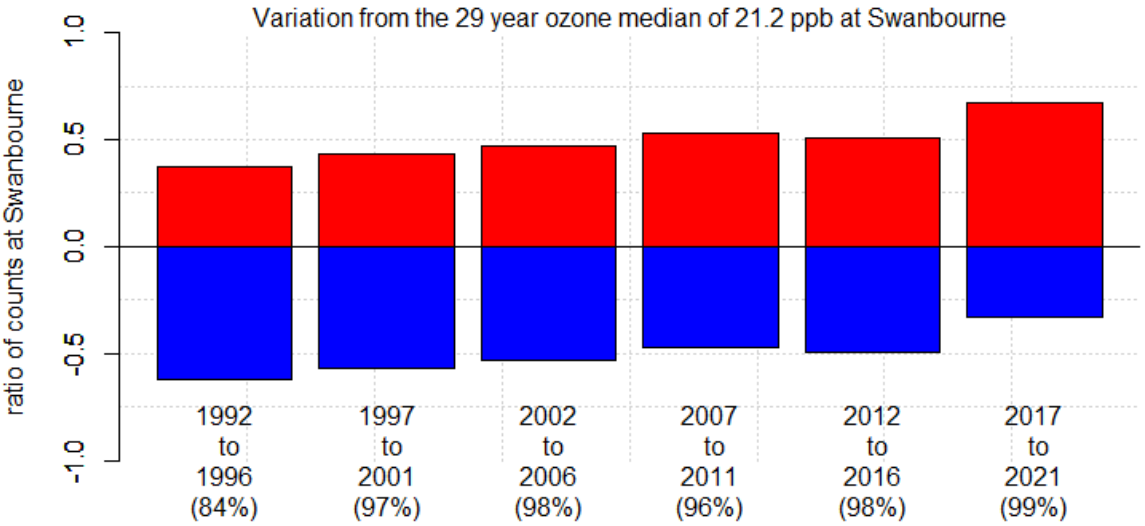
A third performance monitoring site is at South Lake. It was chosen because:

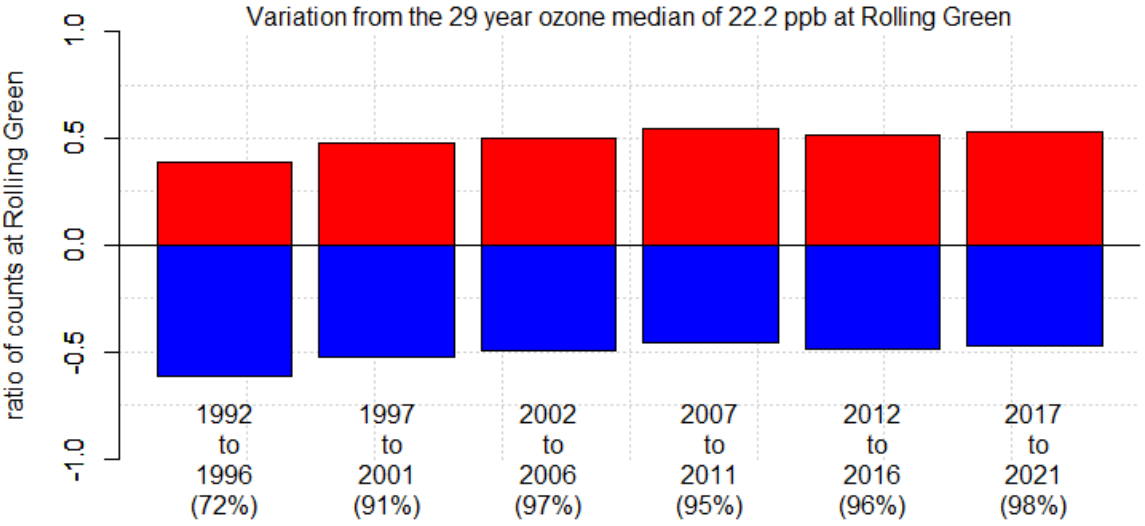
- it provides a good spatial spread of sites (it measures O_3 returning on shore in the southern part of the metropolitan area)
- it is a moderate distance inland in a growing urban area, so it is classified as a population-average site
- it may occasionally detect the interactions of O_3-rich air with the nitrogen oxide-rich (NO_x) plumes from Kwinana industry, potentially giving elevated nitrogen dioxide (NO_2) concentrations.

Caversham, Swanbourne and South Lake sites are all nominated as trend sites.

The department will continue to maintain the sites at Rockingham, Quinns Rocks and Rolling Green as part of its wider ozone network to enable a better understanding of O_3 events.

Long-term analysis is presented in Figure A5. The number of times when the one-hour O_3 concentration exceeded the long-term average at the coastal site of Swanbourne has increased for every five-year period analysed.


Variation from the 29 year ozone median of 21.2 ppb at Swanbourne
ratio of counts at Swanbourne
1.0
0.5
0.0
-0.5
-1.0
1992 to 1996 (84%)
1997 to 2001 (97%)
2002 to 2006 (98%)
2007 to 2011 (96%)
2012 to 2016 (98%)
2017 to 2021 (99%)


Variation from the 29 year ozone median of 22.2 ppb at Rolling Green
ratio of counts at Rolling Green
1.0
0.5
0.0
-0.5
-1.0
1992 to 1996 (72%)
1997 to 2001 (91%)
2002 to 2006 (97%)
2007 to 2011 (95%)
2012 to 2016 (96%)
2017 to 2021 (98%)

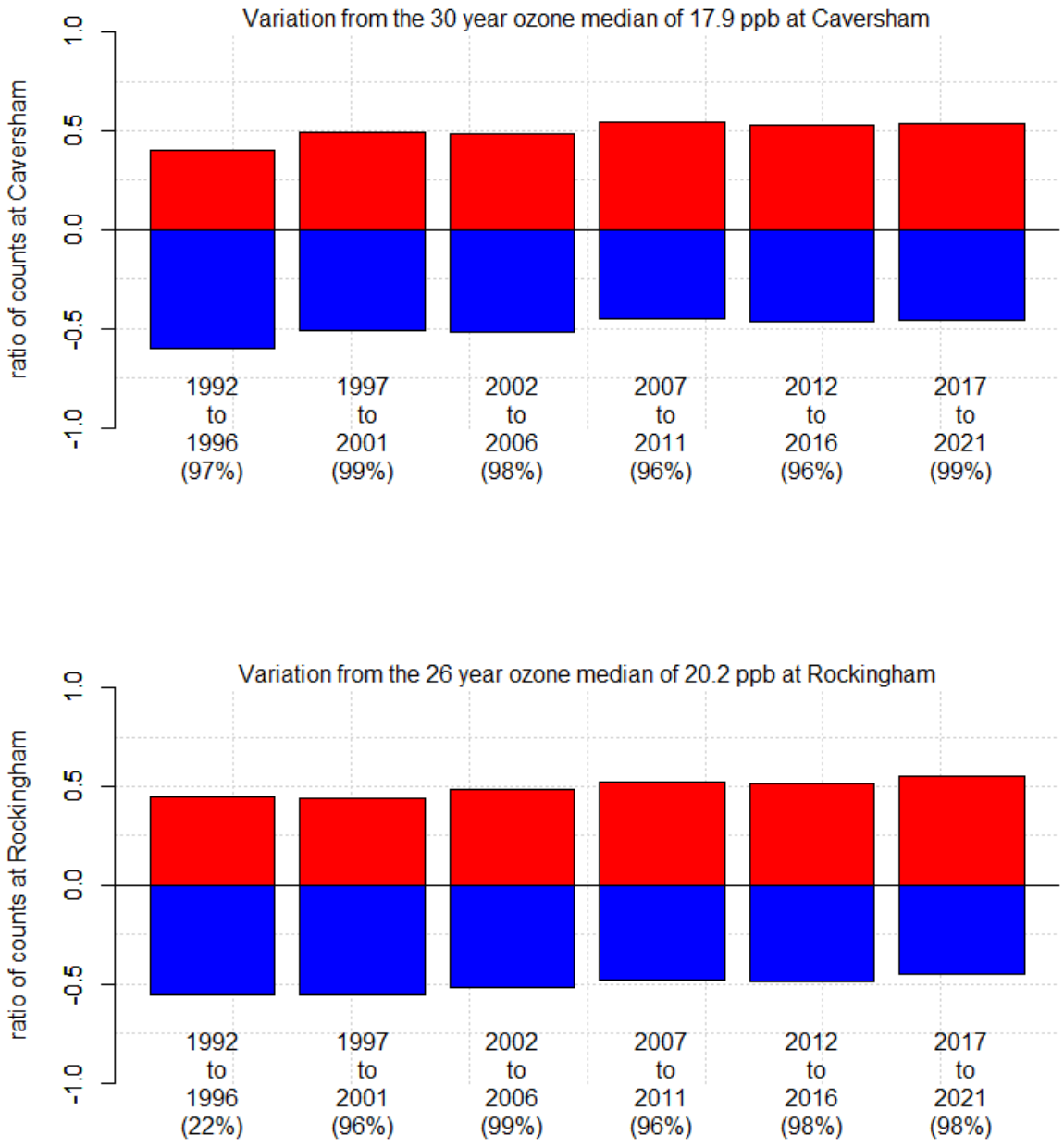


Figure A5 *Ratio of the number of hourly averaged O_3 concentrations at Swanbourne (top panel), Rolling Green, Caversham and Rockingham (bottom panel) that was higher (red) or equal to or lower (blue) than the long-term average concentration for that site (bracketed percentages indicate data recovery for the nominated period).*

A similar increasing pattern is not as evident at the other southern coastal site of Rockingham. The inland sites of Caversham and Rolling Green also have a less distinct pattern.

A.4 Nitrogen dioxide

This section describes nitrogen dioxide (NO_2) monitoring performed in WA.

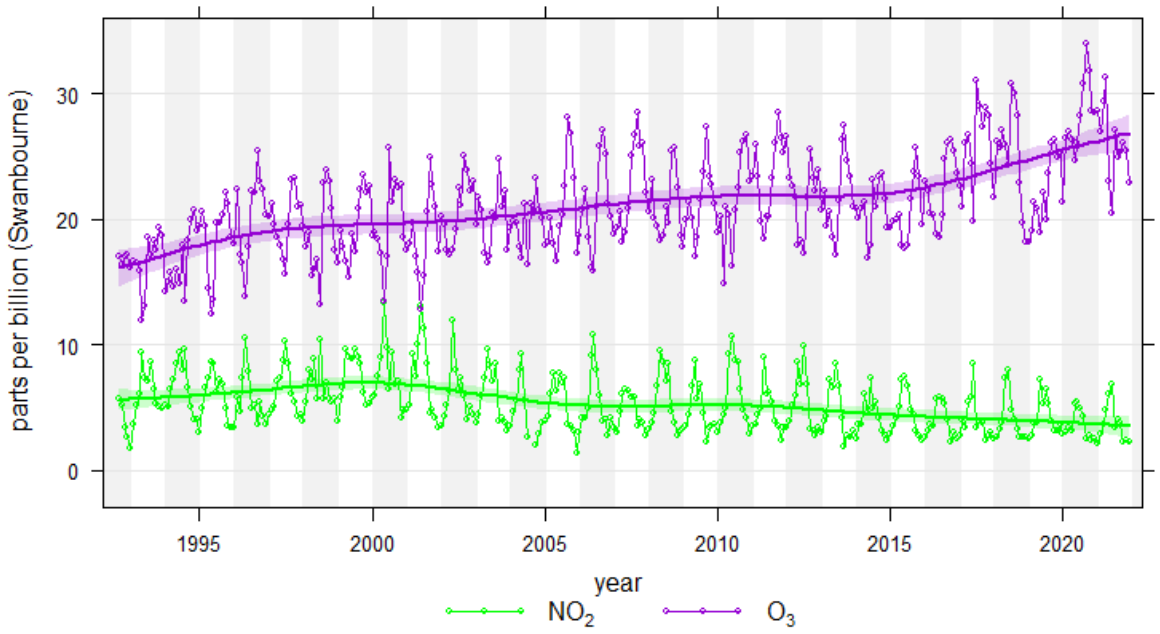
Nitrogen oxides (NO + NO_2) are primarily generated through vehicle use and industrial processes.

Owing to their close chemical reactivity relationship, NO_2 is currently being monitored at all sites where O_3 is monitored. Caversham, Swanbourne and South Lake sites were chosen as performance monitoring sites for NO_2 as they provide a good spatial distribution. Caversham, Swanbourne and South Lake sites are also trend sites.

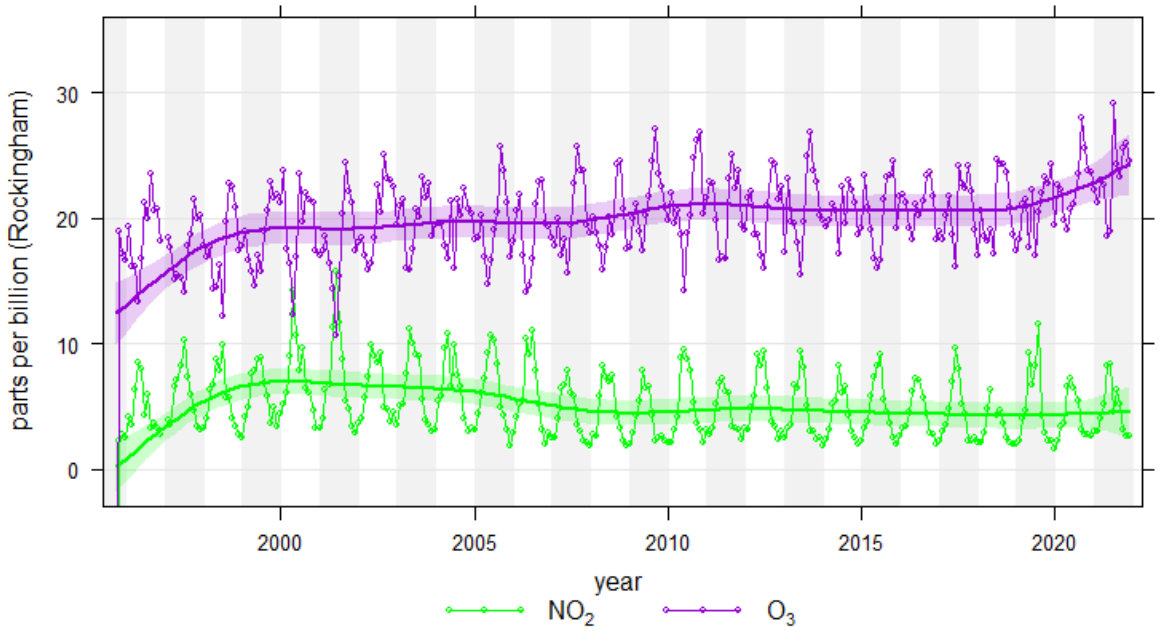
The department will continue to measure NO_2 at Quinns Rocks, Rolling Green and Duncraig as part of its wider network to enable a better understanding of photochemical smog formation.

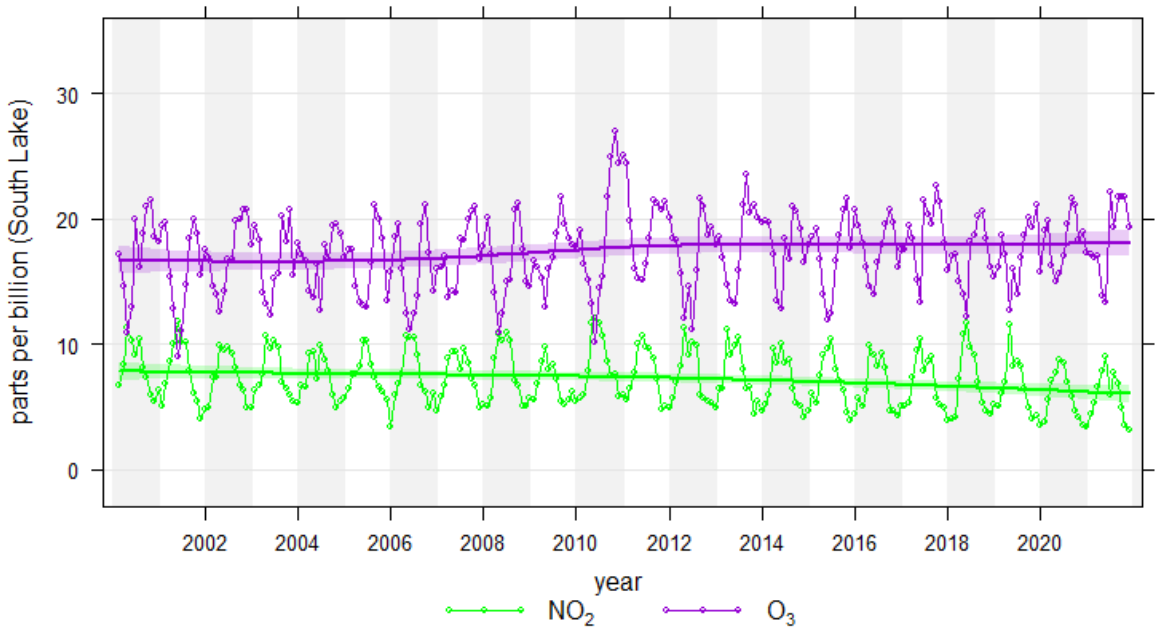
Figure A6 demonstrates how the monthly averages for nitrogen oxides (NO + NO_2) have decreased at all sites. The monthly NO has also seen a general decrease over time, with Duncraig experiencing an average of 0.65 parts per billion (ppb) per annum decrease since 1996.

A possibly unintended consequence of these decreasing concentrations of nitrogen oxides is the inability to suppress ozone formation fully by (typically) producing NO_2 ($NO + O_3 \rightarrow NO_2 + O_2$). The general build-up in O_3 therefore starts earlier (and consequently closer to populated areas) than it otherwise would.[2]



[2] Stedman DH (2004) 'Photochemical ozone formation, simplified', *Environmental Chemistry* 1(2): 65-66.


parts per billion (Rockingham)
30
20
10
0
2000
2005
2010
2015
2020
year
NO2
O3


parts per billion (South Lake)
30
20
10
0
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
year
NO2
O3

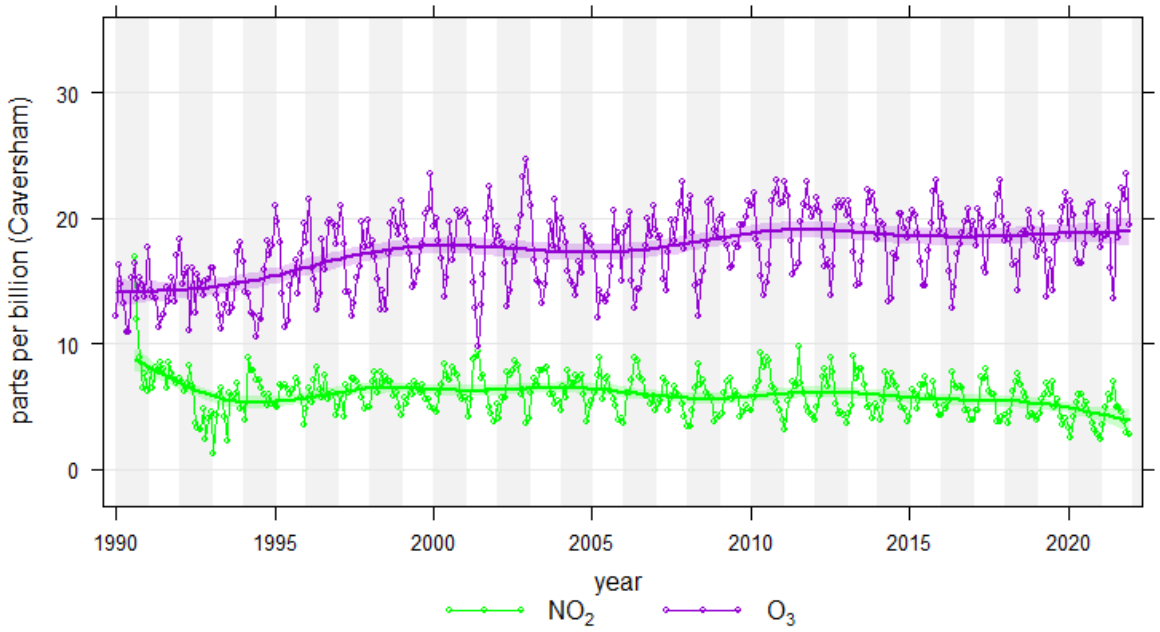


Figure A6 *Smoothed trend (dark lines) at Swanbourne (top panel), Rockingham, South Lake and Caversham (bottom panel) using the monthly average concentration of NO_2 (green) and O_3 (violet).*

A.5 Sulfur dioxide

This section describes sulfur dioxide (SO_2) monitoring performed in WA.

Heavy industry in the Kwinana Industrial Area (KIA) is the only significant source of SO_2 in the Perth region. Concentrations of SO_2 have reduced substantially since the late 1970s because of the transition from high to low-sulfur content fuels and the installation of SO_2 emission control technologies. Emissions are controlled through conditions of licences issued by the department under Part V Division 3 of the *Environmental Protection Act 1986*, together with the Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999 (EPP), to ensure ambient concentrations do not exceed the standards and limits set in the EPP.

The department operates one performance monitoring site at South Lake for SO_2, while maintaining a source management network which includes the Wattleup and Rockingham monitoring sites.

South Lake site is an upper-bound performance monitoring site for SO_2, and a trend site. South Lake is centrally located in the southern metropolitan corridor and downwind of Kwinana during sea breezes.

Long-term trends for SO_2 are presented in Figure A7.

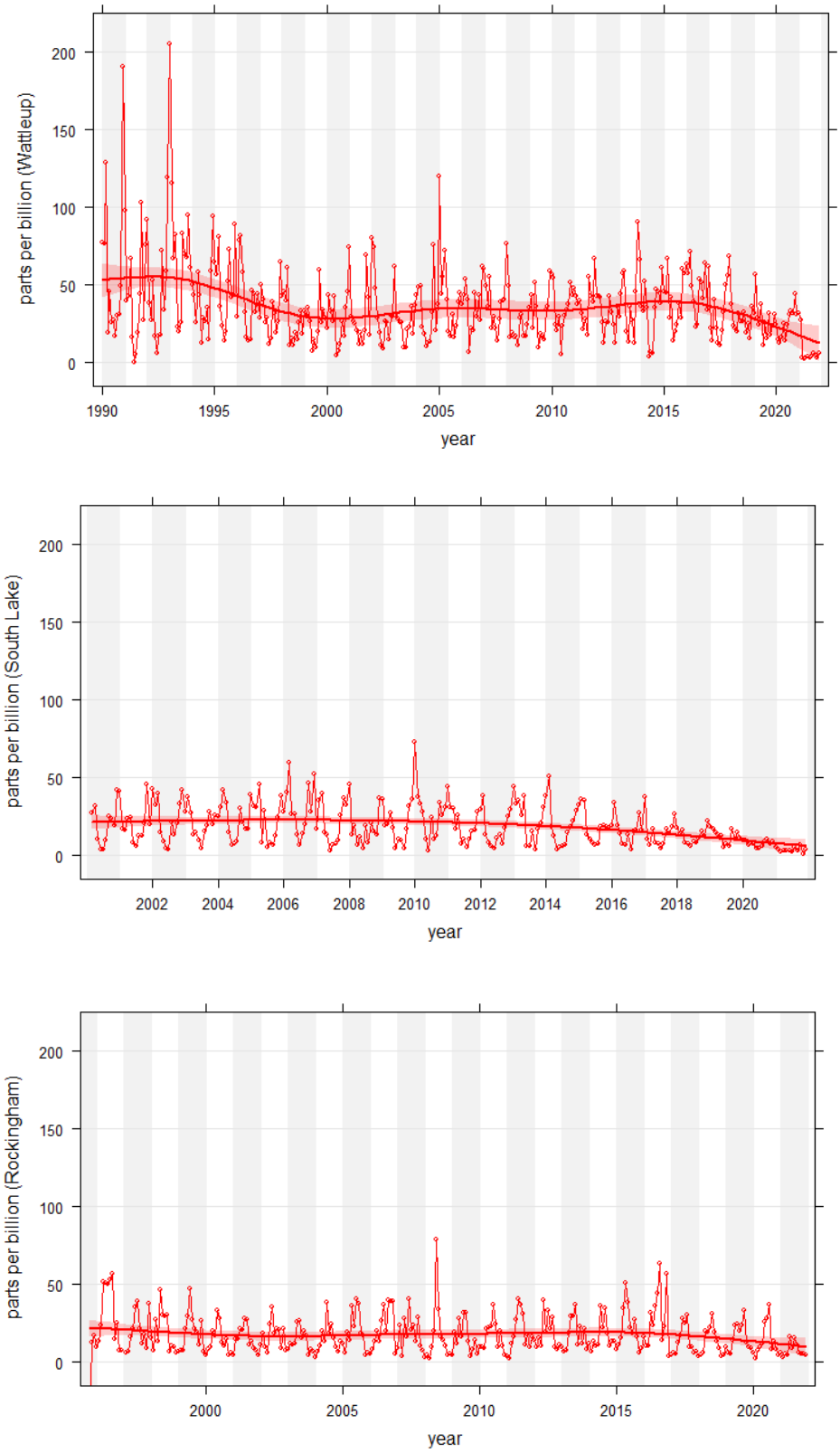


Figure A7 *Trend line for maximum hourly averaged SO_2 concentration at Wattleup, within the Kwinana industrial buffer (top), South Lake (centre) and Rockingham (bottom).*

SO_2 is also monitored in Kalgoorlie; however, there is not yet enough data to allow any trend analysis.

A.6 Lead

This section describes lead monitoring previously performed in WA.

Since 1995, lead levels within the Perth CBD have been below 60 per cent of the AAQ NEPM annual standard of 0.5 particle micrograms per cubic metre (µg/m^3). In 2001, the average lead level in Perth was 0.022 µg/m^3, which is less than five per cent of the AAQ NEPM standard. The decreasing trend was the result of the phase out of leaded petrol.

In accordance with AAQ NEPM Technical Paper No. 4: Screening Procedures, and the WA Monitoring Plan, a performance monitoring site for lead has not been maintained since 2001.

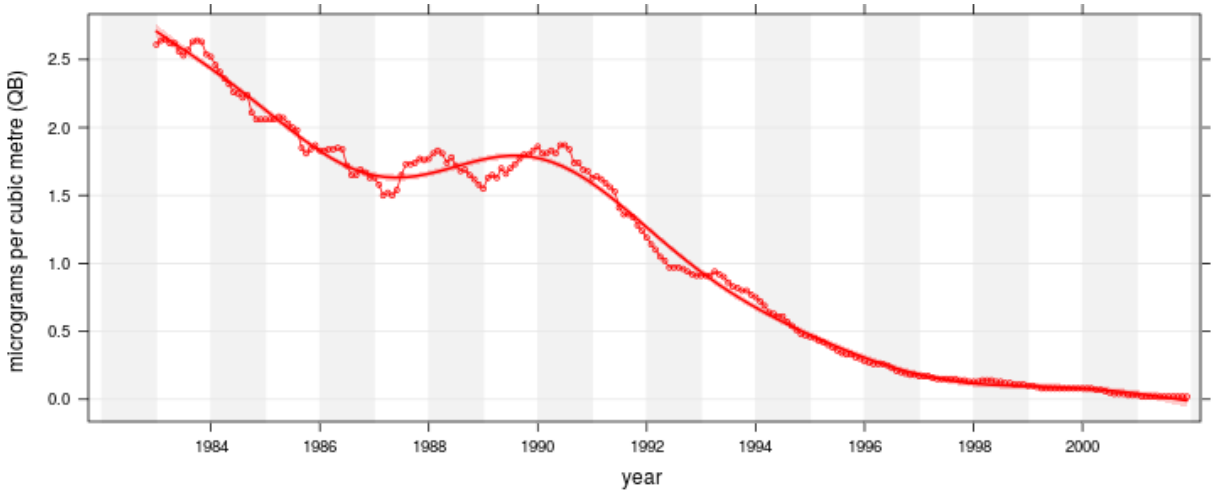


Figure A8 Trend line for annual moving average lead concentration within the Perth CBD.

A.7 Particles as PM_{10}

This section describes PM_{10} particle monitoring performed in WA.

The *Perth air emissions study 2011–12* estimated emissions from natural and man-made sources. Mining and quarries (46%), marine aerosols (21%), wind erosion (13%) and manufacturing (6%) were the biggest sources of particles as PM_{10} from an overall airshed perspective.

Duncraig is an upper-bound performance monitoring site for PM_{10}. High levels of PM_{10} at this suburban location are caused by a combination of vehicle and domestic wood heater emissions during strongly stable meteorological conditions.

Similarly, South Lake measures some PM_{10} concentrations arising from wood fires and industrial emissions.

Duncraig and South Lake are both nominated as trend sites.

Additional monitoring sites were established at Geraldton in 2005, Albany in 2006, Collie in 2008, Kalgoorlie in 2017, Mandurah in 2019 and Armadale in 2020.

A frequency distribution of hourly particle concentrations is shown in Figure A9 for three metropolitan sites and one regional site for the 15 years between 2006–21. It can demonstrate differences in the ratio of $PM_{2.5}$:PM_{10} and provides some insight as to the source of the pollutant. A high ratio of $PM_{2.5}$:PM_{10} indicates a high proportion of smaller particles and is generally caused by particles originating from smoke or fumes. A lower ratio may indicate anthropogenic dust or crustal materials.

The blue plots in Figure A9 represent periods where the one-hour averaged PM_{10} exceeded an arbitrary concentration of 50 µg/m^3. This cut-off was chosen to limit the analysis to those concentrations at the higher end of the spectrum. While Duncraig exhibits a lower overall number, both Duncraig and Bunbury exhibit a higher proportion of high-ratio events where the particles are dominated by fine particles, and both Caversham and South Lake display a larger number of low-ratio events where the particles are dominated by coarse particles.

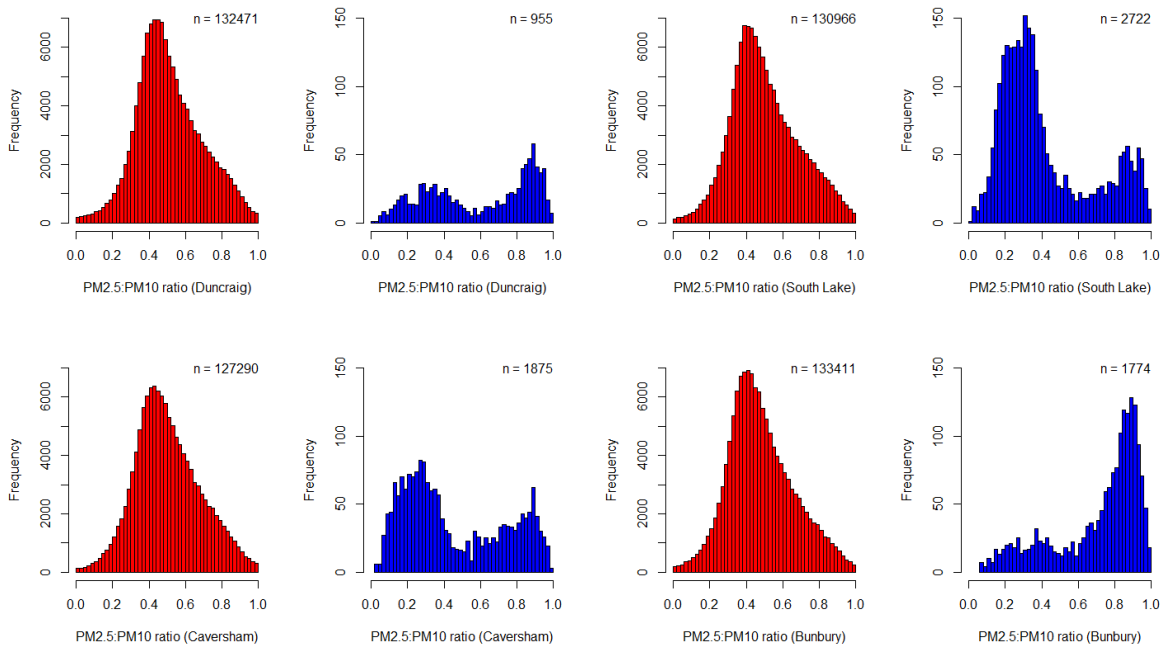


Figure A9 *Frequency distribution of $PM_{2.5}$:PM_{10} ratios of hourly averages at Duncraig (top left), South Lake (top right), Caversham (lower left) and Bunbury (lower right) for the 15-year period from 2006 to 2021 using all data (red) and data where hourly averaged PM_{10} was greater than or equal to 50 µg/m³ (blue).*

These differences can be explained based on the site locations.

Duncraig is 3.5 km from the coast within a medium density housing area with no industry close by, so will be mainly influenced by vehicles, sea salt and smoke from the occasional bush fire or prescribed burn and, to a lesser extent, domestic wood heater emissions. Consequently, the site is likely to record a higher $PM_{2.5}$:PM_{10} ratio, which is characteristic of combustion products.

Bunbury is a large town in the south-west of the state surrounded by farms and bushland which are subjected to controlled burns and occasional bush fires. So, a higher $PM_{2.5}$:PM_{10} ratio characteristic of combustion products would be expected here too.

Caversham is in the semi-rural Swan Valley north-east of Perth CBD and has horticulture, viticulture and some brick manufacturing facilities. These two industries are more likely to produce coarse fraction particles producing a lower $PM_{2.5}$:PM_{10} ratio.

South Lake, within a medium density housing area, is close to the KIA, horticultural areas, new housing developments and a cement manufacturing plant. It is, therefore, more likely that $PM_{2.5}$:PM_{10} ratios will be lower.

A.8 Particles as $PM_{2.5}$

This section describes $PM_{2.5}$ particle monitoring performed in WA.

To make assessments against the AAQ NEPM standard, $PM_{2.5}$ tapered element oscillating microbalances (TEOMs) have been installed in the greater Perth Metropolitan and Peel regions at Quinns Rocks, Caversham, Duncraig, South Lake, Armadale and Mandurah, and in the rural locations of Bunbury, Busselton, Geraldton and Kalgoorlie. All will remain in use at these locations indefinitely with the intention of developing trend data.

All TEOMs used by the department are operated continuously (unadjusted for temperature).

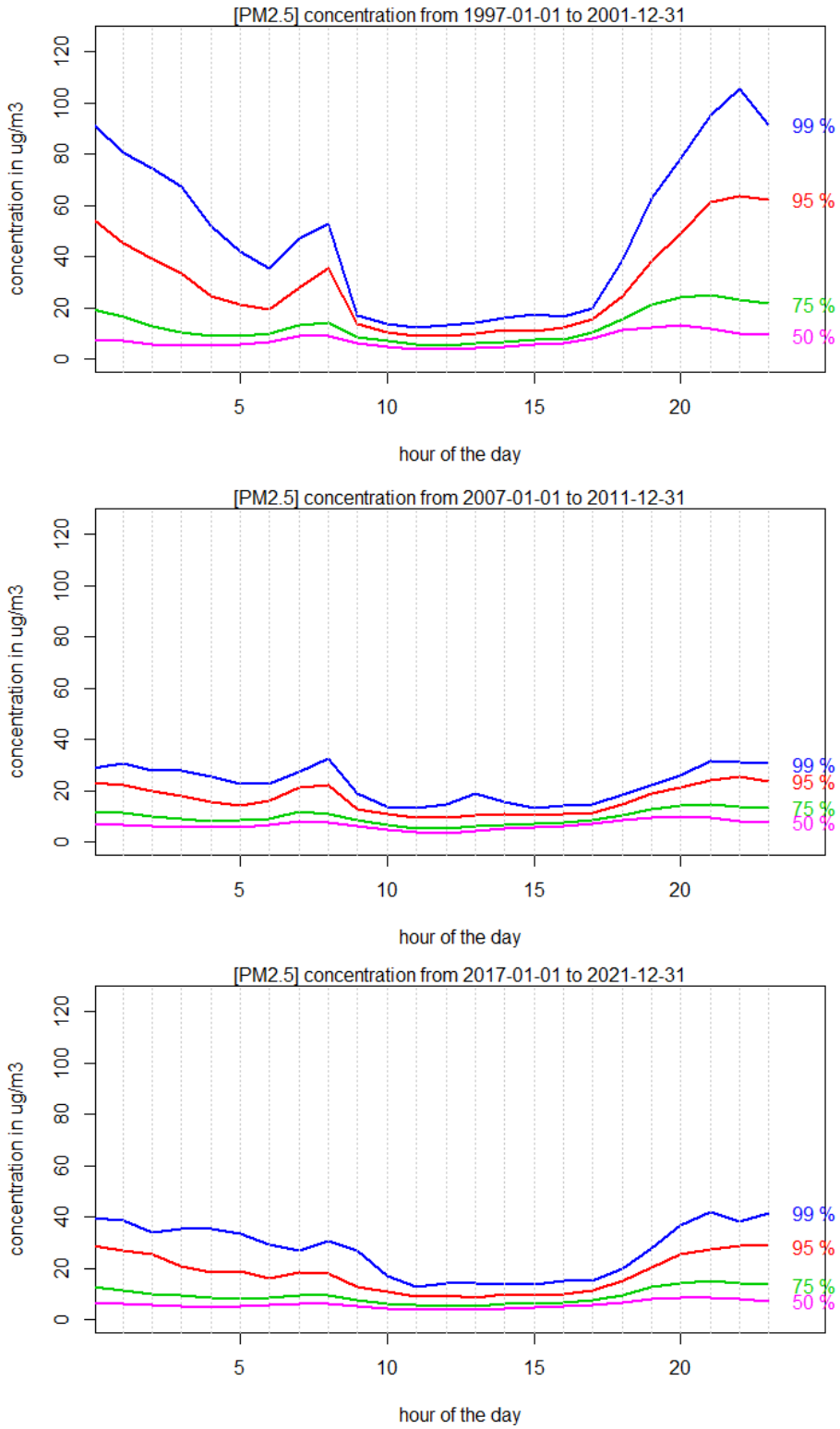


Figure A10 *The $PM_{2.5}$ 99th (blue), 95th (red), 75th (green) and 50th (mauve) percentiles for each hour of the day at Duncraig over winter months spanning the five-year periods 1997–2001 (top), 2007–2011 (centre) and 2017–2021 (bottom).*

Percentile concentrations for $PM_{2.5}$ for each hour of the day over winter months during three four-year periods at Duncraig are shown in Figure A10. The $PM_{2.5}$ profile shows a marked decrease in overnight concentrations over the initial 10-year timespan with a little or no improvement over the second decade. As indicated in Section A2 (carbon monoxide), one possible reason for this initial and dramatic decrease in fine particle concentrations during winter was the introduction of the

Environmental Protection (Domestic Solid Fuel Burning Appliances and Firewood Supply) Regulations 1998[3], which required heating appliances (wood heaters) for sale to meet emission standards set out in the relevant Australian and New Zealand Standard (AS/NZS4013:1999) and regulated the moisture content of wood sold as firewood.

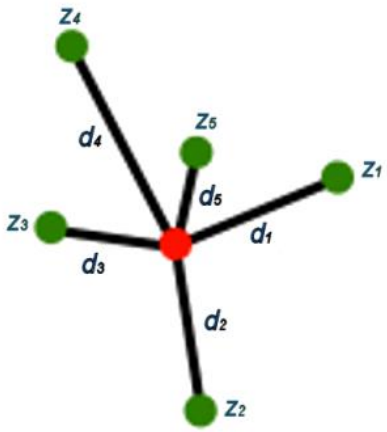
In addition, in 2006 and 2007, wood heater replacement programs were conducted by the department, which offered up to $600 as an economic incentive to encourage people using wood heaters or fireplaces as the main source of heating in their homes to convert to an alternative heating source.

A.9 Population exposure

The requirement for an annual assessment of population exposure to particles as $PM_{2.5}$ was made on 26 February 2016. In May 2021, this was extended to the annual reporting of population exposure from O_3 and NO_2.

Pending a nationally consistent method to assess population exposures for various pollutants, the WA assessment has used a simple inverse distance weighing (IDW) method.

$$Z(x) = \frac{\sum w_i z_i}{\sum w_i}$$



where

$$w_i = \frac{1}{d(x, x_i)^2}$$

In this simple IDW function, $Z(x)$ represents a known location for which a $PM_{2.5}$ concentration needs to be estimated, z_i represents known locations for which $PM_{2.5}$ concentrations are available while $d(x, x_i)$ is the distance from a point x_i for which we have a known concentration to a point x where the concentration estimate is needed.

$$Population\ exposure = \sum \frac{Z(x)P_x}{P_{total}}$$

where

$$P_x = population\ at\ each\ Z(x)\ or\ suburb$$

It is important to note that this method uses a very simple interpolation and does not consider land-use or terrain effects. This results in the concentrations of nearer sites having a greater effect on the estimated concentration than more distant sites.

In 2021, metropolitan $PM_{2.5}$ particle, O_3 and NO_2 data were collected from metropolitan and regional sites. Using the centroid of each suburb in metropolitan Perth and their associated population data, the population weighted averages for Perth are:

Pollutant	Number of sites	Concentration
$PM_{2.5}$	7	7.3 µg/m^3
Ozone	7	21.7 ppb
Nitrogen dioxide	8	4.5 ppb

[3] Repealed and replaced by the Environmental Protection (Solid Fuel Heater and Firewood) Regulations 2018 on 1 September 2018

A.10 Mandurah and marine aerosols

The Monitoring Plan for WA (the plan), prepared in accordance with the AAQ NEPM in 2001, describes the monitoring required to determine compliance with the standards and goals of the AAQ NEPM. The plan identified that monitoring sites were required in Mandurah, Geraldton and Kalgoorlie-Boulder, based on population size.

In relation to Mandurah, the plan states:

> The preferred Mandurah monitoring site is close to the coast, in order to measure O_3 concentrations before any significant titration with fresh NO occurs and before convective mixing over the land causes significant dilution … PM_{10} particles will be measured at Mandurah. Wood fires, wildfires and prescribed burning, sea salt and, to a lesser extent, vehicles are likely sources. Secondary particles in smog plumes from the Perth Region may also be measured.

The Mandurah air quality monitoring site was commissioned in November 2019 with the site located about 120 metres from the ocean in the suburb of Halls Head. Since installation, the Mandurah site has been recording a larger than expected number of PM_{10} particle exceedances of the AAQ NEPM standard. During the 2021 calendar year, 19 PM_{10} and three $PM_{2.5}$ particle exceedances were recorded at Mandurah. Of these, 17 PM_{10} exceedances were due to marine aerosols. There were no marine aerosol $PM_{2.5}$ exceedances.

Marine aerosols include all types of particles associated with ocean processes. These include particles generated mechanically at the sea surface, such as salt and other compounds, as well as compounds formed chemically from the atmospheric reactions of gases emitted from the sea surface.

The AAQ NEPM defines an ‘exceptional event’ as a fire or dust occurrence which adversely affects air quality at a particular location and causes an exceedance of daily standards in excess of normal historical fluctuations and background levels, and which is directly related to bushfire, jurisdiction-authorised hazard reduction burning or continental-scale windblown dust. Clause 18(3C) of the AAQ NEPM states:

> For the purpose of reporting compliance against PM_{10} and $PM_{2.5}$ 1-day average standards, jurisdictions shall exclude monitoring data that has been determined as being directly associated with an exceptional event.

As the Mandurah particle exceedances caused by marine aerosols cannot be defined as exceptional events, these exceedances are deemed assessable events and have been counted for the purposes of determining whether the AAQ NEPM PM_{10} goal of no allowable exceedances has been met at Mandurah. Notwithstanding these exceedances, the Department of Health has provided advice that inhaling ‘sea air’ or ‘ocean air’ is not harmful.

Mandurah $PM_{2.5}$ concentrations are similar to all other metropolitan sites.

A.11 Variation to the AAQ NEPM

In May 2021, the AAQ NEPM was varied to:

- establish an ozone (O_3) standard with an 8-hour averaging period that reflects the health evidence and its use internationally, with a numerical value of 65 ppb.
- significantly strengthen nitrogen dioxide (NO_2) reporting standards for 1-hour and annual averaged NO_2 to 80 ppb and 15 ppb respectively, bringing forward standards initially proposed for 2025. This reflects the most recent health evidence emerging about the health impacts of NO_2.
- significantly strengthen sulfur dioxide (SO_2) reporting standards for 1-hour and 1-day averaged SO_2 to 100 ppb and 20 ppb respectively. The 1-hour averaged SO_2 standard will be strengthened again in 2025 to 75 ppb.
- remove annual SO_2 and 1-hour and 4-hour O_3 averaging periods to align the standards with the recent health evidence and for consistency with many international agencies.
- change the form of the standards to the maximum value with no allowable exceedances.
- extend the application of the existing exceptional events rule, that applied to the particle standards, to O_3 given the linkages between elevated O_3 levels and fire events. This rule is used by jurisdictions to determine compliance with the standards.

- extend the range of pollutants used for annual reporting of population exposure to include $PM_{2.5}$, O_3 and NO_2 given the widespread exposure across whole populations.

A.12 Exceedance summary

There were exceedances of the O_3 8-hour NEPM standard and the $PM_{2.5}$ and PM_{10} NEPM daily standards in 2021 which are listed in Table A10. Detailed summaries of all exceedances are provided in Section F.

Table A10 AAQ NEPM standard exceedances recorded during 2021

Date	Pollutant and averaging period	Site	Concentrations [1]	Cause [2]	EE [2]	AE [2]
4/01/2021	PM10 - 1-day	Geraldton	50.2	WD		●
5/01/2021	PM10 - 1-day	Geraldton	119	BF	●	
5/01/2021	PM2.5 - 1-day	Geraldton	29.2			
6/01/2021	PM10 - 1-day	Geraldton	93.0	WD		●
13/01/2021	PM10 - 1-day	Geraldton	50.3	WD		●
14/01/2021	PM10 - 1-day	Geraldton	54.5	WD		●
16/01/2021	PM10 - 1-day	Geraldton	108	WD		●
20/01/2021	PM2.5 - 1-day	Busselton	28.6	BF	●	
2/02/2021	PM10 - 1-day	Caversham	50.7	BF	●	
2/02/2021	PM2.5 - 1-day	Caversham	39.7			
2/02/2021	PM2.5 - 1-day	Duncraig	32.1			
19/04/2021	PM10 - 1-day	Armadale	50.7	PB	●	
19/04/2021	PM2.5 - 1-day	Armadale	45.4			
19/04/2021	PM2.5 - 1-day	Caversham	28.0			
19/04/2021	PM2.5 - 1-day	Duncraig	41.4			
19/04/2021	PM2.5 - 1-day	Geraldton	25.8			
19/04/2021	PM2.5 - 1-day	Mandurah	26.0			
19/04/2021	PM2.5 - 1-day	Quinns Rocks	40.6			
19/04/2021	PM2.5 - 1-day	South Lake	30.6			
21/04/2021	PM2.5 - 1-day	Bunbury	40.9	PB	●	
25/04/2021	PM10 - 1-day	Collie	63.8	PB	●	
25/04/2021	PM2.5 - 1-day	Duncraig	27.8			
25/04/2021	PM2.5 - 1-day	South Lake	25.2			
26/04/2021	PM10 - 1-day	Bunbury	89.6	PB	●	
26/04/2021	PM10 - 1-day	Busselton	131			
26/04/2021	PM10 - 1-day	Collie	84.7			
26/04/2021	PM10 - 1-day	Mandurah	96.1			
26/04/2021	PM2.5 - 1-day	Armadale	28.0			
26/04/2021	PM2.5 - 1-day	Bunbury	83.1			
26/04/2021	PM2.5 - 1-day	Busselton	126			
26/04/2021	PM2.5 - 1-day	Mandurah	83.4			
27/04/2021	PM10 - 1-day	Busselton	63.4	PB	●	
27/04/2021	PM10 - 1-day	Collie	61.7			
27/04/2021	PM2.5 - 1-day	Armadale	25.2			
27/04/2021	PM2.5 - 1-day	Bunbury	32.2			
27/04/2021	PM2.5 - 1-day	Busselton	58.1			
27/04/2021	PM2.5 - 1-day	South Lake	25.1			
28/04/2021	Ozone - 8-hours	Caversham	78.3 ppb	PB	●	
28/04/2021	Ozone - 8-hours	Quinns Rocks	78.9 ppb			
28/04/2021	Ozone - 8-hours	Swanbourne	75.9 ppb			
28/04/2021	PM10 - 1-day	Armadale	96.1			
28/04/2021	PM10 - 1-day	Caversham	97.7			
28/04/2021	PM10 - 1-day	Duncraig	105			
28/04/2021	PM10 - 1-day	Mandurah	103			
28/04/2021	PM10 - 1-day	South Lake	101			
28/04/2021	PM2.5 - 1-day	Armadale	88.6			
28/04/2021	PM2.5 - 1-day	Caversham	88.3			

Date	Pollutant and averaging period	Site	Concentrations [1]	Cause [2]	EE [2]	AE [2]
28/04/2021	PM2.5 - 1-day	Duncraig	96.5			
28/04/2021	PM2.5 - 1-day	Mandurah	87.9			
28/04/2021	PM2.5 - 1-day	South Lake	92.1			
29/04/2021	PM10 - 1-day	Caversham	61.3	PB	●	
29/04/2021	PM10 - 1-day	Collie	58.8			
29/04/2021	PM10 - 1-day	Duncraig	61.7			
29/04/2021	PM2.5 - 1-day	Armadale	31.1			
29/04/2021	PM2.5 - 1-day	Caversham	51.8			
29/04/2021	PM2.5 - 1-day	Duncraig	53.4			
29/04/2021	PM2.5 - 1-day	Quinns Rocks	42.2			
29/04/2021	PM2.5 - 1-day	South Lake	37.0			
14/05/2021	PM2.5 - 1-day	Quinns Rocks	32.4	PB	●	
20/05/2021	PM2.5 - 1-day	Armadale	26.4	WH		●
5/06/2021	PM2.5 - 1-day	Caversham	30.8	WH		●
5/06/2021	PM2.5 - 1-day	Quinns Rocks	27.0			●
5/06/2021	PM2.5 - 1-day	South Lake	25.6			●
6/06/2021	PM2.5 - 1-day	Caversham	32.8	WH		●
25/06/2021	PM2.5 - 1-day	Kalgoorlie	33.9	WH		●
26/06/2021	PM2.5 - 1-day	Kalgoorlie	26.0	WH		●
28/06/2021	PM10 - 1-day	Mandurah	60.3	MA		●
1/07/2021	PM10 - 1-day	Mandurah	54.5	MA		●
3/07/2021	PM2.5 - 1-day	South Lake	26.9	WH		●
5/07/2021	PM10 - 1-day	Mandurah	56.7	MA		●
7/07/2021	PM10 - 1-day	Mandurah	53.2	MA		●
13/07/2021	PM10 - 1-day	Mandurah	55.5	MA		●
14/07/2021	PM10 - 1-day	Mandurah	53.7	MA		●
18/07/2021	PM2.5 - 1-day	Busselton	27.8	WH		●
19/07/2021	PM2.5 - 1-day	Busselton	27.2	WH		●
24/07/2021	PM10 - 1-day	Mandurah	55.1	MA		●
25/07/2021	PM10 - 1-day	Mandurah	60.8	MA		●
27/07/2021	PM10 - 1-day	Mandurah	66.7	MA		●
28/07/2021	PM10 - 1-day	Mandurah	65.3	MA		●
29/07/2021	PM10 - 1-day	Mandurah	52.8	MA		●
30/07/2021	PM10 - 1-day	Mandurah	52.5	MA		●
3/08/2021	PM2.5 - 1-day	Busselton	25.1	WH		●
10/08/2021	PM10 - 1-day	Mandurah	54.1	MA		●
31/08/2021	PM10 - 1-day	Mandurah	53.0	MA		●
6/09/2021	PM10 - 1-day	Mandurah	51.5	MA		●
7/09/2021	PM10 - 1-day	Mandurah	52.9	MA		●
30/09/2021	PM10 - 1-day	Mandurah	67.1	MA		●
11/10/2021	PM2.5 - 1-day	Quinns Rocks	29.7	LB		●
16/10/2021	PM10 - 1-day	Busselton	54.3	PB	●	
16/10/2021	PM2.5 - 1-day	Busselton	43.7		●	
18/10/2021	PM2.5 - 1-day	Collie	25.8	PB	●	
10/11/2021	PM2.5 - 1-day	Bunbury	28.1	PB	●	
10/11/2021	PM2.5 - 1-day	Busselton	30.7		●	
11/11/2021	PM2.5 - 1-day	Duncraig	30.1	PB	●	
16/11/2021	PM10 - 1-day	Busselton	74.4	WD		●
30/12/2021	Ozone - 8-hours	Rolling Green	65.2 ppb	IO		●

1. All particle concentrations are daily averages in micrograms per cubic metre

2.Event Cause and Type.

Event cause		Event type	
BF	Bushfire	AE	Assessable event
MA	Marine Aerosols	EE	Exceptional event
PB	Prescribed burning activities		
LB	Local Burn		
WD	Windborne dust		
WH	Wood heater		
IO	Inland ozone		

B. Assessment of compliance with standards and goals

Table B1 2021 compliance summary for carbon monoxide

AAQ NEPM standard
9.0 ppm (eight-hour average)

Regional performance monitoring station	Data availability rates (% of hours)					Number of exceedances (days)	Performance against the standards and goal
	Q1	Q2	Q3	Q4	Annual		
Perth region							
Caversham (North East Metro)	97.9	97.4	97.3	97.4	97.5	0	met
Duncraig (North Metro)	97.8	94.4	94.8	92.7	94.9	0	met
South Lake (South East Metro)	94.5	97.8	97.8	97.2	96.8	0	met
Peel region							
Mandurah	97.1	97	86.5	97.7	94.6	0	met
Goldfields region							
Kalgoorlie	97.7	97.6	87.8	75.7	89.7	0	met

Performance against the standards and goal: “met”, “not met”, “not demonstrated” (ND).

Table B2 2021 compliance summary for nitrogen dioxide

AAQ NEPM standard
0.08 ppm (one-hour average)
0.015 ppm (one-year average)

Regional performance monitoring station	Data availability rates (% of hours)					Annual average	Number of exceedances	Performance against the standards and goal	
	Q1	Q2	Q3	Q4	Annual	(ppm)	(days)	1-hour	1-year
Perth region									
Caversham (North East Metro)	99.9	98.6	99.2	99.5	99.3	0.004	0	met	met
Duncraig (North Metro)	99.8	96.5	96.8	85.4	94.6	0.005	0	met	met
Quinns Rocks (Outer North Coast)	99.8	99.9	99.9	99.3	99.7	0.004	0	met	met
Rockingham (South Coast)	99.9	100.0	99.3	99.9	99.8	0.005	0	met	met
Rolling Green (Outer East Rural)	96.1	99.9	99.7	99.9	98.9	0.002	0	met	met
South Lake (South East Metro)	99.7	99.9	99.9	94.0	98.4	0.006	0	met	met
Swanbourne (Inner West Coast)	99.7	99.7	98.6	99.7	99.4	0.004	0	met	met
Peel region									
Mandurah	98.8	94.8	96.8	95.3	96.4	0.002	0	met	met

Performance against the standards and goal: “met”, “not met”, “not demonstrated” (ND)

Table B3 2021 compliance summary for ozone

AAQ NEPM standard
0.065 ppm (eight-hour average)

Regional performance monitoring station	Data availability rates (% of hours)					Number of exceedances (days)	Performance against the standards and goal
	Q1	Q2	Q3	Q4	Annual	8-hour	8-hour
Perth region							
Caversham (North East Metro)	100.0	99.6	99.2	99.6	99.6	1	not met
Quinns Rocks (Outer North Coast)	100.0	100.0	99.9	98.2	99.5	1	not met
Rockingham (South Coast)	100.0	99.9	98.5	99.7	99.5	0	met
Rolling Green (Outer East Rural)	96.2	100.0	93.4	100.0	97.4	1	not met
South Lake (South East Metro)	99.3	100.0	99.9	100.0	99.8	0	met
Swanbourne (Inner West Coast)	99.6	99.5	100.0	99.8	99.7	1	not met
Peel region							
Mandurah	99.2	96.4	97.2	99.7	98.1	0	met

Performance against the standards and goal: “met”, “not met”, “not demonstrated (ND)”.

Table B4 2021 compliance summary for sulfur dioxide

AAQ NEPM standard
0.10 ppm (one-hour average)
0.02 ppm (one-day average)

Regional 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	1-day	1-hour	1-day
Perth region									
Rockingham (South Coast)	97.8	97.9	97.5	97.8	97.8	0	0	met	met
South Lake (South East Metro)	98.8	97.8	97.9	97.8	98.1	0	0	met	met
Wattleup (South Metro)	97.5	94.3	92.6	92.6	94.2	0	0	met	met
Goldfields region									
Kalgoorlie	97.7	97.3	87.2	73.7	88.9	0	0	ND	ND

Performance against the standards and goal: “met”, “not met”, “not demonstrated (ND)”.

Table B5 2021 compliance summary for particles as PM_{10}

AAQ NEPM standard
50 µg/m^3 (1-day average)
25 µg/m^3 (annual average)

Regional performance monitoring station	Data availability rates (% of days)					Number of exceedances	Performance against the standards and goal	
	Q1	Q2	Q3	Q4	Annual	(days)	1-day	Annual
Perth region								
Caversham (North East Metro)	91.9	99.3	99	99.3	97.4	3	met	met
Duncraig (North Metro)	99.4	96	96.6	98.8	97.7	2	met	met
Quinns Rocks (Outer North Coast)	97.5	94.3	99.8	98.1	97.4	0	met	met
South Lake (South East Metro)	99.6	98.9	99.7	97.8	99.0	1	met	met
Peel region								
Mandurah	98.8	98.8	93.9	91.8	95.8	19	not met	met
Southwest region								
Albany	99.6	99.6	98.6	99	99.2	0	met	met
Bunbury	93.2	97.8	98.2	99.5	97.2	1	met	met
Busselton	99.6	98.2	99.9	94.6	98	4	not met	met
Collie	91.2	96.6	99.9	99.4	96.8	4	met	met
Mid West region								
Geraldton	98.8	96.3	99.6	99.3	98.5	6	not met	met
Goldfields region								
Kalgoorlie	99.6	99.7	86	77.4	90.6	0	met	met

Performance against the standards and goal: “met”, “not met”, “not demonstrated (ND)”.

Table B6 2021 compliance summary for particles as $PM_{2.5}$

AAQ NEPM standard
25 µg/m^3 (1-day average)
8 µg/m^3 (annual average)

Regional performance monitoring station	Data availability rates (% of days)					Number of exceedances	Performance against the standards and goal	
	Q1	Q2	Q3	Q4	Annual	(Days)	1-day	annual
Perth region								
Caversham (North East Metro)	91.9	99.3	99	99.3	97.4	6	not met	met
Duncraig (North Metro)	99.4	96	96.6	98.8	97.7	6	met	met
Quinns Rocks (Outer North Coast)	97.5	94.3	99.8	98.1	97.4	5	not met	not met
South Lake (South East Metro)	99.6	98.9	99.7	97.8	99	7	not met	met
Peel region								
Mandurah	98.8	98.8	93.9	91.8	95.8	3	not met	met
Southwest region								
Bunbury	93.2	97.8	98.2	99.5	97.2	4	met	met
Busselton	99.6	98.2	99.9	94.6	98	8	not met	not met
Collie	0	0	0	94.2	23.7	1	ND	ND
Mid West region								
Geraldton	99.2	96.2	99.3	99.1	98.5	2	met	met
Goldfields region								
Kalgoorlie	99.6	99.7	86	77.4	90.6	2	not met	met

Performance against the standards and goal: “met”, “not met”, “not demonstrated” (ND)

C. Analysis of air quality monitoring

C.1 Carbon monoxide

The AAQ NEPM standard for carbon monoxide of 9.0 ppm averaged over eight hours was not exceeded at any site during 2021. The AAQ NEPM goal of no exceedance was met at each site. Table C1 contains the summary statistics for daily peak eight-hour carbon monoxide.

Table C1 2021 summary statistics for daily peak eight-hour carbon monoxide

AAQ NEPM standard
9.0 ppm (eight-hour average)

Regional performance monitoring station	Data availability rates (%)	Highest (ppm)	Highest (date)	Highest (time)	2nd highest (ppm)	2nd highest (date)	2nd highest (time)
Perth region							
Caversham (North East Metro)	97.5	1.2	02/02/2021	2000	1.0	07/06/2021	0600
Duncraig (North Metro)	94.9	1.5	19/04/2021	1100	1.3	05/06/2021	0300
South Lake (South East Metro)	96.8	1.5	26/06/2021	0300	1.3	05/06/2021	0400
Peel region							
Mandurah	94.6	1.6	28/04/2021	1300	1.3	26/04/2021	1300
Goldfields region							
Kalgoorlie	89.7	1.8	26/06/2021	0700	1.6	25/06/2021	0600

C.2 Nitrogen dioxide

The AAQ NEPM standards for nitrogen dioxide of 0.08 ppm averaged over one hour and the 0.015 ppm annual average were not exceeded at any site during 2021. The AAQ NEPM goal of no exceedance was met at each site. Table C2 contains the summary statistics for daily peak one-hour nitrogen dioxide.

Table C2 2021 summary statistics for daily peak one-hour nitrogen dioxide

AAQ NEPM standard
0.08 ppm (one-hour average)

Regional performance monitoring station	Data availability rates (%)	Highest (ppm)	Highest (date)	Highest (time)	2nd highest (ppm)	2nd highest (date)	2nd highest (time)
Perth region							
Caversham (North East Metro)	99.3	0.034	29/03/2021	2200	0.033	28/04/2021	2000
Duncraig (North Metro)	94.6	0.033	21/09/2021	2300	0.029	04/08/2021	2100
Quinns Rocks (Outer North Coast)	99.7	0.033	24/06/2021	2000	0.032	13/08/2021	2000
Rockingham (South Coast)	99.8	0.037	27/04/2021	1000	0.031	11/08/2021	0900
Rolling Green (Outer East Rural)	98.9	0.020	24/06/2021	0800	0.020	24/02/2021	0700
South Lake (South East Metro)	98.4	0.034	23/04/2021	1900	0.033	15/10/2021	2100
Swanbourne (Inner West Coast)	99.4	0.033	13/08/2021	2100	0.031	04/06/2021	2200
Peel region							
Mandurah	96.4	0.021	24/06/2021	2000	0.021	18/06/2021	2000

The AAQ NEPM standard for nitrogen dioxide of 0.015 ppm averaged over one year was not exceeded at any site during 2021. Table C2a contains the summary statistics for annual nitrogen dioxide.

Table C2a 2021 summary statistics for annual nitrogen dioxide

AAQ NEPM standard
0.015 ppm (annual average)

Regional performance monitoring station	Data availability rates (%)	Annual average (ppm)
Perth region		
Caversham (Northeast Metro)	99.1	0.004
Duncraig (North Metro)	99.3	0.005
Quinns Rocks (Outer North Coast)	72.0	0.004
Rockingham (South Coast)	96.6	0.005
Rolling Green (Outer East Rural)	99.2	0.002
South Lake (Southeast Metro)	99.1	0.006
Swanbourne (Inner West Coast)	99.2	0.004
Peel region		
Mandurah	98.6	0.002

C.3 Photochemical smog as ozone

The AAQ NEPM standard for ozone of 0.065 ppm averaged over eight hours was exceeded during 2021 at Caversham, Quinns Rocks, Rolling Green and Swanbourne. Table C3 contains the summary statistics for daily peak eight-hour ozone in WA.

Table C3 2021 summary statistics for daily peak eight-hour ozone

AAQ NEPM standard
0.065 ppm (eight-hour average)

Regional performance monitoring station	Data availability rates (%)	Highest (ppm)	Highest (date)	(time)	2nd highest (ppm)	2nd highest (date)	(time)
Perth region							
Caversham (North East Metro)	99.6	0.078	28/04/2021	1800	0.054	18/03/2021	1800
Quinns Rocks (Outer North Coast)	99.5	0.079	28/04/2021	1900	0.059	29/03/2021	1800
Rockingham (South Coast)	99.5	0.064	29/03/2021	1800	0.061	20/03/2021	1900
Rolling Green (Outer East Rural)	97.4	0.065	30/12/2021	1900	0.061	20/01/2021	1900
South Lake (South East Metro)	99.8	0.059	29/03/2021	1800	0.055	28/04/2021	1800
Swanbourne (Inner West Coast)	99.7	0.076	28/04/2021	1800	0.063	29/03/2021	1900
Peel region							
Mandurah	98.1	0.061	20/03/2021	1900	0.059	08/01/2021	1900

C.4 Sulfur dioxide

The AAQ NEPM standard for sulfur dioxide of 0.20 ppm averaged over one hour was not exceeded at any site during 2021. Table C5 contains the summary statistics for daily peak one-hour sulfur dioxide.

Table C5 2021 summary statistics for daily peak one-hour sulfur dioxide

AAQ NEPM standard
0.10 ppm (one-hour average)

Regional performance monitoring station	Data availability rates (%)	Highest (ppm)	Highest (date)	Highest (time)	2nd highest (ppm)	2nd highest (date)	2nd highest (time)
Perth region							
Rockingham (South Coast)	97.8	0.016	27/05/2021	0600	0.016	04/07/2021	0600
South Lake (South East Metro)	98.1	0.007	09/10/2021	0700	0.006	07/01/2021	1800
Wattleup (South Metro)	94.2	0.032	22/01/2021	1700	0.027	02/02/2021	1700
Goldfields region							
Kalgoorlie	88.9	0.081	07/05/2021	2200	0.043	18/02/2021	2200

The AAQ NEPM standard for sulfur dioxide of 0.02 ppm averaged over 24 hours was not exceeded at any site during 2021. Table C6 contains the summary statistics for daily peak 1-day sulfur dioxide.

Table C6 2021 summary statistics for 1-day sulfur dioxide

AAQ NEPM standard
0.02 ppm (1-day average)

Regional performance monitoring station	Data availability rates (%)	Highest (ppm)	Highest (date)	Highest (time)	2nd highest (ppm)	2nd highest (date)	2nd highest (time)
Perth region							
Rockingham (South Coast)	97.8	0.006	30/08/2021	2400	0.006	31/08/2021	2400
South Lake (South East Metro)	98.1	0.002	06/08/2021	2400	0.002	25/06/2021	2400
Wattleup (South Metro)	94.2	0.004	21/01/2021	2400	0.003	03/02/2021	2400
Goldfields region							
Kalgoorlie	88.9	0.007	07/05/2021	2400	0.007	12/12/2021	2400

C.5 Particles as PM_{10}

The AAQ NEPM standard for particles as PM_{10} of 50 µg/m^3 averaged over 24 hours was exceeded during 2021, as detailed in Table A10. Table C8 contains the summary statistics for daily PM_{10}.

Table C8 2021 summary statistics for 1-day particles as PM_{10}

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

Regional performance monitoring station	Data availability rates (%)	Highest (µg/m^3)	Highest (date)	6th Highest (µg/m^3)	6th Highest (date)
Perth region					
Caversham (North East Metro)	97.4	**97.7**	28/04/2021	34.9	06/06/2021
Duncraig (North Metro)	97.7	**105.1**	28/04/2021	33.9	03/02/2021
Quinns Rocks (Outer North Coast)	97.4	47.6	19/04/2021	36.6	15/01/2021
South Lake (South East Metro)	99	**101.5**	28/04/2021	33.1	02/02/2021
Peel region					
Mandurah	95.8	**103.2**	28/04/2021	**60.8**	25/07/2021
South West region					
Albany	99.2	34.3	24/02/2021	27.3	05/04/2021
Bunbury	97.2	**89.6**	26/04/2021	31.8	24/04/2021
Busselton	98	**131.0**	26/04/2021	39.3	20/01/2021
Collie	96.8	**84.7**	26/04/2021	36.6	24/06/2021
Mid West region					
Geraldton	98.5	**119.7**	05/01/2021	**50.2**	04/01/2021
Goldfields region					
Kalgoorlie	90.6	42.7	25/06/2021	28.4	04/06/2021

Bold numerals indicate where a standard has been exceeded.

Table C9 contains the summary statistics for annual PM_{10}.

Table C9 2021 summary statistics for annual particles as PM_{10}

Regional performance monitoring station	Data availability rates (%)	Annual average (µg/m^3)
	AAQ NEPM standard	25 µg/m^3 (annual average)
Perth region		
Caversham (North East Metro)	97.4	13.2
Duncraig (North Metro)	97.7	13.2
Quinns Rocks (Outer North Coast)	97.4	17.2
South Lake (South East Metro)	99	14.5
Peel region		
Mandurah	95.8	22.2
South West region		
Albany	99.2	14.3
Bunbury	97.2	14.3
Busselton	98	15.2
Collie	96.8	17.0
Mid West region		
Geraldton	98.5	19.4
Goldfields region		
Kalgoorlie	90.6	11.3

Bold numerals indicate where a standard has been exceeded.

C.6 Particles as $PM_{2.5}$

The AAQ NEPM standard for particles as $PM_{2.5}$ of 25 µg/m^3 averaged over one day was exceeded in 2021, as detailed in Table A10. The Table C10 contains the summary statistics for daily $PM_{2.5}$.

Table C10 2021 summary statistics for 1-day particles as $PM_{2.5}$

AAQ NEPM standard
25 µg/m^3 (1-day average)

Regional Performance Monitoring Station	Data availability rates (%)	Highest		6th highest	
		(µg/m^3)	(date)	(µg/m^3)	(date)
Perth Region					
Caversham (North East Metro)	97.4	**88.3**	28/04/2021	**28.1**	19/04/2021
Duncraig (North Metro)	97.7	**96.6**	28/04/2021	**27.9**	25/04/2021
Quinns Rocks (Outer North Coast)	97.4	**42.2**	29/04/2021	24.7	12/10/2021
South Lake (South East Metro)	99	**92.2**	28/04/2021	**25.3**	25/04/2021
Peel Region					
Mandurah (Peel)	95.8	**87.9**	28/04/2021	23.4	21/04/2021
South West Region					
Bunbury (South West Region)	97.2	**83.1**	26/04/2021	23.5	30/11/2021
Busselton (South West Region)	98	**126.3**	26/04/2021	**27.9**	18/07/2021
Collie (South West Region)	23.7	**25.9**	18/10/2021	11.8	31/10/2021
Mid West Region					
Geraldton (Mid West Region)	98.5	**29.2**	05/01/2021	16.8	14/01/2021
Goldfields Region					
Kalgoorlie (Goldfields)	90.6	**34.0**	25/06/2021	21.0	01/07/2021

Bold numerals indicate where a standard has been exceeded.

Table C11 contains the summary statistics for annual $PM_{2.5}$ in WA.

Table C11 2021 summary statistics for annual particles as $PM_{2.5}$

Regional performance monitoring station	Data availability rates (%)	Annual average (µg/m³)
		AAQ NEPM standard 8 µg/m³ (annual average)
Perth region		
Caversham (North East Metro)	97.4	6.9
Duncraig (North Metro)	97.7	6.7
Quinns Rocks (Outer North Coast)	97.4	**9.7**
South Lake (South East Metro)	99	7.6
Peel region		
Mandurah	95.8	6.7
South West region		
Bunbury	97.2	6.5
Busselton	98	**8.4**
Collie	23.7	5.4
Mid West region		
Geraldton	98.5	7.0
Goldfields region		
Kalgoorlie	90.6	4.0

Bold numerals indicate where a standard has been exceeded.

D. Data analysis

D.1 Maxima and percentiles by pollutant in 2021

Table D1 2021 percentiles of daily peak eight-hour carbon monoxide concentrations

AAQ NEPM standard
9.0 ppm (eight-hour average)

Regional performance monitoring station	Data availability rates (%)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
Perth region								
Caversham (North East Metro)	97.5	1.2	0.9	0.7	0.5	0.4	0.3	0.2
Duncraig (North Metro)	94.9	1.5	1.2	1.1	0.8	0.6	0.4	0.2
South Lake (South East Metro)	96.8	1.5	1.2	1.1	0.8	0.6	0.3	0.2
Peel region								
Mandurah	94.6	1.6	0.6	0.6	0.5	0.4	0.2	0.2
Goldfields region								
Kalgoorlie	89.7	1.8	1.3	1.2	0.8	0.4	0.2	0.2

Table D2 2021 percentiles of daily peak one-hour nitrogen dioxide concentrations

AAQ NEPM standard
0.08 ppm (one-hour average)

Regional performance monitoring station	Data availability rates (%)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
Perth region								
Caversham (North East Metro)	99.3	0.034	0.029	0.027	0.024	0.021	0.016	0.011
Duncraig (North Metro)	94.6	0.033	0.028	0.027	0.025	0.024	0.020	0.013
Quinns Rocks (Outer North Coast)	99.7	0.033	0.031	0.030	0.026	0.022	0.016	0.010
Rockingham (South Coast)	99.8	0.037	0.028	0.027	0.025	0.023	0.016	0.011
Rolling Green (Outer East Rural)	98.9	0.020	0.017	0.014	0.012	0.010	0.007	0.004
South Lake (South East Metro)	98.4	0.034	0.030	0.029	0.026	0.024	0.019	0.014
Swanbourne (Inner West Coast)	99.4	0.033	0.027	0.027	0.024	0.019	0.013	0.009
Peel region								
Mandurah	96.4	0.021	0.019	0.017	0.014	0.011	0.007	0.004

Table D3 2021 percentiles of daily peak eight-hour ozone concentrations

AAQ NEPM standard
0.065 ppm (four-hour average)

Regional performance monitoring station	Data availability rates (%)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
Perth region								
Caversham (North East Metro)	99.6	**0.078**	0.050	0.046	0.041	0.036	0.031	0.027
Quinns Rocks (Outer North Coast)	99.5	**0.079**	0.050	0.047	0.042	0.038	0.034	0.030
Rockingham (South Coast)	99.5	0.064	0.057	0.053	0.043	0.038	0.034	0.030
Rolling Green (Outer East Rural)	97.4	**0.065**	0.050	0.047	0.043	0.037	0.032	0.029
South Lake (South East Metro)	99.8	0.059	0.046	0.042	0.038	0.034	0.030	0.026
Swanbourne (Inner West Coast)	99.7	**0.076**	0.056	0.053	0.047	0.041	0.035	0.032
Peel region								
Mandurah	98.1	0.061	0.056	0.045	0.040	0.035	0.032	0.028

Bold numerals indicate where a relevant standard has been exceeded.

Table D4 2021 percentiles of daily peak one-hour sulfur dioxide concentrations

AAQ NEPM standard
0.10 ppm (one-hour average)

Regional performance monitoring station	Data availability rates (%)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
Perth region								
Rockingham (South Coast)	97.8	0.016	0.008	0.006	0.005	0.005	0.004	0.003
South Lake (South East Metro)	98.1	0.007	0.005	0.004	0.003	0.003	0.002	0.001
Wattleup (South Metro)	94.2	0.032	0.022	0.018	0.007	0.003	0.002	0.002
Goldfields region								
Kalgoorlie	88.9	0.081	0.037	0.021	0.013	0.009	0.003	0.002

Table D5 2021 percentiles of daily peak 1-day sulfur dioxide concentrations

AAQ NEPM standard
0.02 ppm (one-day average)

Regional performance monitoring station	Data availability rates (%)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
Perth region								
Rockingham (South Coast)	97.8	0.006	0.005	0.005	0.004	0.004	0.003	0.002
South Lake (South East Metro)	98.1	0.002	0.002	0.002	0.001	0.001	0.001	0.001
Wattleup (South Metro)	94.2	0.004	0.003	0.002	0.002	0.002	0.001	0.001
Goldfields region								
Kalgoorlie	88.9	0.007	0.004	0.003	0.003	0.002	0.001	0.001

Table D6 2021 percentiles of daily peak 1-day particles as PM_{10} concentrations

AAQ NEPM standard
50 µg/m³ (1-day average)

Regional performance monitoring station	Data availability rates (%)	Max conc. (µg/m³)	99th percentile (µg/m³)	98th percentile (µg/m³)	95th percentile (µg/m³)	90th percentile (µg/m³)	75th percentile (µg/m³)	50th percentile (µg/m³)
Perth region								
Caversham (North East Metro)	97.4	**97.7**	37.5	32.9	24.3	20.3	15.6	11.5
Duncraig (North Metro)	97.7	**105.1**	39.6	31.1	22.8	18.8	15.3	12.1
South Lake (South East Metro)	99	**101.5**	34.9	31.1	24.7	21.8	17.4	13.2
Peel region								
Mandurah	95.8	**103.2**	**66.1**	**57.2**	**52.3**	40.9	28.0	18.4
South West region								
Albany	99.2	34.3	27.9	26.1	23.1	20.6	17.2	14.0
Bunbury	97.2	**89.6**	35.6	30.0	24.3	21.7	17.1	13.5
Busselton	98	**131.0**	46.0	34.7	27.8	24.7	18.1	13.2
Collie	96.8	**84.7**	48.8	36.1	28.3	25.3	19.6	15.3
Mid West region								
Geraldton	98.5	**119.7**	**52.0**	45.2	37.2	32.8	23.2	16.6
Goldfields region								
Kalgoorlie	90.6	42.7	29.1	27.4	23.2	19.0	14.1	10.5

Bold numerals indicate where a standard has been exceeded.

Table D7 2021 percentiles of daily peak 1-day particles as $PM_{2.5}$ concentrations

AAQ NEPM standard
25 µg/m³ (1-day average)

Regional performance monitoring station	Data availability rates (%)	Max conc. (µg/m³)	99th percentile (µg/m³)	98th percentile (µg/m³)	95th percentile (µg/m³)	90th percentile (µg/m³)	75th percentile (µg/m³)	50th percentile (µg/m³)
Perth region								
Caversham (North East Metro)	97.4	**88.3**	**31.7**	22.2	18.3	13.1	7.5	5.2
Duncraig (North Metro)	97.7	**96.6**	**31.0**	23.9	16.0	11.5	7.5	4.9
Quinns Rocks (Outer North Coast)	97.4	**42.2**	**28.3**	22.3	18.5	15.4	12.0	8.2
South Lake (South East Metro)	99	**92.2**	**26.1**	24.8	18.2	13.7	8.6	6.0
Peel region								
Mandurah	95.8	**87.9**	24.5	19.7	13.8	11.0	7.5	5.3
South West region								
Bunbury	97.2	**83.1**	**26.0**	20.0	16.5	12.2	7.5	4.8
Busselton	98	**126.3**	**29.5**	25.0	20.4	15.1	10.0	6.1
Collie	23.7	**25.9**	15.8	14.1	11.9	9.5	6.1	4.4
Mid West region								
Geraldton	98.5	**29.2**	17.9	16.2	12.4	11.2	7.9	6.3
Goldfields region								
Kalgoorlie	90.6	**34.0**	22.1	18.9	12.1	6.9	4.2	2.9

Bold numerals indicate where a standard has been exceeded.

D.2 Maxima and percentiles by site 2012-21

Table D8 Daily peak eight-hour carbon monoxide at Caversham (2012–21)
Trend station/region: Caversham

AAQ NEPM standard
9.0 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	98.0	0	0.9	0.7	0.6	0.5	0.4
2013	97.5	0	0.9	0.7	0.6	0.5	0.4
2014	96.1	0	0.7	0.7	0.6	0.5	0.4
2015	94.1	0	1.2	0.8	0.7	0.6	0.5
2016	99.2	0	0.9	0.6	0.6	0.5	0.4
2017	97.5	0	2.9	1.1	0.8	0.5	0.4
2018	97.4	0	1.1	0.7	0.6	0.5	0.4
2019	96.6	0	1.0	0.7	0.6	0.5	0.4
2020	97.1	0	1.6	0.9	0.7	0.5	0.4
2021	97.5	0	1.2	0.9	0.7	0.5	0.4

Table D9 Daily peak eight-hour carbon monoxide at Duncraig (2012–21)
Trend station/region: Duncraig

AAQ NEPM standard
9.0 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	99.5	0	2.4	1.9	1.5	1.1	0.9
2013	99.5	0	2.1	1.8	1.6	1.2	0.8
2014	99.7	0	1.9	1.4	1.0	0.8	0.7
2015	99.5	0	1.7	1.4	1.3	1.0	0.7
2016	99.8	0	1.4	1.2	1.1	0.8	0.7
2017	96.9	0	1.4	1.1	0.9	0.8	0.6
2018	98.7	0	1.5	1.2	1.0	0.8	0.7
2019	97.4	0	1.2	1.1	1.0	0.8	0.6
2020	97.4	0	1.2	1.0	0.9	0.7	0.6
2021	94.9	0	1.5	1.2	1.1	0.8	0.6

Table D10 Daily peak eight-hour carbon monoxide at South Lake (2012–21)
Trend station/region: South Lake

AAQ NEPM standard
9.0 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	98.9	0	2.2	1.6	1.4	1.0	0.8
2013	98.5	0	1.7	1.3	1.2	1.0	0.6
2014	99.5	0	1.8	1.4	1.0	0.8	0.7
2015	98.5	0	1.9	1.3	1.2	0.9	0.8
2016	99.8	0	2.3	1.3	1.1	0.9	0.7
2017	98.6	0	1.9	1.4	1.3	1.0	0.7
2018	99.7	0	1.9	1.3	1.3	1.0	0.9
2019	97.3	0	1.4	1.2	1.2	1.0	0.8
2020	96.6	0	1.4	1.1	1.0	0.8	0.6
2021	96.8	0	1.5	1.2	1.1	0.8	0.6

Table D11 Daily peak eight-hour carbon monoxide at Kalgoorlie (2012–21)

Campaign station/region: Kalgoorlie

AAQ NEPM standard
9.0 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-
2018	86.9	0	1.9	0.9	0.8	0.5	0.4
2019	95.5	0	2.1	1.1	1.0	0.8	0.5
2020	97.4	0	2.0	1.3	1.1	0.7	0.4
2021	89.7	0	1.8	1.3	1.2	0.8	0.4

Table D12 Daily peak eight-hour carbon monoxide at Mandurah (2012–21)

Campaign station/region: Mandurah

AAQ NEPM standard
9.0 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-
2020	96.6	0	1.8	0.6	0.5	0.4	0.3
2021	94.6	0	1.6	0.6	0.6	0.5	0.4

Table D13 Daily peak one-hour nitrogen dioxide at Caversham (2012–21)

Trend station/region: Caversham

AAQ NEPM standard
0.08 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	97.0	0	0.037	0.033	0.032	0.029	0.025
2013	97.5	0	0.043	0.034	0.032	0.029	0.025
2014	94.2	0	0.033	0.031	0.030	0.026	0.024
2015	94.6	0	0.041	0.035	0.032	0.027	0.025
2016	99.5	0	0.036	0.032	0.030	0.026	0.024
2017	95.3	0	0.042	0.032	0.031	0.028	0.025
2018	98.6	0	0.034	0.029	0.028	0.026	0.024
2019	98.4	0	0.039	0.030	0.028	0.025	0.023
2020	99.1	0	0.030	0.028	0.025	0.023	0.020
2021	99.3	0	0.034	0.029	0.027	0.024	0.021

Table D14 Daily peak one-hour nitrogen dioxide at Duncraig (2012–21)

Trend station/region: Duncraig

AAQ NEPM standard
0.08 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	96.8	0	0.047	0.037	0.033	0.030	0.027
2013	97.9	0	0.040	0.031	0.030	0.028	0.026
2014	99.3	0	0.048	0.029	0.028	0.026	0.024
2015	98.2	0	0.036	0.034	0.032	0.028	0.026
2016	99.8	0	0.033	0.029	0.028	0.026	0.024
2017	98.2	0	0.032	0.031	0.030	0.027	0.026
2018	97.1	0	0.036	0.031	0.030	0.027	0.025
2019	95.9	0	0.037	0.033	0.031	0.028	0.025
2020	99.3	0	0.031	0.030	0.028	0.026	0.025
2021	94.6	0	0.033	0.028	0.027	0.025	0.024

Table D15 Daily peak one-hour nitrogen dioxide at Quinns Rocks (2012–21)

Trend station/region: Quinns Rocks

AAQ NEPM standard
0.08 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	97.3	0	0.041	0.032	0.031	0.027	0.024
2013	97.9	0	0.032	0.026	0.026	0.023	0.020
2014	99.6	0	0.031	0.026	0.024	0.020	0.017
2015	98.8	0	0.030	0.028	0.026	0.024	0.020
2016	97.8	0	0.029	0.026	0.024	0.022	0.020
2017	21.5	0	0.019	0.017	0.016	0.015	0.014
2018	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-
2020	72.0	0	0.038	0.033	0.032	0.028	0.026
2021	99.7	0	0.033	0.031	0.030	0.026	0.022

Table D16 Daily peak one-hour nitrogen dioxide at Rockingham (2012–21)

Trend station/region: Rockingham

AAQ NEPM standard
0.08 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	96.4	0	0.053	0.030	0.030	0.027	0.024
2013	97.8	0	0.035	0.031	0.029	0.027	0.025
2014	98.7	0	0.034	0.027	0.026	0.024	0.021
2015	98.8	0	0.062	0.032	0.029	0.026	0.023
2016	99.3	0	0.029	0.027	0.026	0.024	0.022
2017	93.4	0	0.074	0.047	0.034	0.026	0.023
2018	82.2	0	0.029	0.026	0.025	0.023	0.020
2019	93.4	0	0.107	0.059	0.042	0.029	0.025
2020	96.6	0	0.041	0.028	0.027	0.024	0.021
2021	99.8	0	0.037	0.028	0.027	0.025	0.023

Table D17 Daily peak one-hour nitrogen dioxide at Rolling Green (2012–21)

Trend station/region: Rolling Green

AAQ NEPM standard
0.08 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	91.9	0	0.029	0.019	0.017	0.016	0.014
2013	96.5	0	0.030	0.018	0.017	0.015	0.013
2014	97.2	0	0.021	0.017	0.015	0.013	0.013
2015	98.0	0	0.023	0.018	0.017	0.016	0.013
2016	97.5	0	0.023	0.016	0.016	0.013	0.012
2017	99.1	0	0.018	0.017	0.016	0.014	0.013
2018	99.8	0	0.023	0.018	0.016	0.014	0.012
2019	99.6	0	0.023	0.015	0.015	0.012	0.011
2020	99.2	0	0.018	0.015	0.014	0.012	0.010
2021	98.9	0	0.020	0.017	0.014	0.012	0.010

Table D18 Daily peak one-hour nitrogen dioxide at South Lake (2012–21)

Trend station/region: South Lake

AAQ NEPM standard
0.08 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	98.7	0	0.046	0.038	0.035	0.031	0.028
2013	97.1	0	0.043	0.037	0.033	0.031	0.027
2014	99.5	0	0.034	0.032	0.029	0.028	0.026
2015	98.7	0	0.043	0.034	0.031	0.028	0.026
2016	95.0	0	0.038	0.030	0.029	0.027	0.025
2017	97.3	0	0.045	0.034	0.030	0.028	0.026
2018	98.9	0	0.047	0.035	0.033	0.029	0.027
2019	97.9	0	0.036	0.031	0.030	0.028	0.026
2020	99.1	0	0.036	0.031	0.028	0.025	0.024
2021	98.4	0	0.034	0.030	0.029	0.026	0.024

Table D19 Daily peak one-hour nitrogen dioxide at Swanbourne (2012–21)

Trend station/region: Swanbourne

AAQ NEPM standard
0.08 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	98.4	0	0.045	0.033	0.032	0.030	0.027
2013	99.6	0	0.037	0.033	0.031	0.027	0.025
2014	99.8	0	0.036	0.029	0.028	0.024	0.022
2015	99.5	0	0.036	0.034	0.030	0.027	0.023
2016	96.1	0	0.030	0.028	0.026	0.024	0.020
2017	99.8	0	0.033	0.032	0.030	0.026	0.022
2018	99.3	0	0.039	0.031	0.029	0.026	0.021
2019	98.9	0	0.037	0.031	0.029	0.026	0.022
2020	99.2	0	0.032	0.029	0.027	0.023	0.019
2021	99.4	0	0.033	0.027	0.027	0.024	0.019
2012	98.4	0	0.045	0.033	0.032	0.030	0.027

Table D20 Daily peak one-hour nitrogen dioxide at Mandurah (2012–21)

Trend station/region: Mandurah

AAQ NEPM standard
0.08 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-
2020	98.6	0	0.022	0.019	0.017	0.014	0.011
2021	96.4	0	0.021	0.019	0.017	0.014	0.011

Table D21 Daily peak eight-hour ozone at Caversham (2012–21)

Trend station/region: Caversham

AAQ NEPM standard
0.065 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	97.5	2	**0.076**	0.057	0.050	0.042	0.037
2013	95.7	0	0.060	0.056	0.052	0.043	0.039
2014	96.3	0	0.062	0.045	0.042	0.039	0.035
2015	95.4	1	**0.069**	0.060	0.057	0.047	0.039
2016	99.6	1	**0.073**	0.055	0.046	0.039	0.036
2017	98.7	0	0.061	0.056	0.053	0.043	0.039
2018	99.8	0	0.049	0.046	0.042	0.038	0.034
2019	98.6	0	0.054	0.051	0.049	0.042	0.036
2020	99.2	0	0.053	0.045	0.044	0.040	0.036
2021	99.6	1	**0.078**	0.050	0.046	0.041	0.036

Bold numerals indicate where a relevant standard has been exceeded.

Table D22 Daily peak eight-hour ozone at Quinns Rocks (2012–21)

Trend station/region: Quinns Rocks

AAQ NEPM standard
0.065 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	95.7	3	**0.084**	0.057	0.055	0.046	0.039
2013	99.2	2	**0.068**	0.060	0.054	0.047	0.041
2014	99.3	0	0.053	0.048	0.046	0.041	0.038
2015	98.9	0	0.061	0.058	0.055	0.047	0.038
2016	98.7	2	**0.072**	0.055	0.052	0.046	0.040
2017	21.5	0	0.057	0.053	0.049	0.046	0.043
2018	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-
2020	73.2	0	0.048	0.044	0.041	0.038	0.036
2021	99.5	1	**0.079**	0.050	0.047	0.042	0.038

Bold numerals indicate where a relevant standard has been exceeded.

Table D23 Daily peak eight-hour ozone at Rockingham (2012–21)

Trend station/region: Rockingham

AAQ NEPM standard
0.065 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	99.0	1	**0.066**	0.057	0.054	0.044	0.036
2013	98.8	1	**0.067**	0.054	0.049	0.043	0.037
2014	99.0	0	0.058	0.046	0.043	0.039	0.035
2015	98.9	0	0.061	0.053	0.050	0.043	0.037
2016	98.8	2	**0.072**	0.056	0.051	0.043	0.038
2017	99.1	0	0.052	0.050	0.049	0.041	0.036
2018	99.8	0	0.049	0.040	0.039	0.036	0.035
2019	97.2	0	0.059	0.053	0.047	0.040	0.036
2020	98.6	0	0.051	0.046	0.043	0.039	0.036
2021	98.6	0	0.065	0.050	0.048	0.042	0.037

Bold numerals indicate where a relevant standard has been exceeded.

Table D24 Daily peak eight-hour ozone at Rolling Green (2012–21)

Trend station/region: Rolling Green

AAQ NEPM standard
0.065 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	91.8	0	0.062	0.056	0.051	0.043	0.039
2013	96.8	1	**0.065**	0.055	0.050	0.045	0.039
2014	98.1	0	0.060	0.047	0.045	0.041	0.038
2015	99.2	2	**0.079**	0.056	0.053	0.048	0.044
2016	97.5	0	0.060	0.052	0.048	0.042	0.037
2017	98.6	0	0.055	0.049	0.046	0.039	0.035
2018	98.0	0	0.058	0.049	0.046	0.043	0.038
2019	97.9	1	**0.067**	0.059	0.055	0.049	0.042
2020	99.5	0	0.053	0.049	0.046	0.042	0.039
2021	97.4	1	**0.065**	0.050	0.047	0.043	0.037

Bold numerals indicate where a relevant standard has been exceeded.

Table D25 Daily peak eight-hour ozone at South Lake (2012–21)

Trend station/region: South Lake

AAQ NEPM standard
0.065 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	98.2	1	**0.070**	0.049	0.047	0.040	0.034
2013	98.6	0	0.065	0.051	0.047	0.041	0.035
2014	99.4	0	0.051	0.046	0.041	0.037	0.034
2015	98.8	0	0.055	0.049	0.048	0.039	0.033
2016	99.6	1	**0.069**	0.048	0.046	0.039	0.034
2017	98.5	0	0.057	0.050	0.047	0.040	0.035
2018	99.6	0	0.046	0.039	0.036	0.032	0.030
2019	98.1	0	0.060	0.049	0.044	0.037	0.032
2020	99.3	0	0.047	0.044	0.040	0.036	0.032
2021	99.8	0	0.059	0.046	0.042	0.038	0.034

Bold numerals indicate where a relevant standard has been exceeded.

Table D26 Daily peak eight-hour ozone at Swanbourne (2012–21)

Trend station/region: Swanbourne

AAQ NEPM standard
0.065 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	98.2	1	**0.085**	0.057	0.053	0.046	0.039
2013	99.8	0	0.059	0.053	0.049	0.043	0.038
2014	97.8	0	0.049	0.045	0.043	0.039	0.035
2015	99.9	0	0.062	0.053	0.051	0.043	0.036
2016	98.7	2	**0.069**	0.055	0.052	0.046	0.039
2017	99.5	0	0.065	0.054	0.051	0.047	0.042
2018	99.8	0	0.053	0.047	0.043	0.041	0.039
2019	98.7	0	0.058	0.051	0.047	0.043	0.038
2020	99.7	0	0.053	0.051	0.048	0.044	0.041
2021	99.7	1	**0.076**	0.056	0.053	0.047	0.041

Bold numerals indicate where a relevant standard has been exceeded.

Table D27 Daily peak eight-hour ozone at Mandurah (2012–21)

Trend station/region: Mandurah

AAQ NEPM standard
0.065 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-
2020	98.9	0	0.053	0.046	0.043	0.040	0.037
2021	98.1	0	0.061	0.056	0.045	0.040	0.035

Table D28 Daily peak one-hour sulfur dioxide at Rockingham (2012–21)

Trend station/region: Rockingham

AAQ NEPM standard
0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	94.4	0	0.040	0.020	0.018	0.011	0.008
2013	94.5	0	0.037	0.028	0.022	0.016	0.011
2014	93.9	0	0.036	0.024	0.021	0.013	0.008
2015	94.6	0	0.051	0.033	0.023	0.018	0.012
2016	96.1	0	0.064	0.041	0.035	0.020	0.013
2017	95.8	0	0.030	0.024	0.017	0.012	0.008
2018	95.4	0	0.031	0.021	0.019	0.013	0.008
2019	94.7	0	0.034	0.023	0.020	0.015	0.011
2020	92.4	0	0.037	0.024	0.018	0.008	0.006
2021	97.8	0	0.016	0.008	0.006	0.005	0.005

Table D29 Daily peak one-hour sulfur dioxide at South Lake (2012–21)

Trend station/region: South Lake

AAQ NEPM standard
0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	94.0	0	0.039	0.027	0.019	0.014	0.010
2013	93.3	0	0.044	0.034	0.031	0.020	0.015
2014	94.5	0	0.051	0.028	0.024	0.016	0.012
2015	95.5	0	0.037	0.031	0.029	0.020	0.016
2016	97.4	0	0.034	0.020	0.017	0.014	0.011
2017	95.2	0	0.037	0.023	0.019	0.017	0.013
2018	97.4	0	0.022	0.016	0.015	0.012	0.010
2019	97.3	0	0.019	0.016	0.014	0.012	0.010
2020	99.2	0	0.010	0.009	0.009	0.008	0.006
2021	98.1	0	0.007	0.005	0.004	0.003	0.003

Table D30 Daily peak one-hour sulfur dioxide at Wattleup (2012–21)

Trend station/region: Wattleup

AAQ NEPM standard
0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	94.7	0	0.043	0.039	0.034	0.025	0.017
2013	92.5	0	0.090	0.059	0.047	0.037	0.027
2014	95.1	0	0.061	0.046	0.037	0.031	0.024
2015	95.6	0	0.067	0.046	0.045	0.039	0.031
2016	94.5	0	0.072	0.055	0.048	0.033	0.025
2017	96.3	0	0.068	0.051	0.036	0.026	0.021
2018	97.0	0	0.038	0.033	0.029	0.023	0.017
2019	95.2	0	0.057	0.031	0.029	0.023	0.018
2020	92.0	0	0.044	0.032	0.027	0.022	0.016
2021	94.2	0	0.032	0.022	0.018	0.007	0.003

Table D31 Daily peak one-hour sulfur dioxide at Kalgoorlie (2012–21)

Trend station/region: Goldfields

AAQ NEPM standard
0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-
2018	92.2	1	**0.106**	0.060	0.038	0.019	0.014
2019	95.7	0	0.082	0.053	0.038	0.020	0.012
2020	95.6	0	0.075	0.055	0.046	0.022	0.012
2021	88.9	0	0.081	0.037	0.021	0.013	0.009

Bold numerals indicate where a relevant standard has been exceeded.

Table D32 Daily peak 1-day sulfur dioxide at Rockingham (2012–21)

Trend station/region: Rockingham

AAQ NEPM standard
0.02 ppm (1-day average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	94.4	0	0.006	0.005	0.003	0.002	0.002
2013	94.5	0	0.007	0.005	0.004	0.003	0.002
2014	93.9	0	0.007	0.005	0.004	0.003	0.002
2015	94.6	0	0.013	0.007	0.006	0.004	0.003
2016	96.1	0	0.014	0.010	0.007	0.004	0.002
2017	95.8	0	0.009	0.004	0.003	0.003	0.002
2018	95.4	0	0.007	0.004	0.004	0.003	0.002
2019	94.7	0	0.009	0.005	0.004	0.003	0.002
2020	92.4	0	0.008	0.004	0.003	0.002	0.002
2021	97.8	0	0.006	0.005	0.005	0.004	0.004

Table D33 Daily peak 1-day sulfur dioxide at South Lake (2012–21)

Trend station/region: South Lake

AAQ NEPM standard
0.02 ppm (1-day average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	94.0	0	0.006	0.004	0.003	0.003	0.002
2013	93.3	0	0.014	0.005	0.004	0.003	0.002
2014	94.5	0	0.010	0.005	0.004	0.003	0.003
2015	95.5	0	0.007	0.006	0.005	0.005	0.004
2016	97.4	0	0.010	0.007	0.007	0.006	0.005
2017	95.2	0	0.009	0.008	0.008	0.006	0.005
2018	97.4	0	0.005	0.004	0.004	0.004	0.003
2019	97.3	0	0.006	0.005	0.005	0.004	0.004
2020	99.2	0	0.006	0.005	0.005	0.004	0.003
2021	98.1	0	0.002	0.002	0.002	0.001	0.001

Table D34 Daily peak 1-day sulfur dioxide at Wattleup (2012–21)

Trend station/region: Wattleup

AAQ NEPM standard
0.02 ppm (1-day average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	94.7	0	0.008	0.005	0.004	0.003	0.002
2013	92.5	0	0.010	0.008	0.006	0.005	0.004
2014	95.1	0	0.008	0.007	0.006	0.005	0.004
2015	95.6	0	0.009	0.007	0.006	0.006	0.005
2016	94.5	0	0.011	0.006	0.005	0.004	0.003
2017	96.3	0	0.007	0.005	0.005	0.004	0.003
2018	97.0	0	0.007	0.006	0.005	0.004	0.003
2019	95.2	0	0.008	0.005	0.005	0.004	0.003
2020	92.0	0	0.006	0.005	0.004	0.003	0.003
2021	94.2	0	0.004	0.003	0.002	0.002	0.002

Table D35 Daily peak 1-day sulfur dioxide at Kalgoorlie (2012–21)

Trend station/region: Goldfields

AAQ NEPM standard
0.02 ppm (1-day average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2012	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-
2019	95.7	0	0.012	0.005	0.004	0.003	0.002
2020	95.6	0	0.011	0.006	0.004	0.003	0.002
2021	88.9	0	0.007	0.004	0.003	0.003	0.002

Table D36 Daily peak 1-day particles as PM_{10} at Caversham (2012–21)

Trend station/region: Caversham

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

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (µg/m^3)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	97.8	4	**68.7**	49.2	36.7	27.2	24.4
2013	97.4	1	**62.4**	34.4	30.7	26.2	23.6
2014	97.2	1	**52.6**	37.3	34.5	27.2	24.8
2015	95.7	0	46.8	40.7	37.4	30.4	26.3
2016	99.1	0	38.1	33.7	31.5	26.4	22.8
2017	98.6	3	**79.2**	43.3	32.6	27.8	25.0
2018	98.9	2	**77.9**	36.1	33.2	27.8	25.0
2019	82.1	1	**107.7**	42.1	38.1	29.6	27.0
2020	97.8	3	**71.5**	43.1	36.9	28.0	24.3
2021	97.4	3	**97.7**	37.5	32.9	24.3	20.3

Bold numerals indicate where a relevant standard has been exceeded.

Table D37 Daily peak 1-day particles as PM_{10} at Duncraig (2012–21)

Trend station/region: Duncraig

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

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (µg/m^3)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	99.4	2	**89.5**	35.5	28.3	26.1	23.0
2013	99.3	0	37.6	32.1	28.1	25.6	22.8
2014	99.4	1	**53.0**	31.2	28.1	25.1	22.4
2015	99.4	1	**82.7**	40.1	36.7	28.0	25.2
2016	99.6	0	40.0	34.2	29.7	25.8	21.8
2017	98.4	1	**51.4**	33.4	30.1	26.4	22.5
2018	99.3	1	**61.3**	33.1	28.0	24.1	21.4
2019	96.0	1	**68.1**	30.7	27.2	23.7	22.2
2020	97.8	1	**61.8**	30.7	24.9	23.3	19.5
2021	97.7	2	**105.1**	39.6	31.1	22.8	18.8

Bold numerals indicate where a relevant standard has been exceeded.

Table D38 Daily peak 1-day particles as PM_{10} at South Lake (2012–2021)

Trend station/region: South Lake

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

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (µg/m^3)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	99.1	2	**81.5**	36.6	30.3	28.5	24.1
2013	98.6	0	38.8	34.4	32.3	28.9	25.9
2014	99.4	0	44.5	38.2	34.0	29.4	26.3
2015	97.4	2	**53.3**	45.7	41.7	34.4	28.5
2016	99.5	0	47.0	38.7	33.4	28.9	24.3
2017	98.2	0	49.6	37.7	31.3	28.6	26.2
2018	99.6	1	**57.1**	40.7	34.3	26.7	23.7
2019	98.6	2	**98.8**	40.4	37.0	30.7	26.7
2020	99.0	0	45.2	32.8	31.8	25.3	21.7
2021	99.0	1	**101.5**	34.9	31.1	24.7	21.8

Bold numerals indicate where a relevant standard has been exceeded.

Table D39 Daily peak 1-day particles as PM_{10} at Mandurah (2012–21)

Trend station/region: Mandurah

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

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (µg/m^3)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-
2020	96.5	30	**84.4**	**71.9**	**65.3**	**57.3**	48.5
2021	95.8	19	**103.2**	**66.1**	**57.2**	**52.3**	40.9

Bold numerals indicate where a relevant standard has been exceeded.

Table D40 Daily peak 1-day particles as PM_{10} at Albany (2012–21)

Trend station/region: Albany

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

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (µg/m^3)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	99.5	0	37.0	34.6	31.1	27.4	23.6
2013	98.1	3	**110.8**	43.3	36.0	29.1	23.8
2014	98.6	0	43.5	35.5	31.4	28.1	24.4
2015	99.1	2	**76.7**	37.3	34.7	28.4	24.5
2016	95.5	6	**94.9**	**56.5**	45.2	35.1	28.7
2017	99.5	2	**61.8**	46.7	41.4	30.7	25.8
2018	93.5	2	**89.6**	43.9	30.1	26.3	21.8
2019	98.2	1	**128.5**	35.5	30.9	27.1	22.5
2020	98.4	0	37.2	32.7	29.3	25.9	21.3
2021	99.2	0	34.3	27.9	26.1	23.1	20.6

Bold numerals indicate where a relevant standard has been exceeded.

Table D41 Daily peak 1-day particles as PM_{10} at Bunbury (2012–21)

Trend station/region: Bunbury

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

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (µg/m^3)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	99.5	2	**53.5**	40.0	32.9	26.5	24.1
2013	98.9	0	46.8	38.1	33.5	26.8	22.6
2014	98.1	0	44.5	31.7	26.2	24.6	22.8
2015	99.7	3	**62.9**	48.6	40.6	35.6	27.2
2016	97.5	2	**74.6**	44.4	33.0	28.6	24.9
2017	99.6	0	45.5	36.1	32.9	27.8	24.5
2018	99.6	1	**51.9**	37.8	35.2	27.8	24.4
2019	98.9	3	**131.0**	38.4	31.8	26.8	23.6
2020	95.1	1	**61.1**	41.7	34.9	28.7	24.2
2021	97.2	1	**89.6**	35.6	30.0	24.3	21.7

Bold numerals indicate where a relevant standard has been exceeded.

Table D42 Daily peak 1-day particles as PM_{10} at Collie (2012–21)

Trend station/region: Collie

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

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (µg/m^3)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	99.4	6	**91.7**	**54.9**	46.9	35.1	30.1
2013	99.0	3	**61.6**	46.0	41.3	36.0	32.0
2014	99.3	2	**73.3**	42.2	38.8	34.0	29.8
2015	99.0	10	**111.9**	**67.4**	**53.9**	41.9	37.8
2016	99.5	5	**89.9**	**51.0**	46.9	38.6	30.4
2017	96.8	11	**81.5**	**56.3**	**53.7**	42.5	33.7
2018	98.9	10	**84.6**	**57.4**	**52.4**	39.6	30.8
2019	99.7	7	**83.5**	**60.4**	48.6	39.5	33.9
2020	96.6	5	**130.9**	**57.0**	41.9	35.0	27.4
2021	96.8	4	**84.7**	48.8	36.1	28.3	25.3

Bold numerals indicate where a relevant standard has been exceeded.

Table D43 Daily peak 1-day particles as PM_{10} at Geraldton (2012–21)

Trend station/region: Geraldton

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

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (µg/m^3)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	99.6	3	**61.5**	47.0	45.3	40.2	33.8
2013	99.3	2	**63.1**	45.9	42.1	38.9	34.6
2014	98.8	4	**55.7**	49.7	47.1	41.4	37.5
2015	98.9	5	**68.1**	**54.5**	44.4	39.8	35.2
2016	96.7	3	**66.0**	49.3	42.1	37.3	32.1
2017	99.8	3	**73.5**	44.3	40.0	36.9	33.7
2018	96.0	3	**70.0**	42.2	41.0	36.7	31.8
2019	99.5	6	**88.4**	**51.5**	46.0	39.4	35.2
2020	98.5	3	**445.6**	47.1	43.5	38.3	33.4
2021	98.5	6	**119.7**	**52.0**	45.2	37.2	32.8

Bold numerals indicate where a relevant standard has been exceeded.

Table D44 Daily peak 1-day particles as PM_{10} at Kalgoorlie (2012–21)

Trend station/region: Kalgoorlie

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

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (µg/m^3)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-
2018	93.6	1	**60.5**	31.8	29.3	22.8	20.6
2019	97.7	4	**67.6**	46.6	41.4	31.8	27.2
2020	98.2	4	**77.3**	49.3	39.1	31.8	24.3
2021	90.6	0	42.7	29.1	27.4	23.2	19.0

Bold numerals indicate where a relevant standard has been exceeded.

Table D45 Daily peak 1-day particles as $PM_{2.5}$ at Caversham (2012–21)

Trend station/region: Caversham

AAQ NEPM standard
25 µg/m^3 (1-day average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (µg/m^3)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	96.9	3	**45.9**	19.2	15.9	12.3	10.6
2013	97.4	0	22.6	17.2	16.4	13.6	11.6
2014	97.0	1	**39.3**	16.2	15.2	14.1	11.9
2015	95.8	5	**30.0**	**27.2**	22.4	16.1	12.8
2016	99.5	0	24.1	17.0	14.2	12.6	10.9
2017	98.7	5	**65.9**	**31.3**	21.8	15.7	11.8
2018	99.5	2	**36.7**	20.6	17.3	14.8	11.6
2019	82.1	1	25.4	18.2	17.3	15.2	12.4
2020	97.8	9	**60.9**	**30.9**	**27.9**	17.6	14.6
2021	97.4	6	**88.3**	**31.7**	22.2	18.3	13.1

Bold numerals indicate where a relevant standard has been exceeded.

Table D46 Daily peak 1-day particles as $PM_{2.5}$ at Duncraig (2012–21)

Trend station/region: Duncraig

AAQ NEPM standard
25 µg/m^3 (1-day average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (µg/m^3)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	97.5	3	**77.3**	22.0	14.4	12.7	11.0
2013	98.5	0	18.7	15.6	14.4	12.7	11.4
2014	99.7	1	**47.6**	16.8	15.3	13.0	11.0
2015	99.6	3	**35.8**	22.9	18.3	15.2	12.9
2016	99.4	1	**27.0**	15.9	15.4	12.0	10.9
2017	98.5	3	**40.5**	22.9	19.0	14.2	11.5
2018	99.4	1	**48.6**	19.3	15.6	12.9	11.1
2019	97.3	0	25.0	20.2	15.9	13.9	11.6
2020	98.6	2	**37.2**	18.1	16.3	11.7	9.8
2021	97.7	6	**96.6**	**31.0**	23.9	16.0	11.5

Bold numerals indicate where a relevant standard has been exceeded.

Table D47 Daily peak 1-day particles as $PM_{2.5}$ at Quinns Rocks (2012–21)

Trend station/region: Quinns Rocks

AAQ NEPM standard
25 µg/m^3 (1-day average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (µg/m^3)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	96.5	4	**74.5**	22.7	14.3	11.9	10.6
2013	98.5	0	19.3	16.6	15.0	13.1	10.9
2014	98.8	2	**39.5**	15.8	14.5	13.4	11.7
2015	98.9	2	**37.9**	22.2	20.9	14.8	12.4
2016	98.7	2	**28.8**	18.4	14.8	12.7	10.8
2017	20.7	0	12.2	12.2	11.8	11.1	10.8
2018	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-
2020	70.7	1	**39.8**	19.7	16.9	11.2	10.4
2021	97.4	5	**42.2**	**28.3**	22.3	18.5	15.4

Bold numerals indicate where a relevant standard has been exceeded.

Table D48 Daily peak 1-day particles as $PM_{2.5}$ at Mandurah (2012–21)

Trend station/region: Mandurah

AAQ NEPM standard
25 µg/m^3 (1-day average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (µg/m^3)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-
2020	96.5	5	**53.8**	**26.5**	22.0	20.0	17.1
2021	95.8	3	**87.9**	24.5	19.7	13.8	11.0

Bold numerals indicate where a relevant standard has been exceeded.

Table D49 Daily peak 1-day particles as $PM_{2.5}$ at South Lake (2012–21)

Trend station/region: South Lake

AAQ NEPM standard
25 µg/m^3 (1-day average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (µg/m^3)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	99.0	4	**71.6**	25.0	19.3	14.6	13.2
2013	98.6	0	17.1	15.2	14.9	14.0	11.7
2014	98.7	2	**29.8**	17.7	15.0	13.4	11.5
2015	97.0	5	**34.5**	**29.8**	22.8	17.0	13.4
2016	99.6	3	**30.4**	17.2	15.3	13.1	11.6
2017	98.4	3	**46.6**	24.2	19.8	14.5	12.8
2018	99.7	5	**43.3**	**27.6**	20.2	15.0	12.3
2019	98.7	2	**28.9**	18.0	16.0	13.5	12.4
2020	99.0	4	**34.6**	24.7	21.8	14.3	11.3
2021	99.0	7	**92.2**	**26.1**	24.8	18.2	13.7

Bold numerals indicate where a relevant standard has been exceeded.

Table D50 Daily peak 1-day particles as $PM_{2.5}$ at Bunbury (2012–21)

Trend station/region: Bunbury

AAQ NEPM standard
25 µg/m^3 (1-day average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (µg/m^3)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	99.6	7	**43.0**	**26.3**	21.0	14.9	12.8
2013	99.3	1	**38.3**	16.6	15.7	14.0	11.5
2014	98.4	1	**34.6**	16.1	15.0	13.3	11.7
2015	97.6	9	**52.1**	**35.0**	**30.2**	20.2	14.4
2016	99.7	6	**61.5**	**33.6**	22.4	14.9	12.2
2017	99.5	6	**33.9**	**27.2**	21.5	14.3	12.7
2018	99.7	5	**38.4**	**26.0**	22.2	17.2	12.5
2019	99.0	6	**118.2**	**27.3**	22.5	14.2	12.1
2020	95.2	11	**55.5**	**31.4**	**27.5**	22.1	16.4
2021	97.2	4	**83.1**	**26.0**	20.0	16.5	12.2

Bold numerals indicate where a relevant standard has been exceeded.

Table D51 Daily peak 1-day particles as $PM_{2.5}$ at Busselton (2012–21)

Trend station/region: Busselton

AAQ NEPM standard
25 µg/m^3 (1-day average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	99.6	5	**78.0**	**27.1**	21.4	13.4	11.8
2013	98.6	0	17.9	16.6	15.5	12.9	10.9
2014	99.6	1	**25.1**	13.2	12.4	11.1	10.2
2015	99.1	4	**37.8**	24.4	21.3	18.6	13.9
2016	99.5	4	**61.1**	22.8	17.5	13.7	11.3
2017	97.8	1	**28.8**	22.8	18.0	14.9	12.2
2018	97.0	7	**56.5**	**28.9**	22.2	16.4	11.3
2019	97.8	5	**78.5**	**29.4**	21.6	13.2	11.0
2020	84.0	5	**37.1**	**27.7**	21.2	16.2	14.2
2021	98.0	8	**126.3**	**29.5**	25.0	20.4	15.1

Bold numerals indicate where a relevant standard has been exceeded.

Table D52 Daily peak 1-day particles as $PM_{2.5}$ at Kalgoorlie (2012–21)

Trend station/region: Kalgoorlie

AAQ NEPM standard
25 µg/m^3 (1-day average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-
2018	93.6	1	**36.2**	16.4	14.0	10.2	8.2
2019	97.7	3	**40.8**	24.1	22.1	16.6	12.8
2020	99.3	2	**33.3**	22.0	19.9	13.4	8.9
2021	90.6	2	**34.0**	22.1	18.9	12.1	6.9

Bold numerals indicate where a relevant standard has been exceeded.

Table D53 Daily peak 1-day particles as $PM_{2.5}$ at Geraldton (2012–21)

Trend station/region: Geraldton

AAQ NEPM standard
25 µg/m^3 (1-day average)

Year	Data recovery (%)	No. of exceedances (days)	Max conc. (ppm)	99th percentile (µg/m^3)	98th percentile (µg/m^3)	95th percentile (µg/m^3)	90th percentile (µg/m^3)
2012	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-
2019	99.4	0	18.4	16.5	14.6	13.3	11.8
2020	96.4	1	**162.3**	17.2	15.8	14.1	12.1
2021	98.5	2	**29.2**	17.9	16.2	12.4	11.2

Bold numerals indicate where a relevant standard has been exceeded.

D.3 Maxima by pollutant 2012–21

Table D54 Peak eight-hour carbon monoxide concentrations (ppm) for 2012–21

AAQ NEPM standard
9.0 ppm (eight-hour average)

Regional performance monitoring station	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Perth region										
Caversham (North East Metro)	0.9	0.9	0.7	1.2	0.9	2.9	1.1	1.0	1.6	1.2
Duncraig (North Metro)	2.4	2.1	1.9	1.7	1.4	1.4	1.5	1.2	1.2	1.5
South Lake (South East Metro)	2.2	1.7	1.8	1.9	2.3	1.9	1.9	1.4	1.4	1.5
Peel region										
Mandurah	-	-	-	-	-	-	-	-	1.8	1.6
Goldfields region										
Kalgoorlie	-	-	-	-	-	-	1.9	2.1	2.0	1.8

Table D55 Peak one-hour nitrogen dioxide concentrations (ppm) for 2012–21

AAQ NEPM standard
0.08 ppm (one-hour average)

Regional performance monitoring station	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Perth region										
Caversham (North East Metro)	0.037	0.043	0.033	0.041	0.036	0.042	0.034	0.039	0.030	0.034
Duncraig (North Metro)	0.047	0.040	0.048	0.036	0.033	0.032	0.036	0.037	0.031	0.033
Quinns Rocks (Outer North Coast)	0.041	0.032	0.031	0.030	0.029	0.019	-	-	0.038	0.033
Rockingham (South Coast)	0.053	0.035	0.034	0.062	0.029	0.074	0.029	0.107	0.041	0.037
Rolling Green (Outer East Rural)	0.029	0.030	0.021	0.023	0.023	0.018	0.023	0.023	0.018	0.020
South Lake (South East Metro)	0.046	0.043	0.034	0.043	0.038	0.045	0.047	0.036	0.036	0.034
Swanbourne (Inner West Coast)	0.045	0.037	0.036	0.036	0.030	0.033	0.039	0.037	0.032	0.033
Peel region										
Mandurah	-	-	-	-	-	-	-	-	0.022	0.021

Table D56 Peak eight-hour ozone concentrations (ppm) for 2012–21

AAQ NEPM standard
0.065 ppm (one-hour average)

Regional performance monitoring station	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Perth region										
Caversham (North East Metro)	**0.076**	0.060	0.062	**0.069**	**0.073**	0.061	0.049	0.054	0.053	**0.078**
Quinns Rocks (Outer North Coast)	**0.084**	**0.068**	0.053	0.061	**0.072**	0.057	-	-	0.048	**0.079**
Rockingham (South Coast)	**0.066**	**0.067**	0.058	0.061	**0.072**	0.052	0.049	0.059	0.051	0.065
Rolling Green (Outer East Rural)	0.062	0.065	0.060	**0.079**	0.060	0.055	0.058	**0.067**	0.053	**0.065**
South Lake (South East Metro)	**0.070**	0.065	0.051	0.055	**0.069**	0.057	0.046	0.060	0.047	0.059
Swanbourne (Inner West Coast)	**0.085**	0.059	0.049	0.062	**0.069**	0.065	0.053	0.058	0.053	**0.076**
Peel region										
Mandurah	-	-	-	-	-	-	-	-	0.053	0.061

Bold numerals indicate where a relevant standard has been exceeded.

Table D57 Peak one-hour sulfur dioxide concentrations (ppm) for 2012–21

AAQ NEPM standard
0.10 ppm (one-hour average)

Regional performance monitoring station	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Perth region										
Rockingham (South Coast)	0.040	0.037	0.036	0.051	0.064	0.030	0.031	0.034	0.037	0.016
South Lake (South East Metro)	0.039	0.044	0.051	0.037	0.034	0.037	0.022	0.019	0.010	0.007
Wattleup (South Metro)	0.043	0.090	0.061	0.067	0.072	0.068	0.038	0.057	0.044	0.032
Goldfields region										
Kalgoorlie	-	-	-	-	-	-	**0.106**	0.082	0.075	0.081

Bold numerals indicate where a relevant standard has been exceeded.

Table D58 Peak 1-day sulfur dioxide concentrations (ppm) for 2012–21

AAQ NEPM standard
0.02 ppm (1-day average)

Regional performance monitoring station	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Perth region										
Rockingham (South Coast)	0.006	0.007	0.007	0.013	0.014	0.009	0.007	0.009	0.008	0.006
South Lake (South East Metro)	0.006	0.014	0.010	0.007	0.010	0.009	0.005	0.006	0.006	0.002
Wattleup (South Metro)	0.008	0.010	0.008	0.009	0.011	0.007	0.007	0.008	0.006	0.004
Goldfields region										
Kalgoorlie	-	-	-	-	-	-	0.008	0.012	0.011	0.007

Table D59 Peak 1-day particles as PM_{10} concentrations ($\mu g/m^3$) for 2012–21

AAQ NEPM standard
50 $\mu g/m^3$ (1-day average)

Regional performance monitoring station	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Perth Region										
Caversham (North East Metro)	**68.7**	**62.4**	**52.6**	46.8	38.1	**79.2**	**77.9**	**107.7**	**71.5**	**97.7**
Duncraig (North Metro)	**89.5**	37.6	**53.0**	**82.7**	40.0	**51.4**	**61.3**	**68.1**	**61.8**	**105.1**
South Lake (South East Metro)	-	-	-	-	-	-	-	-	**77.7**	47.6
Quinns Rocks (Outer North Coast)	**81.5**	38.8	44.5	**53.3**	47.0	49.6	**57.1**	**98.8**	45.2	**101.5**
Peel region										
Mandurah	-	-	-	-	-	-	-	-	**84.4**	**103.2**
South West region										
Bunbury	**53.5**	46.8	44.5	**62.9**	**74.6**	45.5	**51.9**	**131.0**	**61.1**	**89.6**
Collie	**91.7**	**61.6**	**73.3**	**111.9**	**89.9**	**81.5**	**84.6**	**83.5**	**130.9**	**84.7**
Albany	37.0	**110.8**	43.5	**76.7**	**94.9**	**61.8**	**89.6**	**128.5**	37.2	34.3
Mid West region										
Geraldton	**61.5**	**63.1**	**55.7**	**68.1**	**66.0**	**73.5**	**70.0**	**88.4**	**445.6**	**119.7**
Goldfields region										
Kalgoorlie	-	-	-	-	-	-	**60.5**	**67.6**	**77.3**	42.7

Bold numerals indicate where a relevant standard has been exceeded.
For explanation of this year's exceedances, please see Table A10 of this report.
For explanation of exceedances in previous years, please refer to the relevant year's report.

Table D60 Peak 1-day particles as $PM_{2.5}$ concentrations ($\mu g/m^3$) for 2012–21

AAQ NEPM standard
25 $\mu g/m^3$ (1-day average)

Regional performance monitoring station	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Perth region										
Caversham (North East Metro)	**45.9**	22.6	**39.3**	**30.0**	24.1	**65.9**	**36.7**	**25.4**	**60.9**	**88.3**
Duncraig (North Metro)	**77.3**	18.7	**47.6**	**35.8**	**27.0**	**40.5**	**48.6**	25.0	**37.2**	**96.6**
Quinns Rocks (Outer North Coast)	**74.5**	19.3	**39.5**	**37.9**	**28.8**	12.2	-	-	**39.8**	**42.2**
South Lake (South East Metro)	**71.6**	17.1	**29.8**	**34.5**	**30.4**	**46.6**	**43.3**	**28.9**	**34.6**	**92.2**
Peel region										
Mandurah	-	-	-	-	-	-	-	-	**53.8**	**87.9**
South West region										
Bunbury	**43.0**	**38.3**	**34.6**	**52.1**	**61.5**	**33.9**	**38.4**	**118.2**	**55.5**	**83.1**
Busselton	**78.0**	17.9	**25.1**	**37.8**	**61.1**	**28.8**	**56.5**	**78.5**	**37.1**	**126.3**
Albany	-	-	-	-	-	-	-	-	-	**25.9**
Mid West region										
Geraldton	-	-	-	-	-	-	-	18.4	**162.3**	**29.2**
Goldfields region										
Kalgoorlie	-	-	-	-	-	-	**36.2**	**40.8**	**33.3**	**34.0**

Bold numerals indicate where a relevant standard has been exceeded.
For explanation of this year's exceedances, please see Table A10 of this report.
For explanation of exceedances in previous years, please refer to the relevant year's report.

Table D61 Annual averaged particles as PM_{10} concentrations ($\mu g/m^3$) for 2012–21

AAQ NEPM standard
25 $\mu g/m^3$ (annual average)

Regional performance monitoring station	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Perth region										
Caversham (North East Metro)	16.8	15.4	17.4	16.7	15.0	16.1	16.3	18.7	15.1	13.2
Duncraig (North Metro)	16.2	15.5	15.5	16.5	14.4	15.7	15.1	14.8	13.4	13.2
South Lake (South East Metro)	16.9	16.6	17.4	17.9	15.8	16.7	16.3	17.7	13.9	14.5
Peel Region										
Mandurah	-	-	-	-	-	-	-	-	**26.6**	22.2
South West region										
Bunbury	17.5	16.8	16.1	17.5	16.5	16.5	16.1	16.6	15.5	14.3
Collie	20.0	20.1	19.2	22.4	19.3	21.7	19.3	22.0	18.1	17.0
Albany	15.0	15.4	16.0	15.9	17.5	16.6	14.6	15.3	14.2	14.3
Mid West region										
Geraldton	21.3	20.9	22.3	20.2	18.8	21.3	20.1	22.2	20.9	19.4
Goldfields region										
Kalgoorlie	-	-	-	-	-	-	12.8	15.2	14.2	11.3

Bold numerals indicate where a relevant standard has been exceeded.

Table D62: Annual averaged particles as $PM_{2.5}$ concentrations ($\mu g/m^3$) for 2012–21

AAQ NEPM standard
8 $\mu g/m^3$ (annual average)

Regional performance monitoring station	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Perth region										
Caversham (North East Metro)	7.8	7.9	**8.1**	**8.5**	7.7	**8.5**	8.0	**8.3**	7.8	6.9
Duncraig (North Metro)	**8.2**	7.6	7.6	**8.4**	7.5	**8.2**	7.7	7.4	6.3	6.7
Quinns Rocks (Outer North Coast)	7.9	7.8	8.0	**8.3**	7.5	7.8	-	-	5.4	**9.7**
South Lake (Outer North Coast)	**8.9**	8.0	**8.1**	**8.8**	8.0	**8.7**	**8.4**	**8.2**	7.2	7.6
Peel region										
Mandurah	-	-	-	-	-	-	-	-	**10.0**	6.7
South West region										
Bunbury	**8.6**	7.8	7.8	**9.3**	**8.4**	**8.7**	**8.4**	**8.5**	7.9	6.5
Busselton	**8.6**	7.7	7.2	**8.6**	**8.1**	**8.2**	7.9	**8.1**	**8.1**	**8.4**
Collie	-	-	-	-	-	-	-	-	-	5.4
Mid West region										
Geraldton	-	-	-	-	-	-	-	7.9	8.0	7.0
Goldfields region										
Kalgoorlie	-	-	-	-	-	-	5.1	5.6	4.7	4.0

Bold numerals indicate where a relevant standard has been exceeded.

E. Graphical trends

This section provides graphical representations of Tables D8 to D53 of Section D.

Each graph shows the maximum, 99th percentile, 98th percentile, 95th percentile and 90th percentile of daily maximum concentrations for all pollutants monitored by the department. The nominated percentiles can also be expressed as an nth highest concentration.

Based on 100 per cent data recovery and a normal year (365 days), the following table gives each percentile an equivalent nth highest ordinal value. The bracketed numbers represent the exact (as calculated) value of the ordinal number.

Percentile	Nth highest
100	1 (maximum)
99	5 (4.65)
98	8 (8.3)
95	19 (19.25)
90	38 (37.5)

E.1 Carbon monoxide

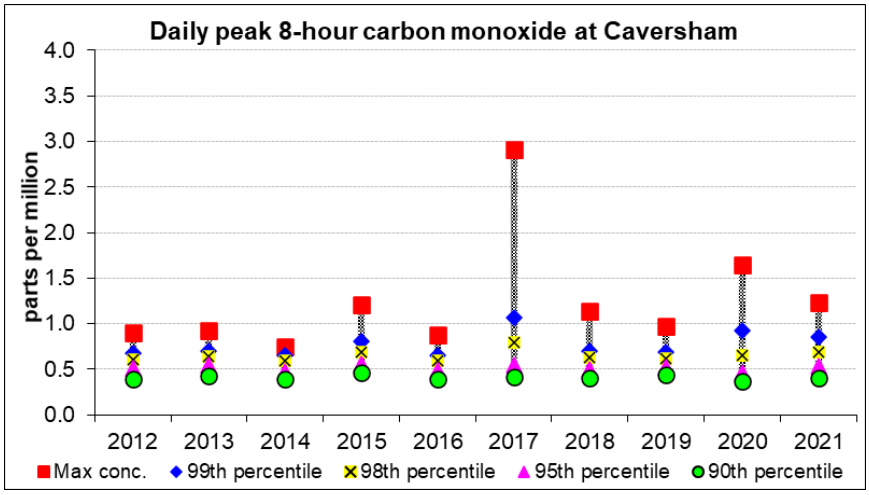


Figure E1-1 Eight-hour carbon monoxide at Caversham.

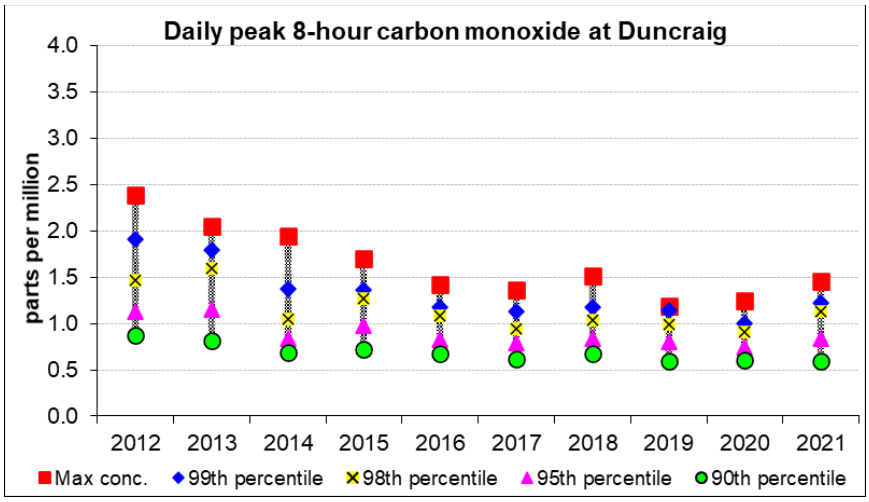


Figure E1-2 Eight-hour carbon monoxide at Duncraig.

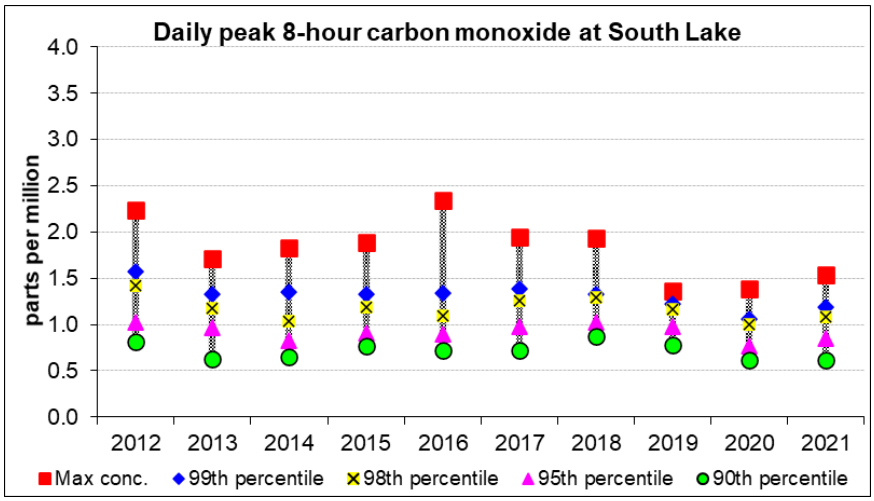


Figure E1-3 Eight-hour carbon monoxide at South Lake.

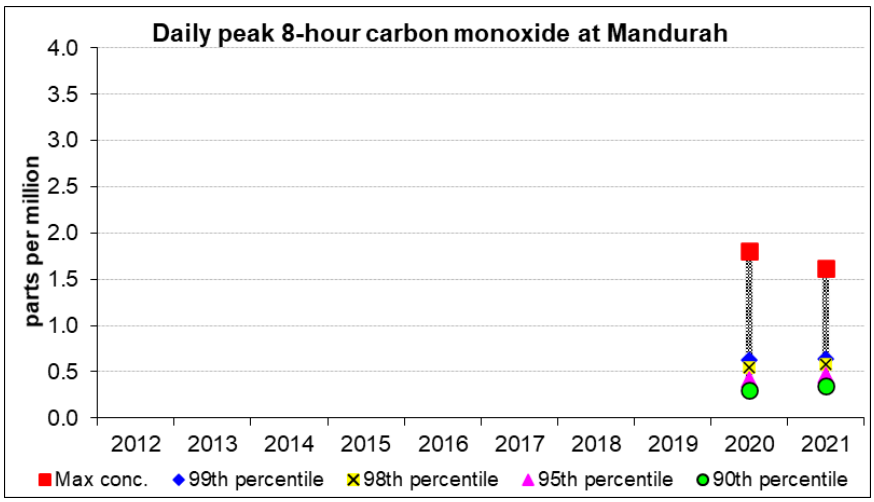


Figure E1-4 Eight-hour carbon monoxide at Mandurah.

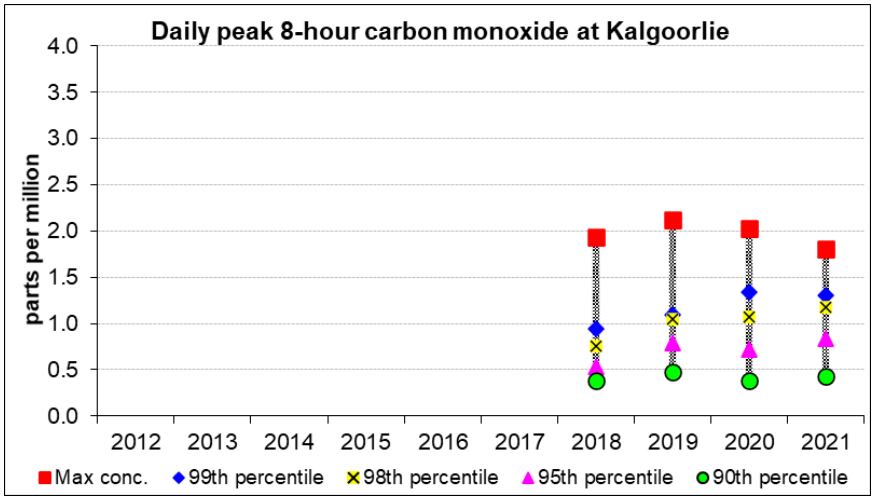


Figure E1-5 Eight-hour carbon monoxide at Kalgoorlie.

E.2 Nitrogen dioxide

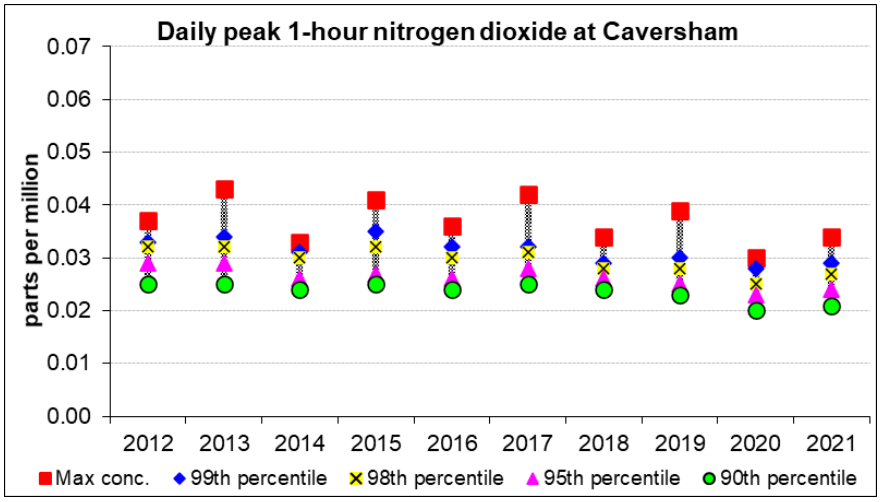


Figure E2-1 One-hour nitrogen dioxide at Caversham.

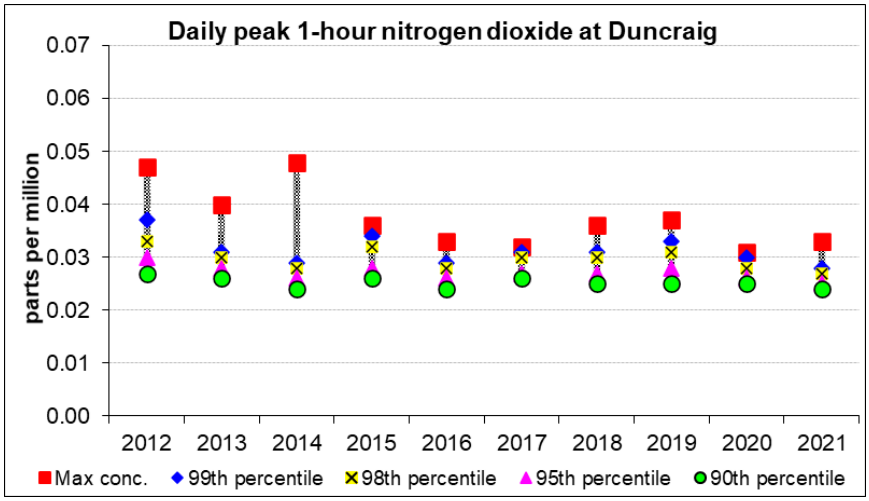


Figure E2-2 One-hour nitrogen dioxide at Duncraig.

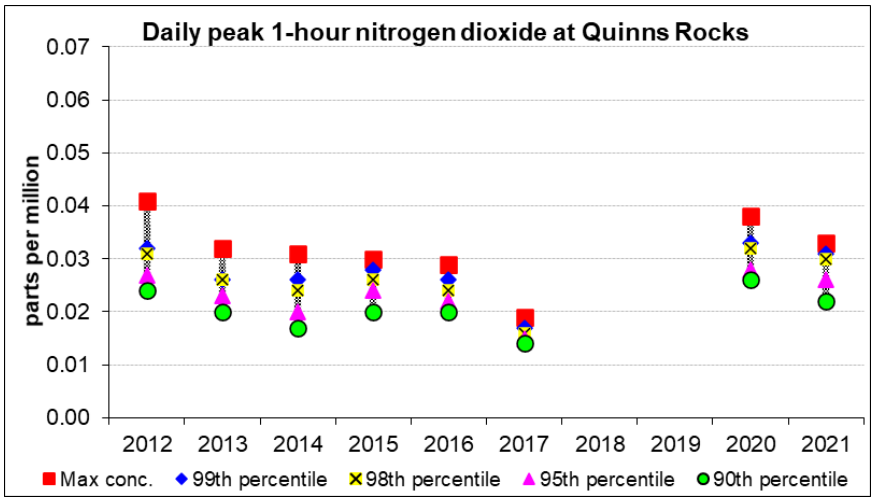


Figure E2-3 One-hour nitrogen dioxide at Quinns Rocks (2017 to 2019 not included).

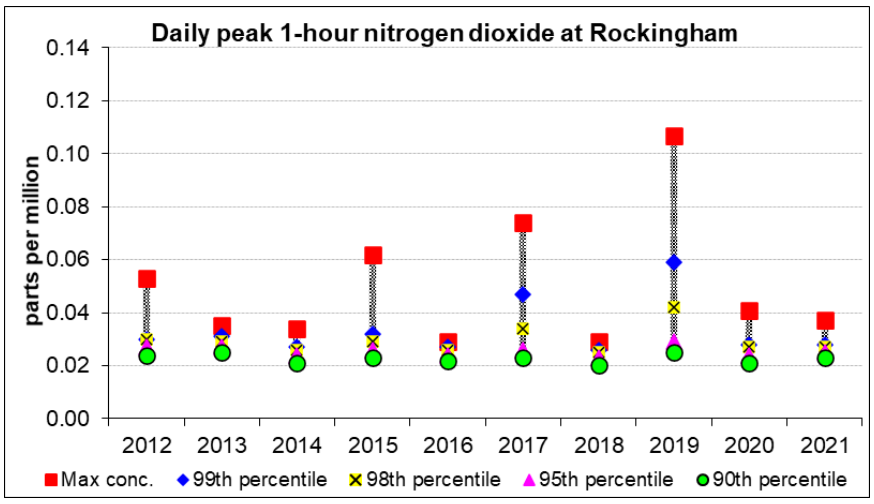


Figure E2-4 One-hour nitrogen dioxide at Rockingham.

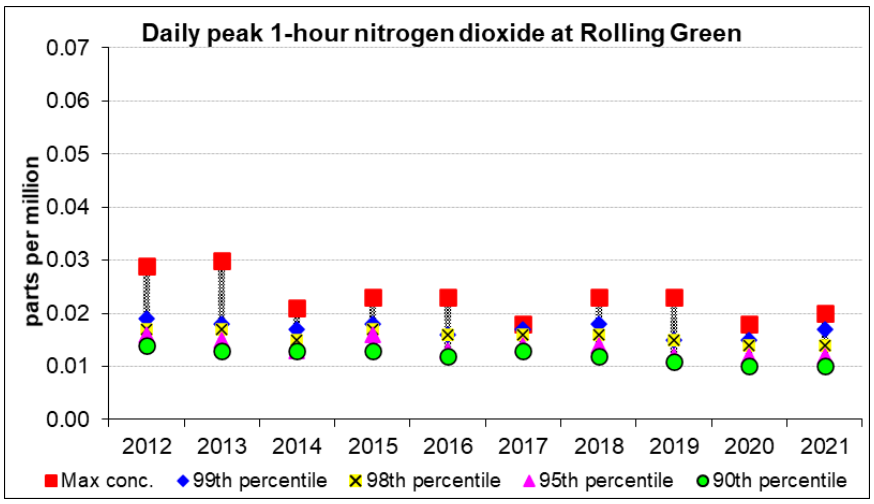


Figure E2-5 One-hour nitrogen dioxide at Rolling Green.

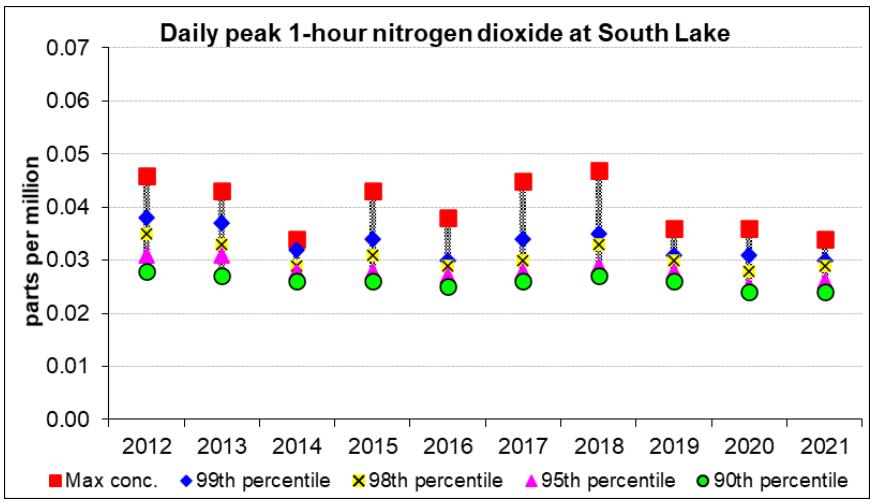


Figure E2-6 One-hour nitrogen dioxide at South Lake.

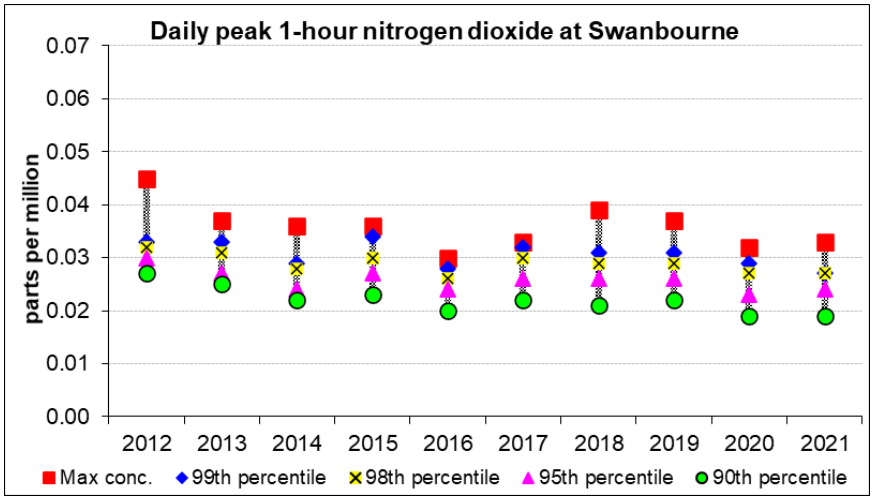


Figure E2-7 One-hour nitrogen dioxide at Swanbourne.

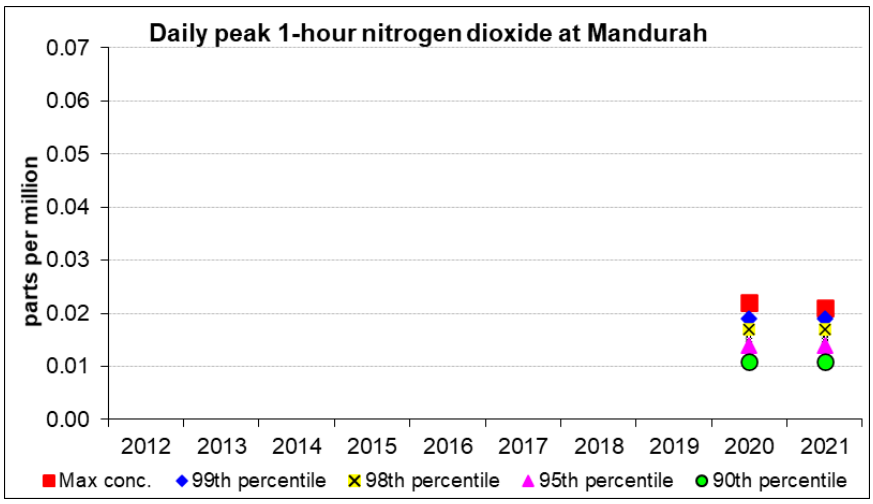


Figure E2-8 One-hour nitrogen dioxide at Mandurah.

E.3 Ozone

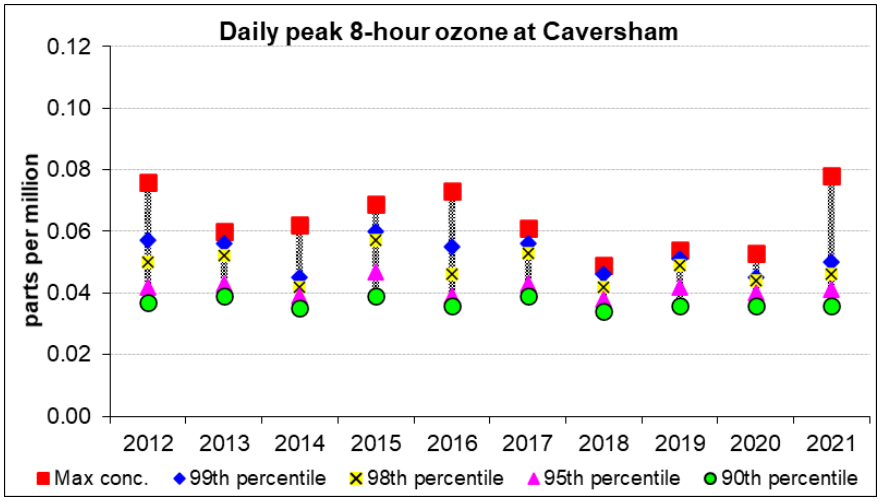


Figure E3-1 Eight-hour ozone at Caversham.

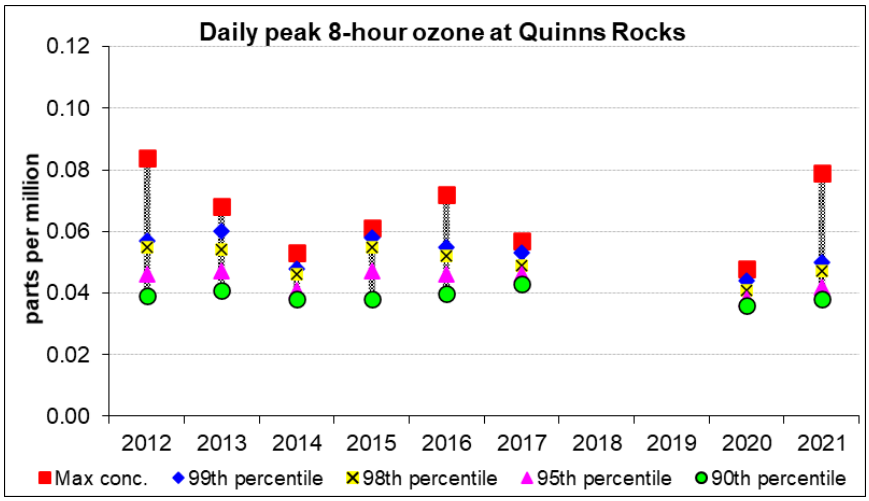


Figure E3-2 Eight-hour ozone at Quinns Rocks.

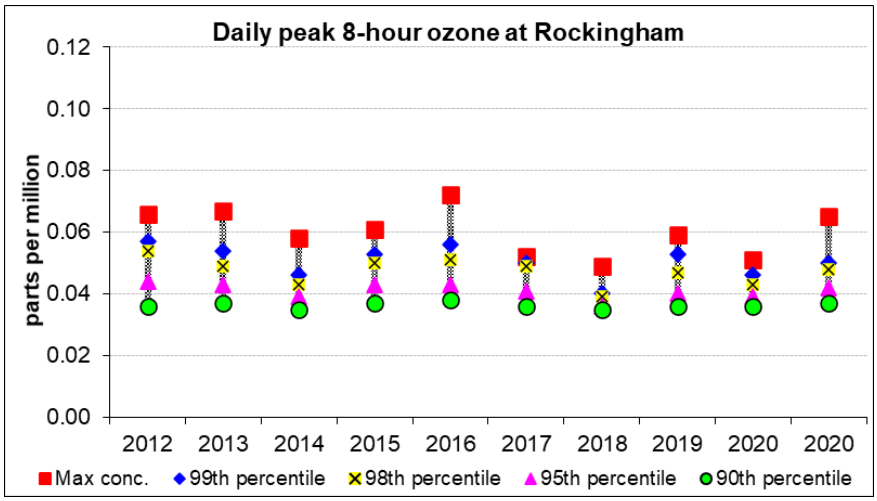


Figure E3-3 Eight-hour ozone at Rockingham.

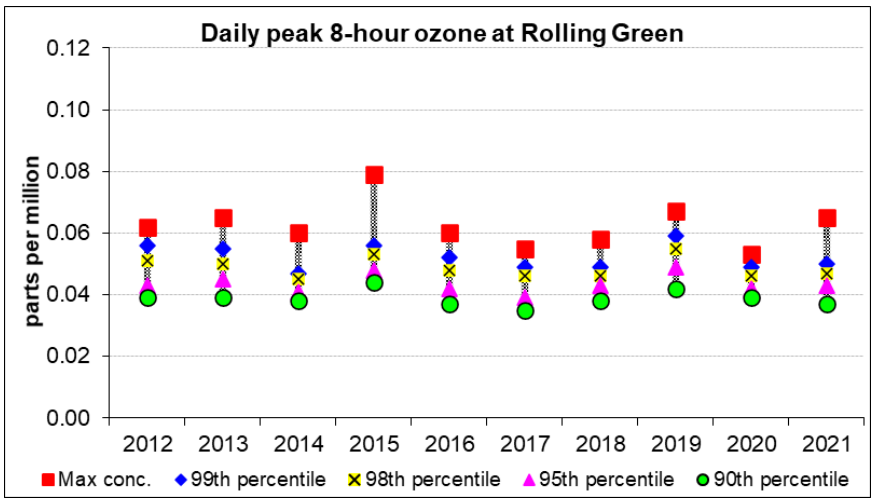


Figure E3-4 Eight-hour ozone at Rolling Green.

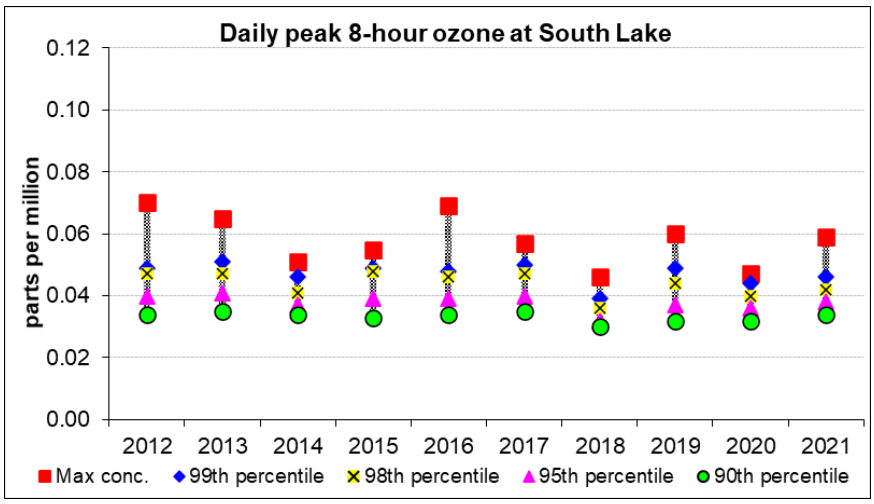


Figure E3-5 Eight-hour ozone at South Lake.

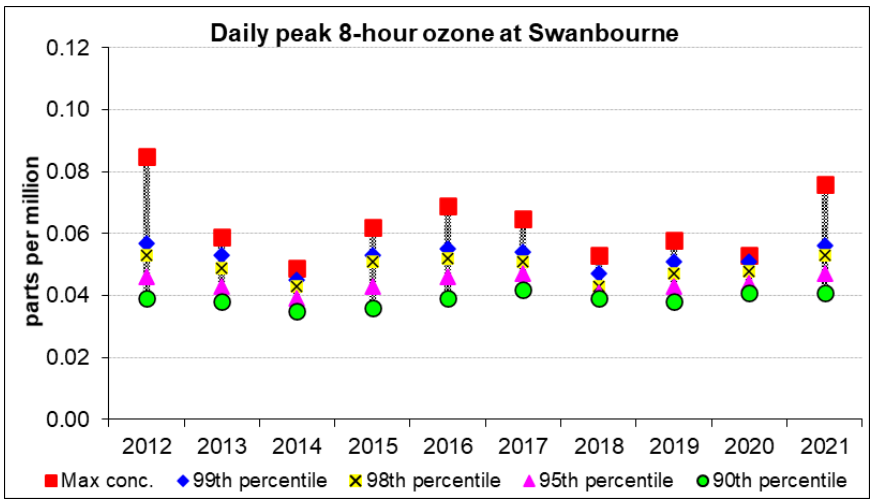


Figure E3-6 Eight-hour ozone at Swanbourne.

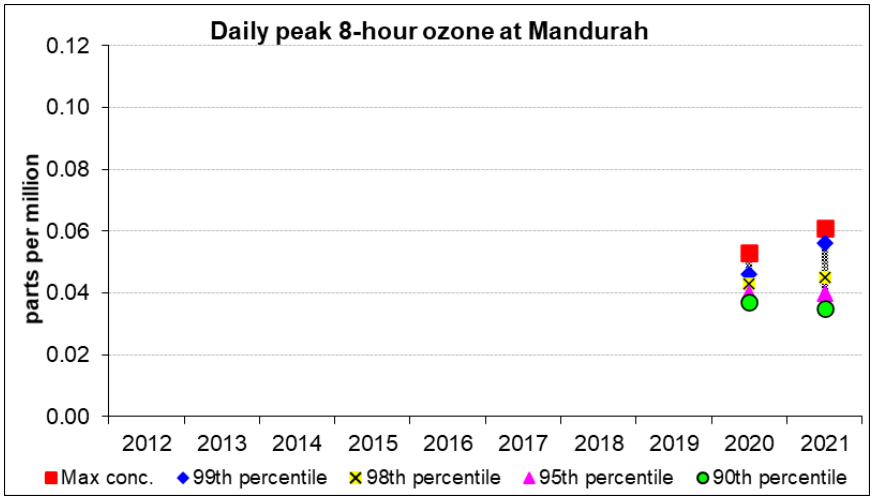


Figure E3-7 Eight-hour ozone at Mandurah.

E.4 Sulfur dioxide

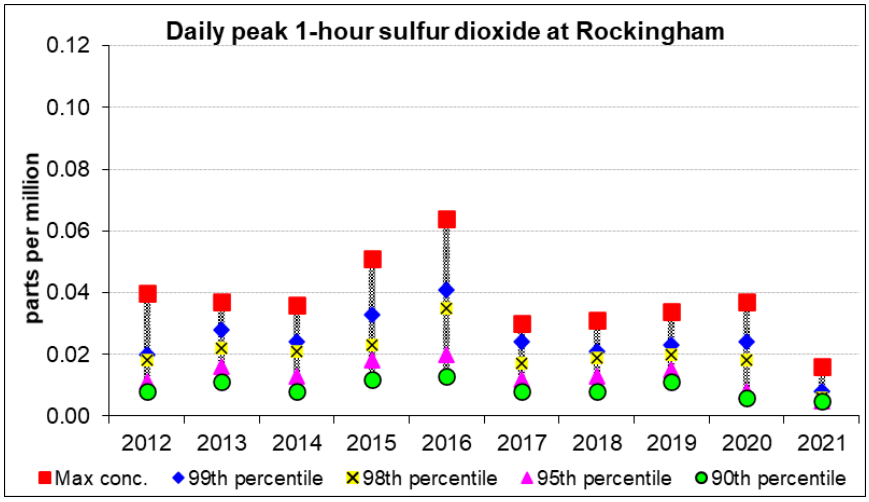


Figure E4-1 One-hour sulfur dioxide at Rockingham.

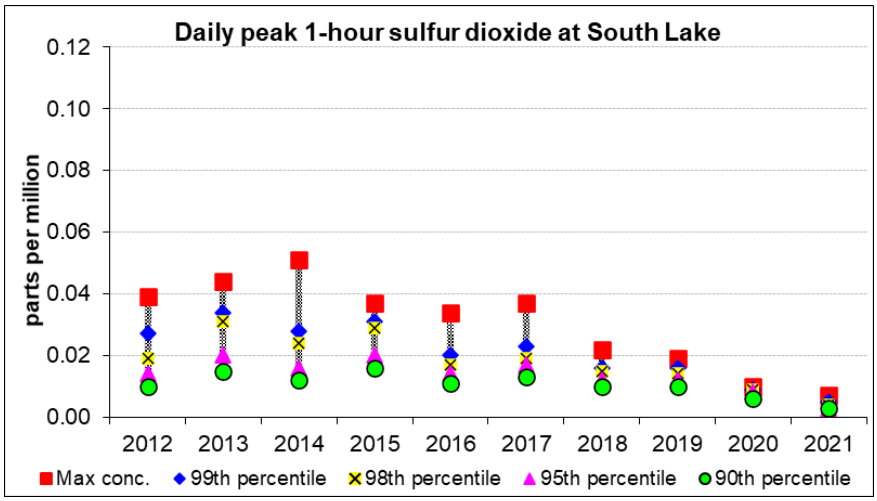


Figure E4-2 One-hour sulfur dioxide at South Lake.

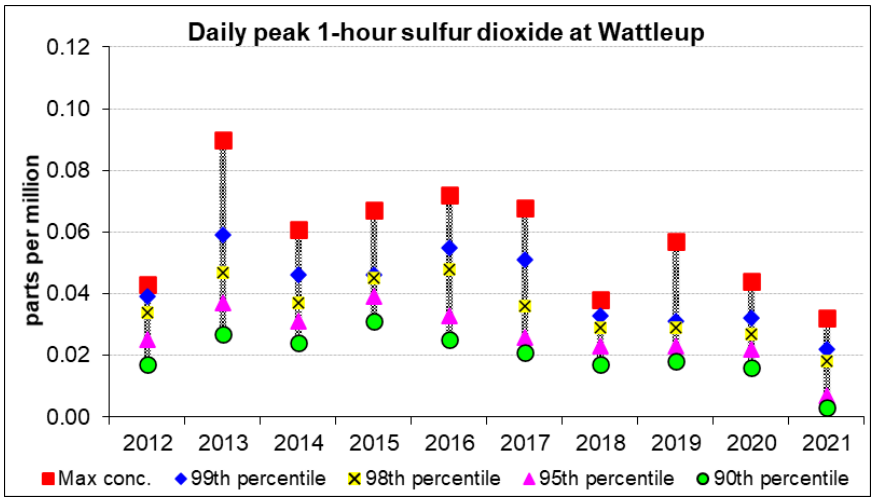


Figure E4-3 One-hour sulfur dioxide at Wattleup.

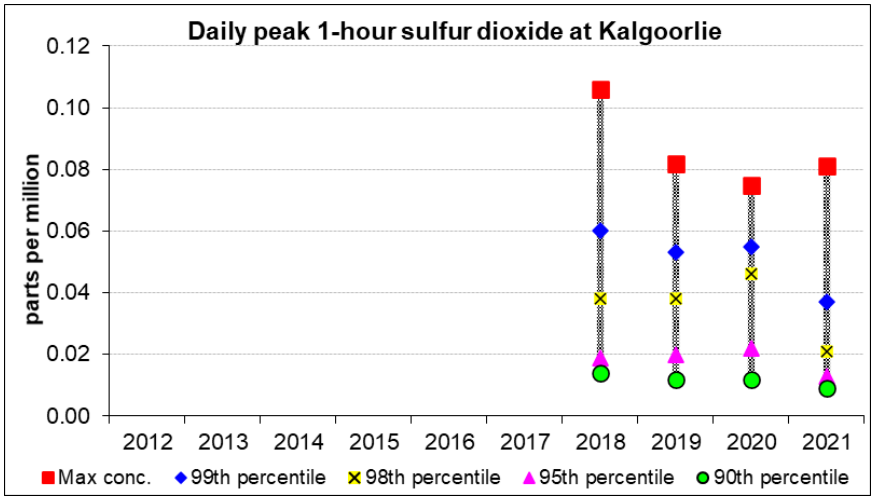


Figure E4-4 One-hour sulfur dioxide at Kalgoorlie.

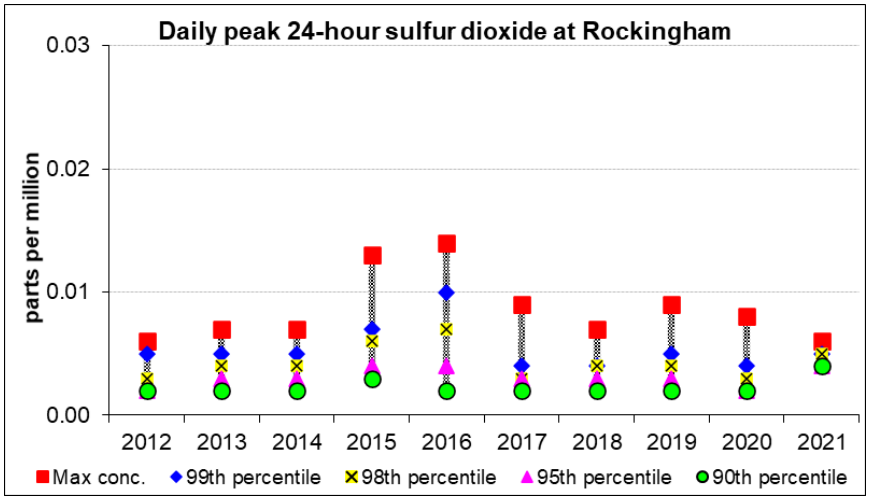


Figure E4-5 1-day sulfur dioxide at Rockingham.

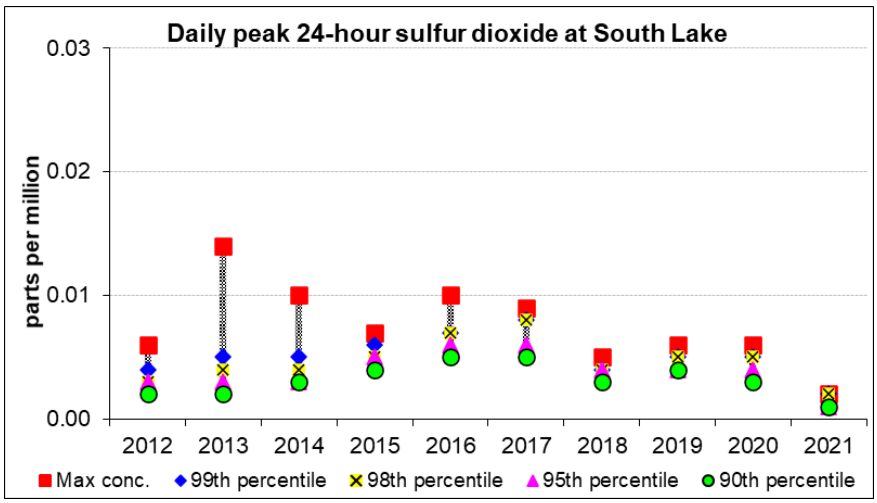


Figure E4-6 1-day sulfur dioxide at South Lake.

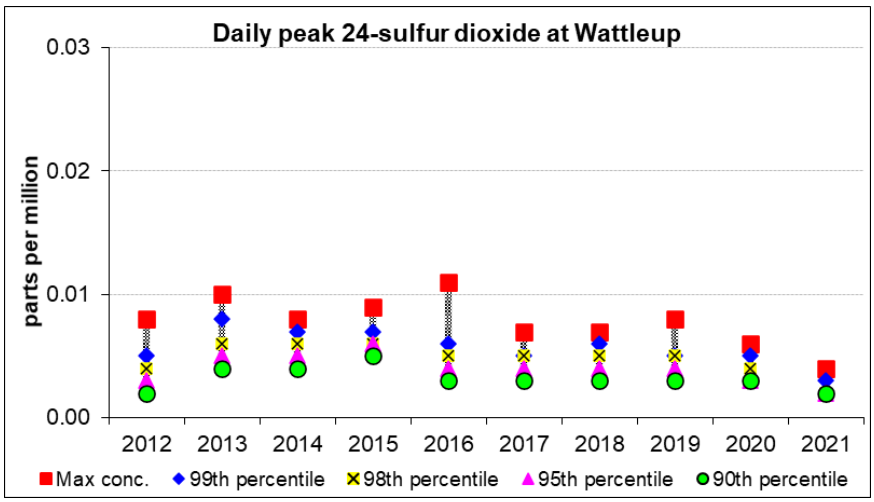


Figure E4-7 1-day sulfur dioxide at Wattleup.

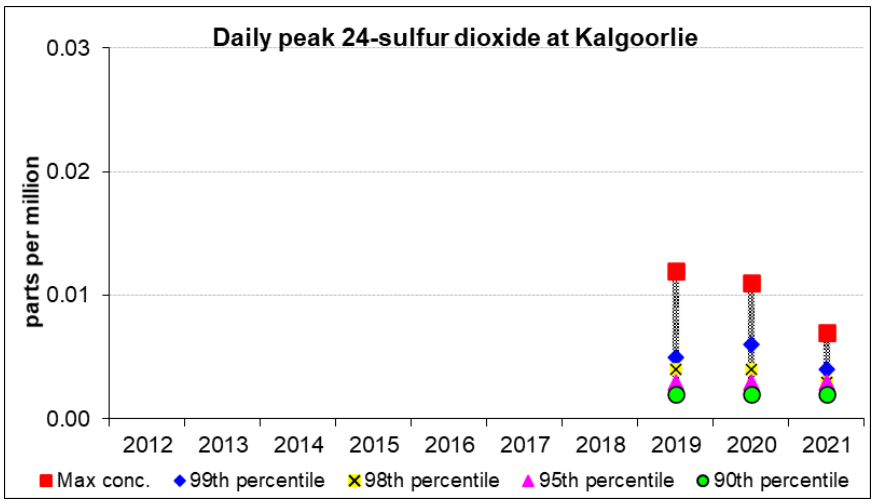


Figure E4-8 1-day sulfur dioxide at Kalgoorlie.

E.5 Particles as PM_{10}

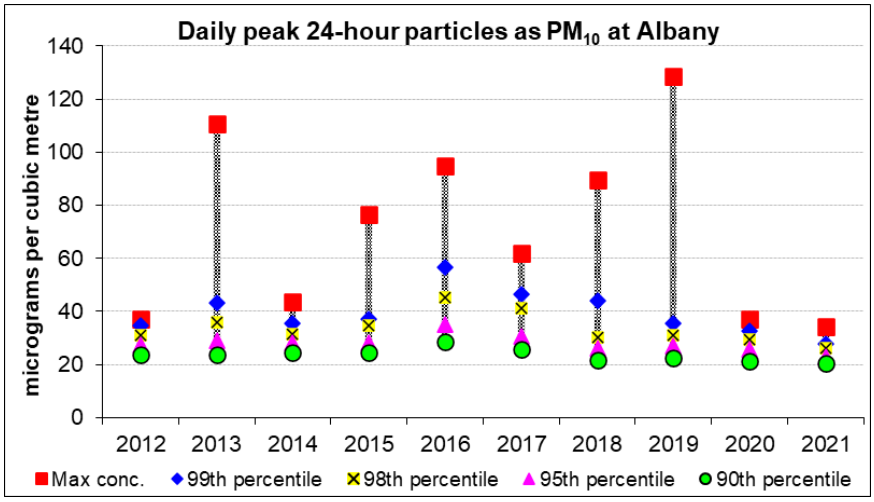


Figure E5-1 1-day PM_{10} at Albany.

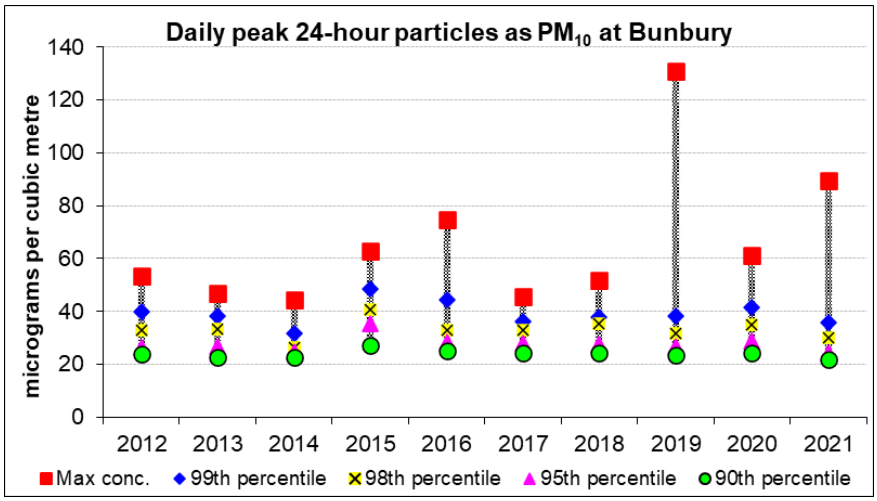


Figure E5-2 1-day PM_{10} at Bunbury.

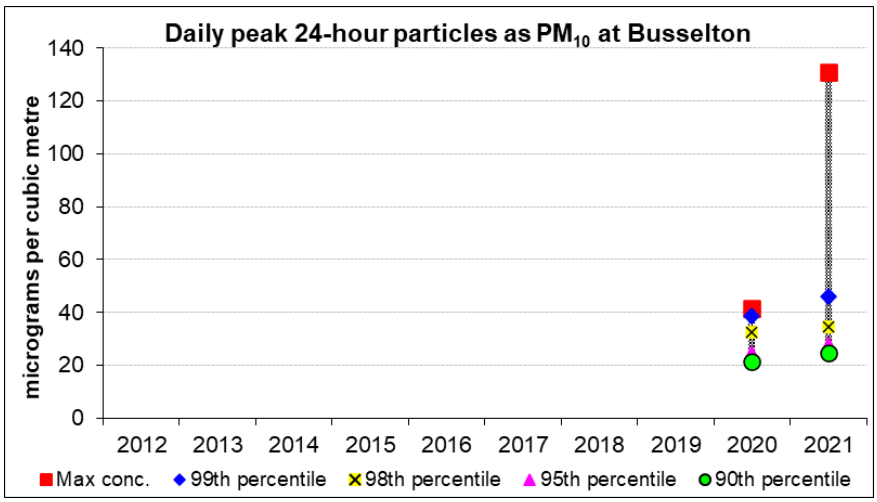


Figure E5-3 1-day PM_{10} at Busselton.

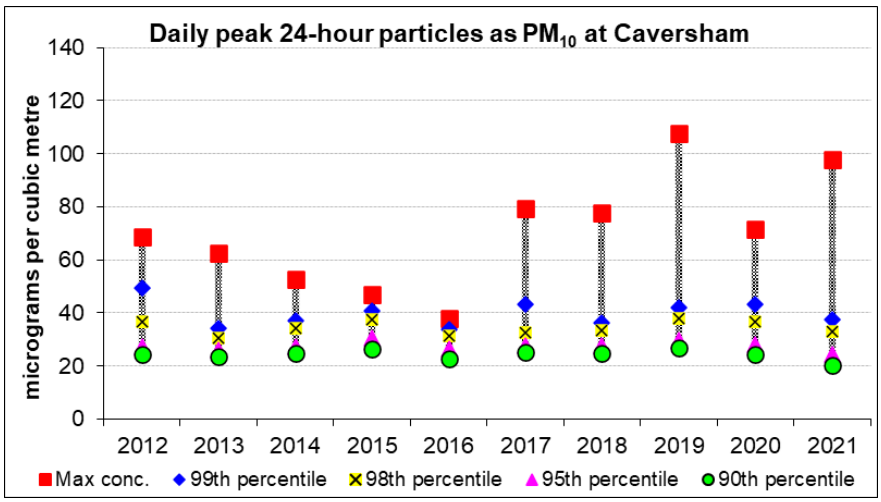


Figure E5-4 1-day PM_{10} at Caversham.

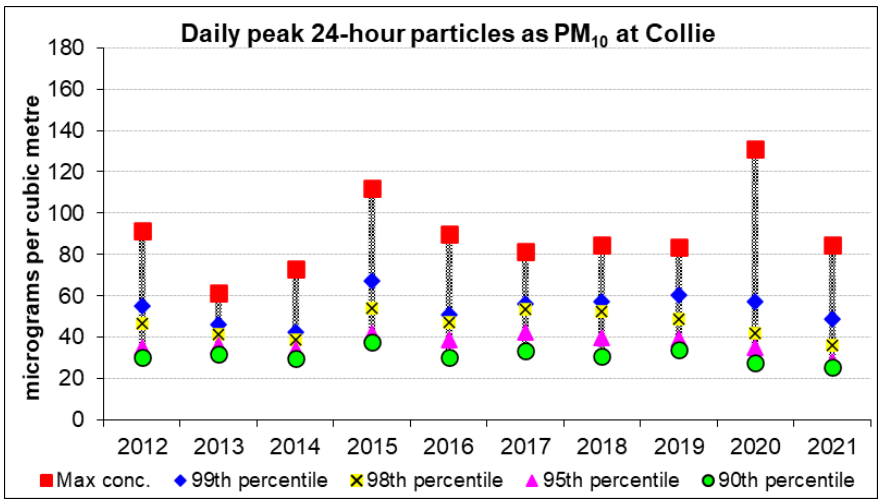


Figure E5-5 1-day PM_{10} at Collie.

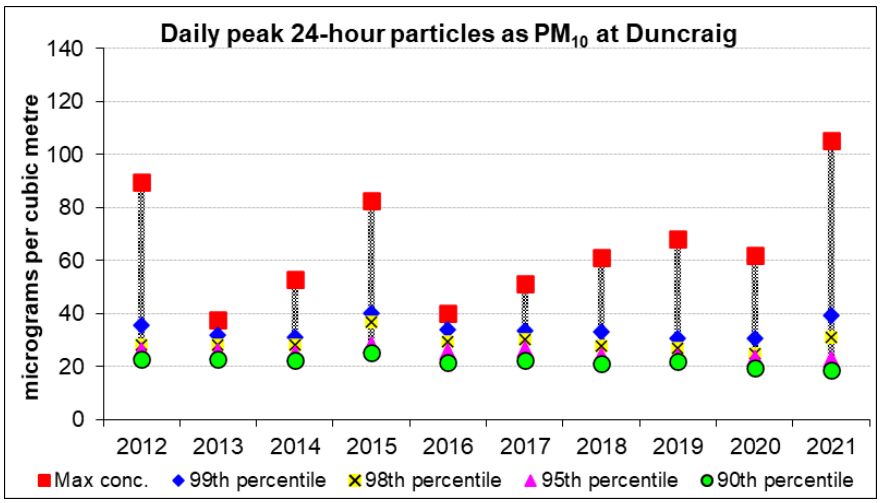


Figure E5-6 1-day PM_{10} at Duncraig.

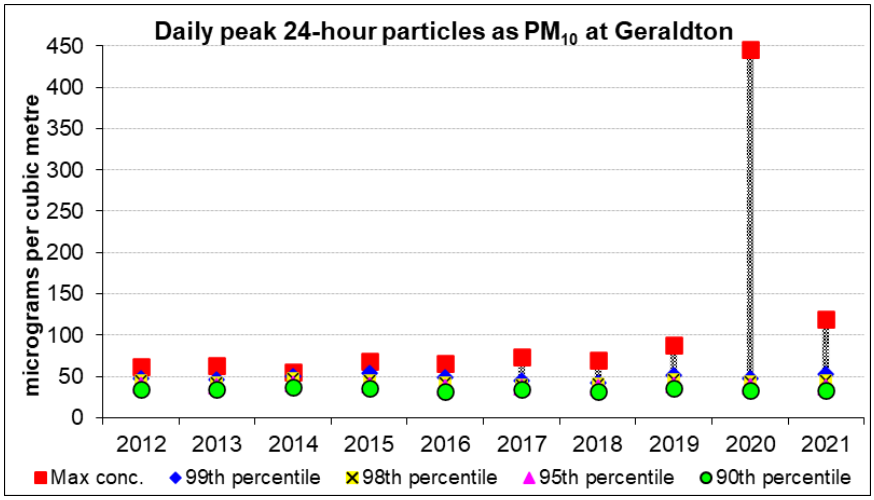


Figure E5-7 1-day PM_{10} at Geraldton.

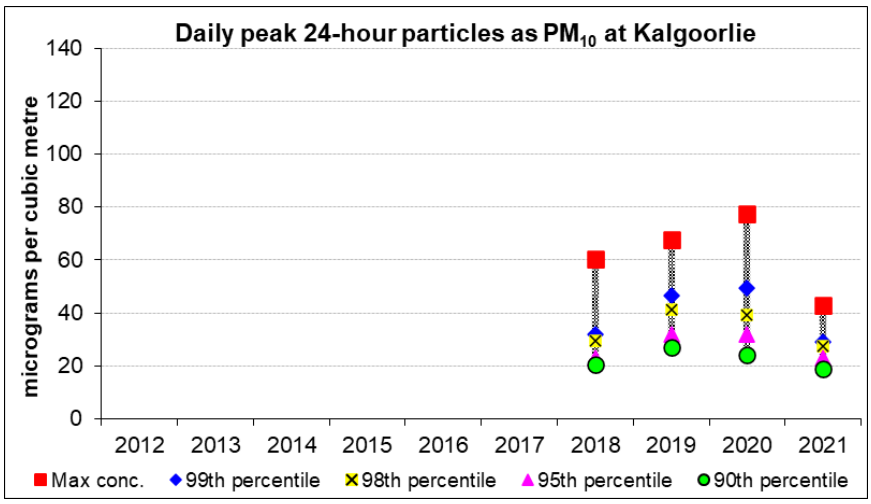


Figure E5-8 1-day PM_{10} at Kalgoorlie.

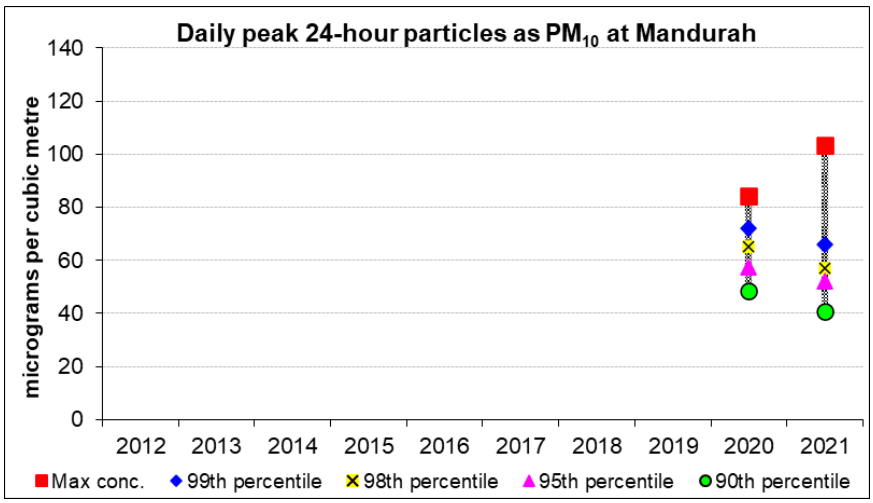


Figure E5-9 1-day PM_{10} at Mandurah.

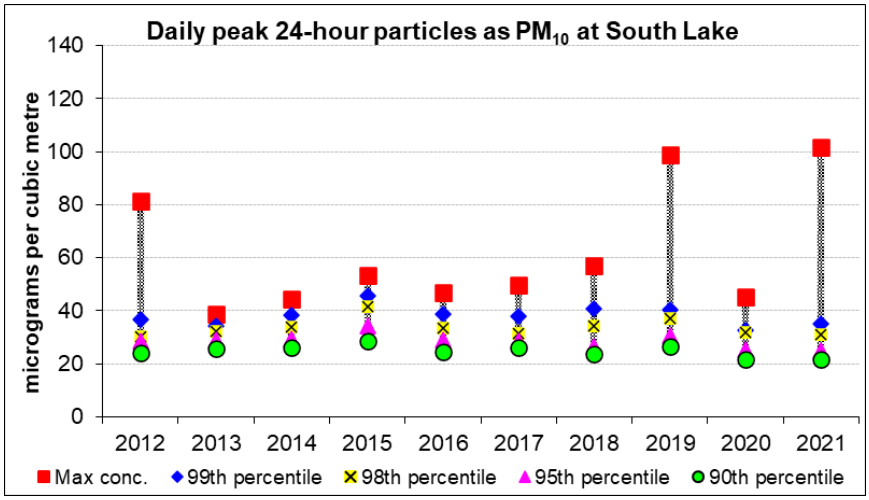


Figure E5-10 1-day PM_{10} at South Lake.

E.6 Particles as $PM_{2.5}$

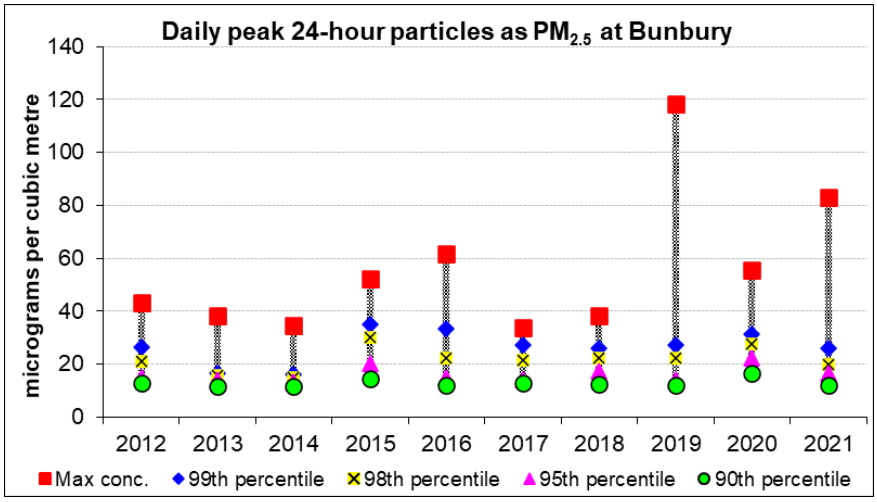


Figure E6-1 1-day $PM_{2.5}$ at Bunbury.

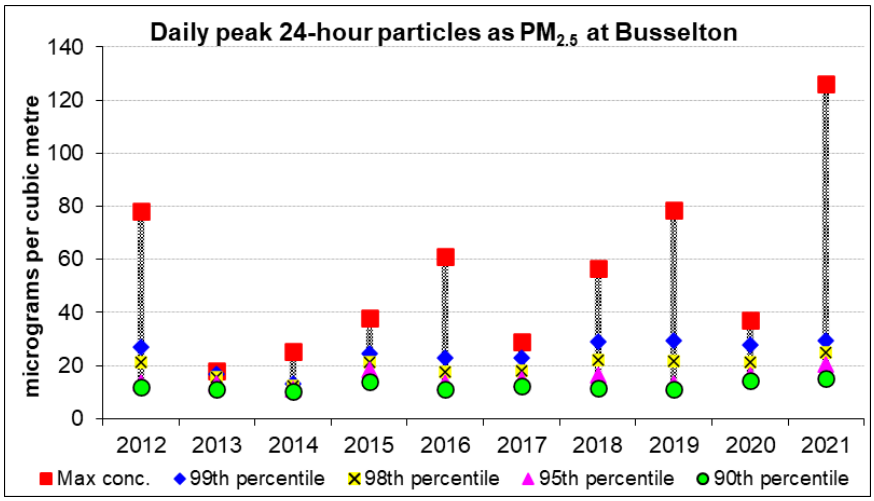


Figure E6-2 1-day $PM_{2.5}$ at Busselton.

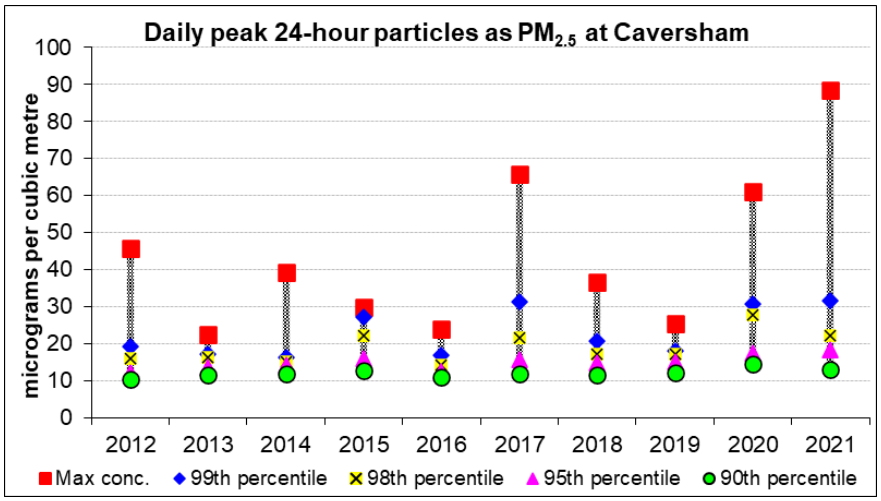


Figure E6-3 1-day $PM_{2.5}$ at Caversham.

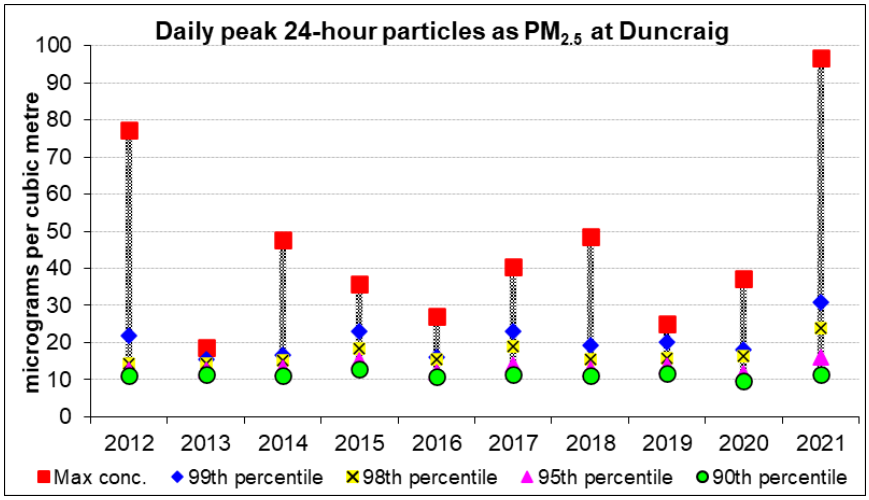


Figure E6-4 1-day $PM_{2.5}$ at Duncraig.

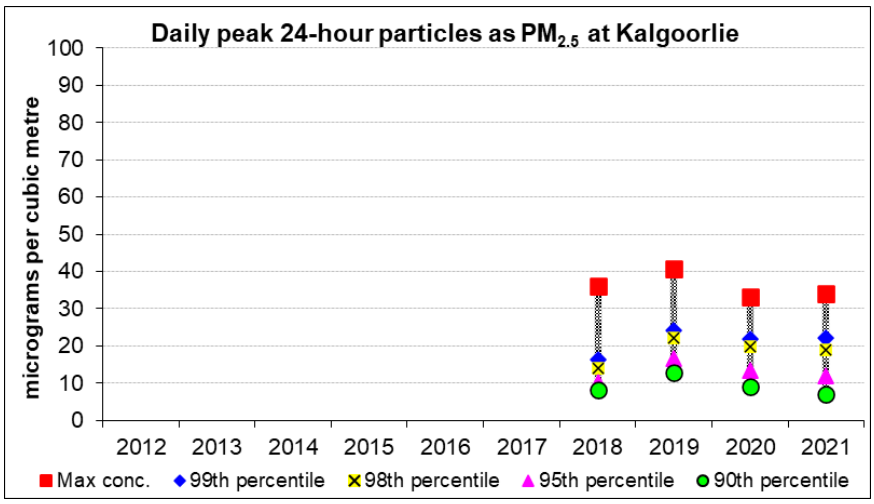


Figure E6-5 1-day $PM_{2.5}$ at Kalgoorlie.

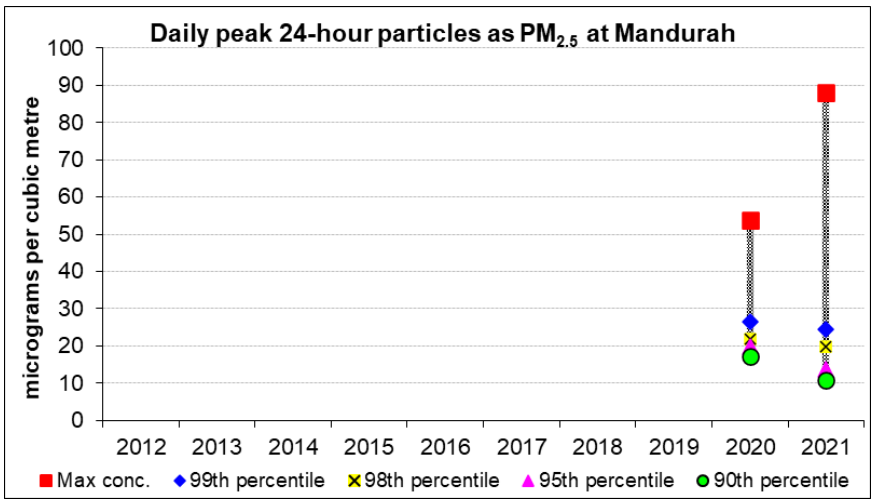


Figure E6-6 1-day $PM_{2.5}$ at Mandurah.

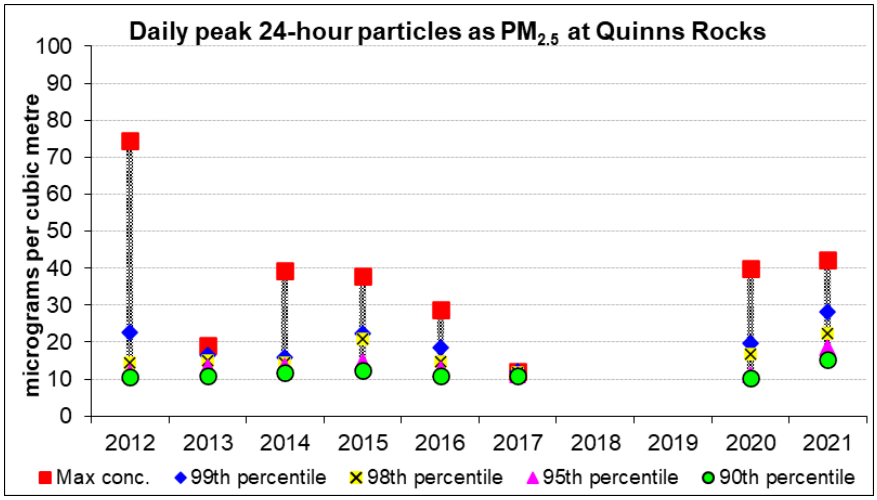


Figure E6-7 1-day $PM_{2.5}$ at Quinns Rocks.

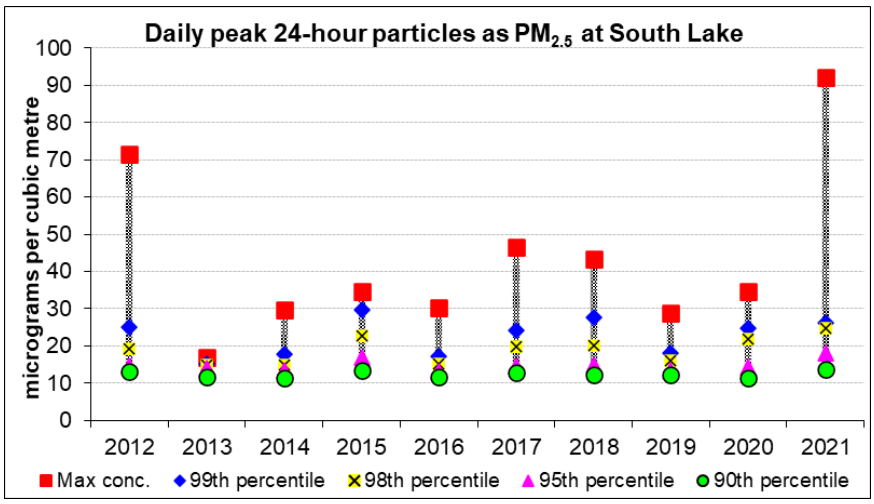


Figure E6-8 1-day $PM_{2.5}$ at South Lake.

F. Exceedance analysis

This section contains information specific to each parameter exceeding the relevant AAQ NEPM standard during 2021. Each analysis is provided in date order and may include a satellite image of the region, a back trajectory, concentration and/or wind plots, together with information on the specific concentrations reached and possible sources.

Each back trajectory (where provided) is specific to one event and shows a possible path that a parcel of air may have taken to arrive at a specific location at a certain time. A back trajectory uses the wind speed and direction information recorded at monitoring sites to track a simple path backwards to a possible origin site. Assumptions made in the calculation of these back trajectories, such as no air dispersion throughout the path, create large uncertainties in the indicated path. Despite this, the back trajectories calculated are considered to provide a reasonable approximation for the possible path taken by an air parcel.

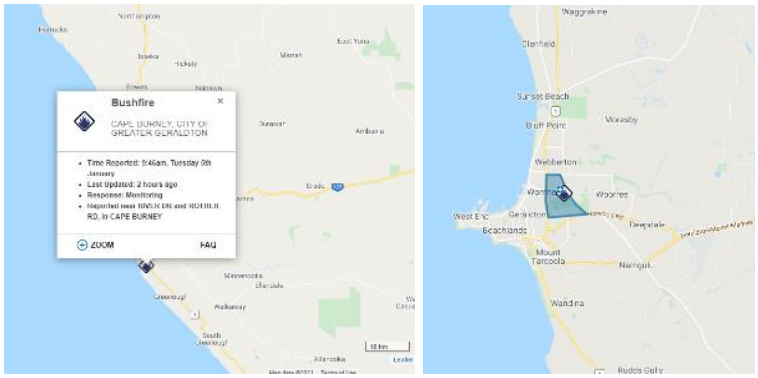
Satellite images are obtained from earthdata.nasa.gov/labs/worldview, where available and when cloud cover does not obscure the plume.

Abbreviations are occasionally used to represent the department's AQMS sites. These are:

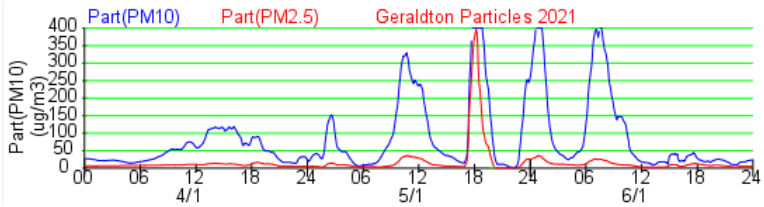
Metropolitan sites	
Ca	Caversham
Du	Duncraig
Ma	Mandurah
QR	Quinns Rocks
Ro	Rockingham
RG	Rolling Green
SL	South Lake
Sw	Swanbourne
Wt	Wattleup

Regional sites	
Al	Albany
Bn	Bunbury
Bs	Busselton
Co	Collie
Ge	Geraldton
Kg	Kalgoorlie

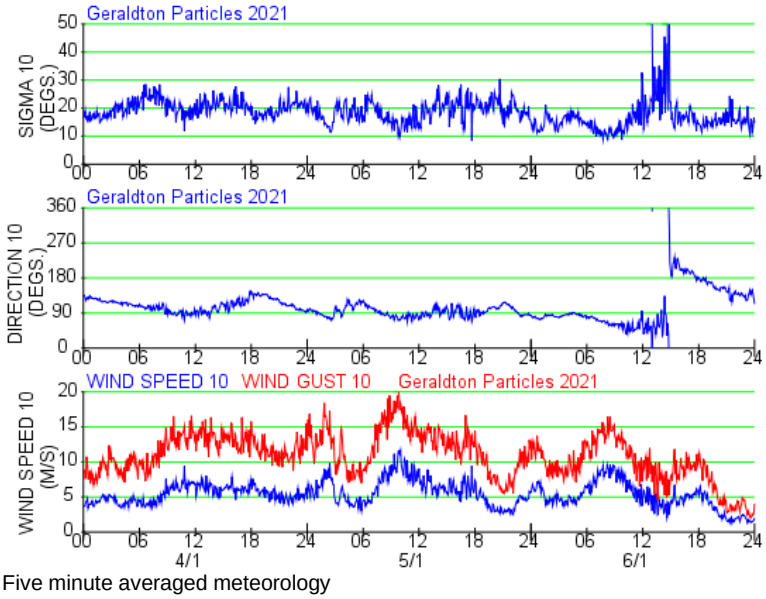
4, 5 & 6 January 2021



https://www.emergency.wa.gov.au/#



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

PM_{10} & $PM_{2.5}$

Monitoring Site

Geraldton

NEPM Standard

PM_{10} – 50 µg/m³

$PM_{2.5}$ – 25 µg/m³

Averaging Period

24 hours

Concentration (µg/m³)

SITE	4 January		5 January		6 January	
	PM10	PM2.5	PM10	PM2.5	PM10	PM2.5
CA	22.2	12.8	23.4	14.5	23.0	13.3
QR	14.6	2.8	14.2	3.1	13.3	3.9
DU	9.6	1.2	11.3	2.9	13.1	4.6
SL	15.7	6.4	11.3	3.7	14.0	6.0
AR	9.5	2.5	9.8	3.2	10.3	3.9
MA	7.5	0.3	8.6	2.2	NA	NA
BN	NA	NA	12.0	2.5	10.9	3.1
BS	9.5	2.3	11.2	3.2	15.1	6.1
CO	22.0	NA	NA	NA	NA	NA
GE	50.2	8.9	120	29.2	93.0	10.6
AL	14.9	NA	16.4	NA	19.1	NA
KG	11.4	0.1	29.3	2.6	11.8	2.1

Description of Event

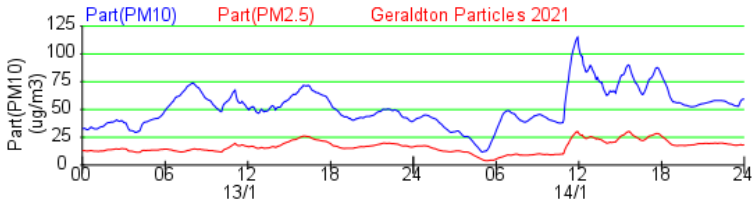
High easterly winds caused some dust lift-off as seen by low $PM_{2.5}$:PM_{10} ratios in the figures for 4 and 6 January. On 5 January, a bushfire advice was in place in the City of Greater Geraldton. Fire was burning east of the monitoring site.

04/01 Assessable event WD

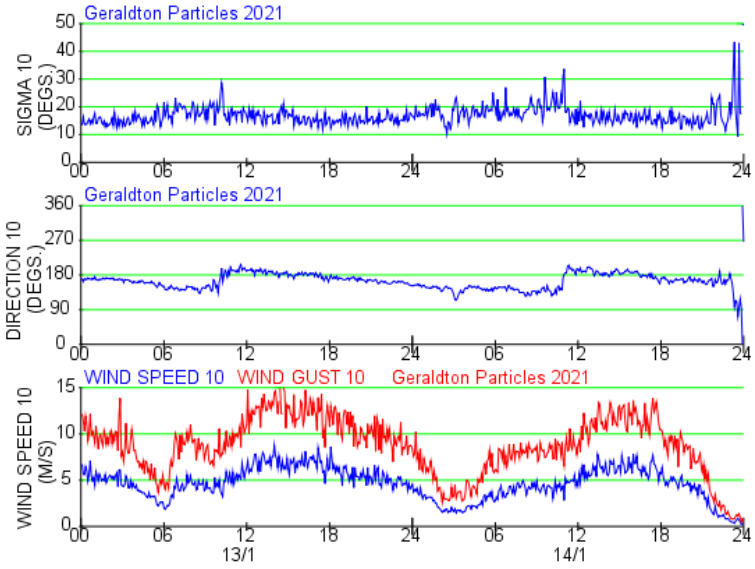
05/01 Exceptional event BF

06/01 Assessable Event WD

13 & 14 January 2021



Hourly averaged PM_{10} (blue) & $PM_{2.5}$ (red)



Five minute averaged meteorology

Pollutant

PM_{10}

Monitoring Site

Geraldton

NEPM Standard

PM_{10} – 50 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

SITE	13 January		14 January	
	PM10	PM2.5	PM10	PM2.5
CA	33.3	20.8	32.5	12.0
QR	26.9	13.6	24.6	4.6
DU	26.1	14.6	21.7	5.6
SL	17.2	8.1	23.9	7.1
AR	18.5	9.5	20.1	4.7
MA	17.5	6.0	24.4	6.8
BN	13.9	4.2	15.3	3.7
BS	15.6	5.7	15.1	3.5
CO	27.1	NA	36.1	NA
GE	50.3	16.3	54.5	16.8
AL	17.5	NA	12.9	NA
KG	16.5	5.9	12.3	3.1

Description of Event

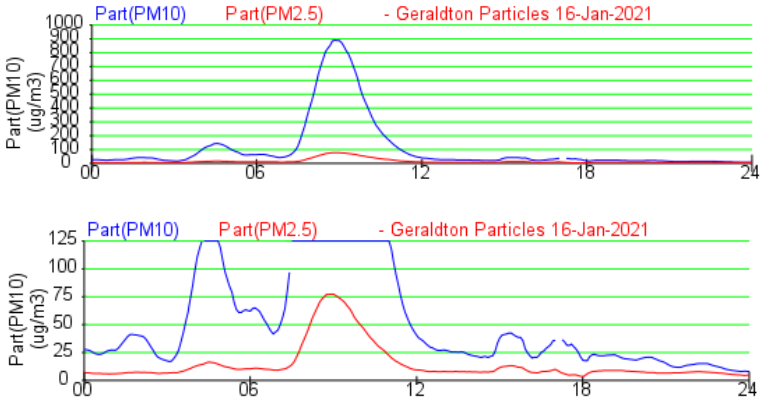
High southerly winds possibly causing some dust lift-off as seen by low $PM_{2.5}$:PM_{10} ratios in the figure.

13/01 Assessable event WD

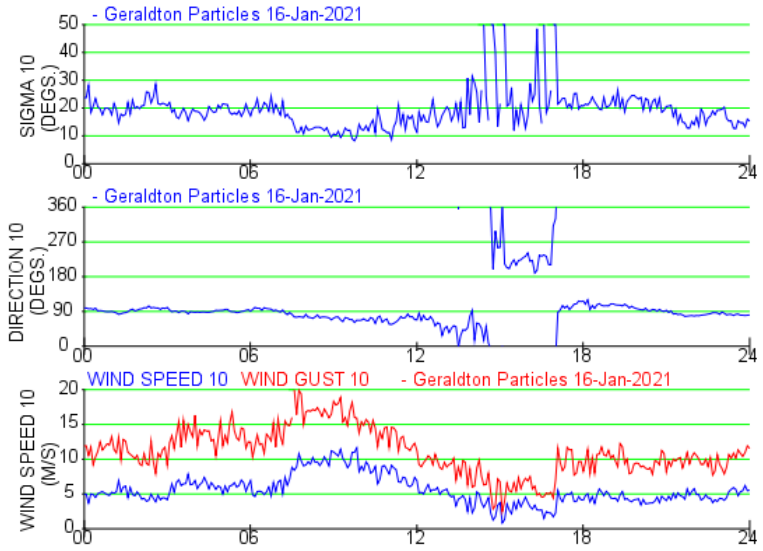
14/01 Assessable event WD

16 January 2021

Satellite (Terra/Modis) view from https://worldview.earthdata.nasa.gov for 16/01/2021. Diffuse dust can be seen over ocean. (Colour enhanced to show plume)



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black) plotted using different concentration scales



Five minute averaged meteorology

Pollutant

PM_{10}

Monitoring Site

Geraldton

NEPM Standard

PM_{10} – 50 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

SITE	16 January	
	PM10	PM2.5
CA	26.0	12.6
QR	18.5	4.2
DU	15.3	4.7
SL	14.0	4.6
AR	12.8	4.0
MA	15.0	5.4
BN	16.8	3.9
BS	15.7	5.2
CO	26.4	NA
GE	108	14.7
AL	16.6	NA
KG	12.7	1.9

Description of Event

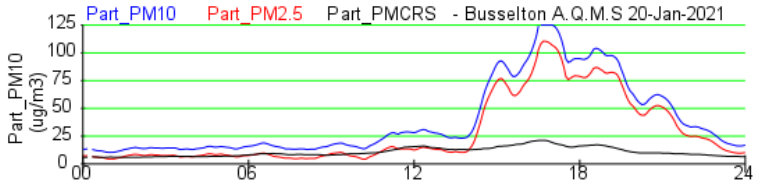
Consistent and high easterly wind gusting up to 72 kph (20 m/s) possibly causing some dust lift-off as seen by low $PM_{2.5}$:PM_{10} ratios in the figure.

Minor contribution from some smoke in the late morning may have contributed to elevate $PM_{2.5}$ but the majority of the particle load came from the coarse fraction indicating windborne dust.

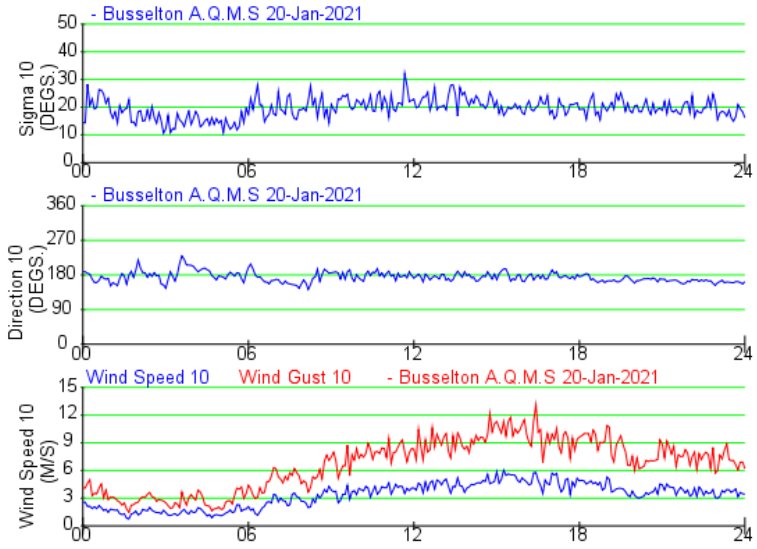
Assessable event WD

20 January 2021

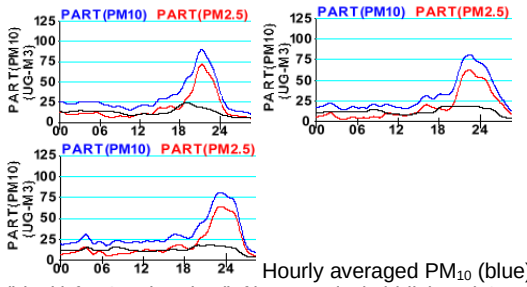
Satellite (Terra/Modis) view from https://worldview.earthdata.nasa.gov for 20/01/2021.



Hourly averaged PM10 (blue), PM2.5 (red) & PMcrse (black)



Five minute averaged meteorology



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black) for South Lake (left) Duncraig (middle) and Caversham (right) for 20/01/2021 showing movement of the plume as it travels north

Pollutant

$PM_{2.5}$

Monitoring Site

Busselton

NEPM Standard

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

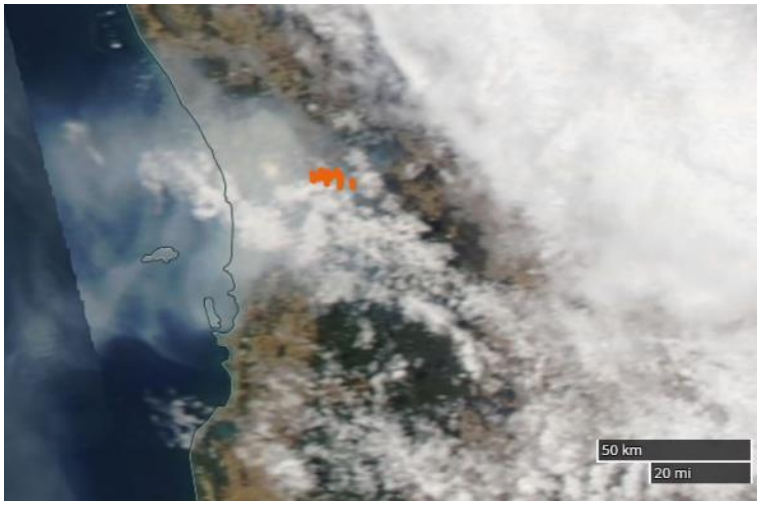
SITE	20 January	
	PM10	PM2.5
CA	31.8	18.3
QR	27.5	13.9
DU	30.6	17.3
SL	34.4	20.4
AR	28.5	14.9
MA	29.5	14.0
BN	18.3	9.4
BS	39.3	28.6
CO	23.7	NA
GE	21.9	9.8
AL	22.5	NA
KG	15.6	2.0

Description of Event

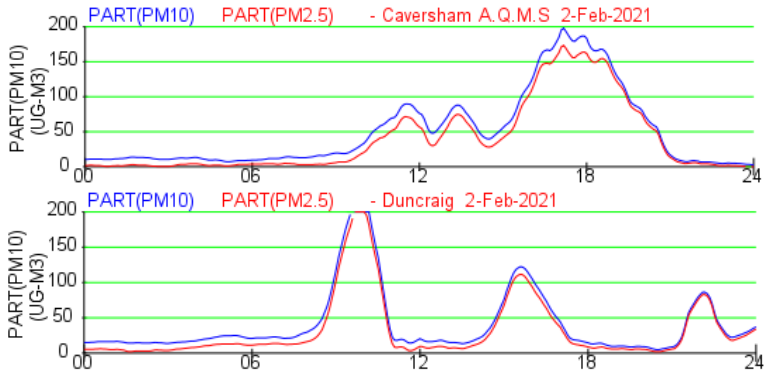
Active bushfire in Shire of Nannup, south of Busselton. A Smoke Alert was issued for areas throughout the South West from Augusta to Bunbury and surrounds in the Shire of Augusta-Margaret River and Cities of Busselton and Bunbury

Exceptional event BF

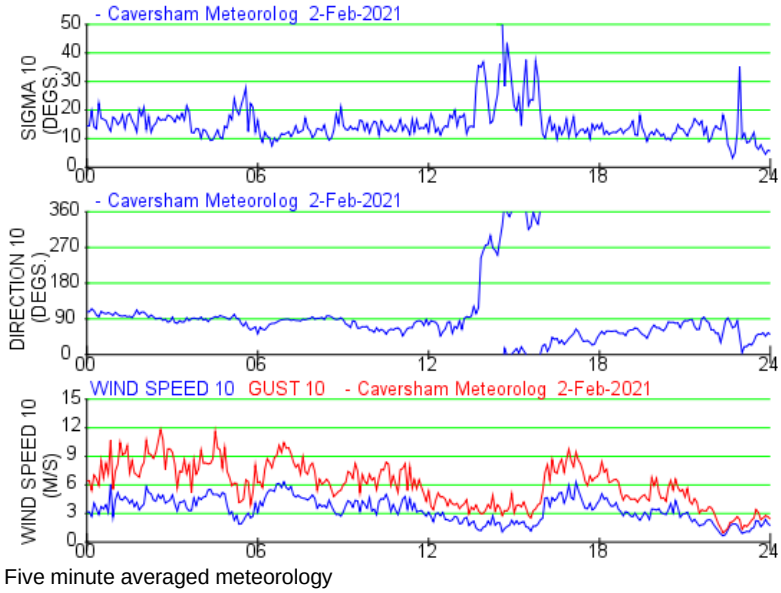
2 February 2021



Satellite image https://worldview.earthdata.nasa.gov/



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

PM_{10} & $PM_{2.5}$

Monitoring Site

Caversham, Duncraig

NEPM Standard

PM_{10} – 50 µg/m³

$PM_{2.5}$ – 25 µg/m³

Averaging Period

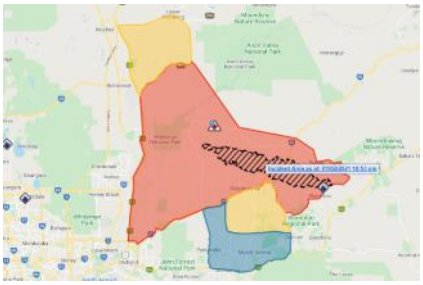
24 hours

Concentration (µg/m³)

SITE	2 February	
	PM10	PM2.5
CA	50.7	39.7
QR	29.0	18.7
DU	41.1	32.1
SL	33.1	23.7
AR	13.2	6.6
MA	26.4	7.6
BN	15.7	6.8
BS	13.8	6.0
CO	24.4	NA
GE	13.3	6.6
AL	20.1	NA
KG	5.9	2.0

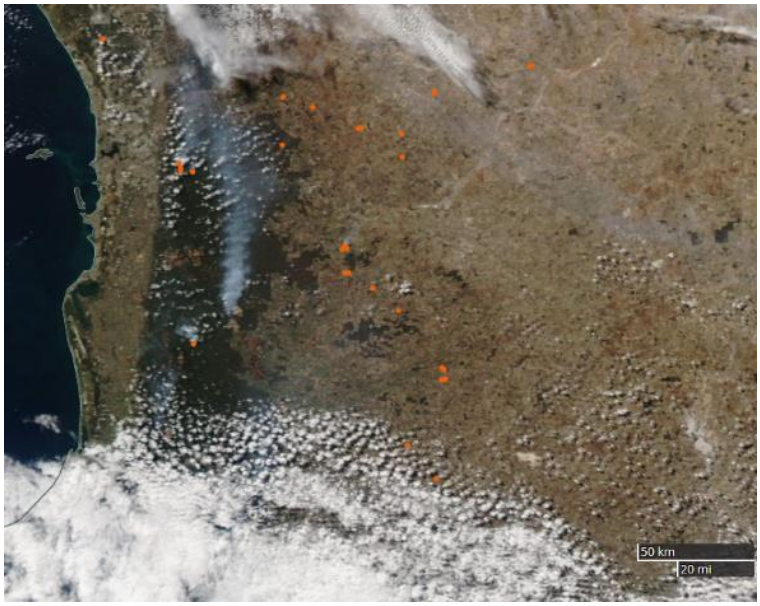
Description of Event

Bushfire in Perth Hills suburb of Wooroloo fire which spread to encompass parts of Chidlow, Wundowie and Gidgegannup.

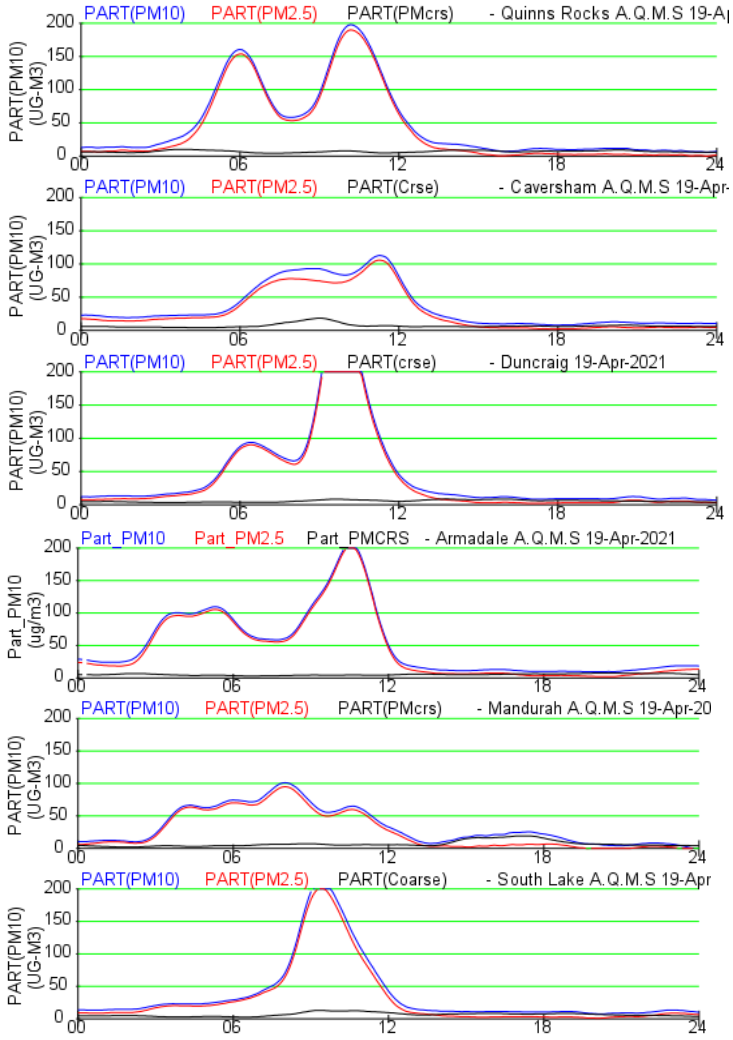


Exceptional event BF

19 April 2021



Satellite image https://worldview.earthdata.nasa.gov/



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)

Pollutant

PM_{10} & $PM_{2.5}$

Monitoring Site

Various

NEPM Standard

PM_{10} – 50 µg/m^3

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

SITE	19 April	
	PM10	PM2.5
CA	35.0	28.0
QR	47.6	40.6
DU	47.0	41.4
SL	37.2	30.6
AR	50.7	45.4
MA	32.8	26.0
BN	10.5	5.9
BS	7.9	3.8
CO	25.4	NA
GE	40.1	25.9
AL	10.6	NA
KG	7.7	2.3

Description of Event

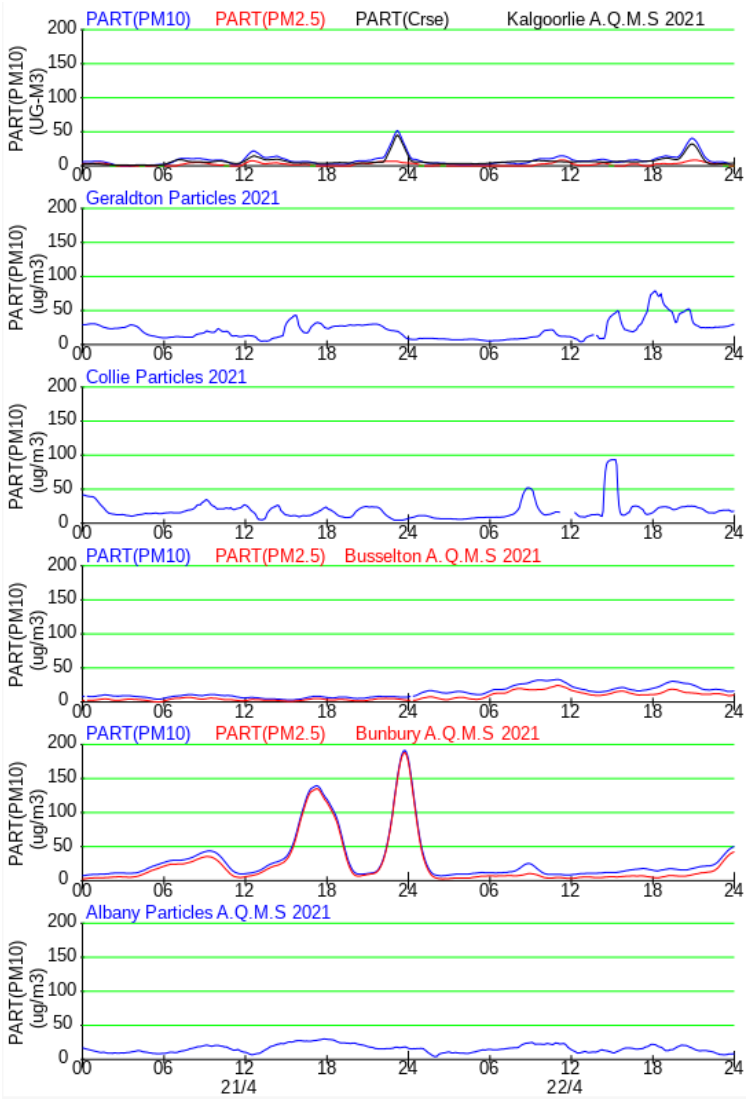
Several prescribed burns were underway in and around the Perth and Peel regions.

A burn off was also being conducted in the City of Geraldton

Exceptional events PB

21 April 2021

Satellite image https://worldview.earthdata.nasa.gov/



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)

Pollutant

PM_{10} & $PM_{2.5}$

Monitoring Site

Bunbury

NEPM Standard

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

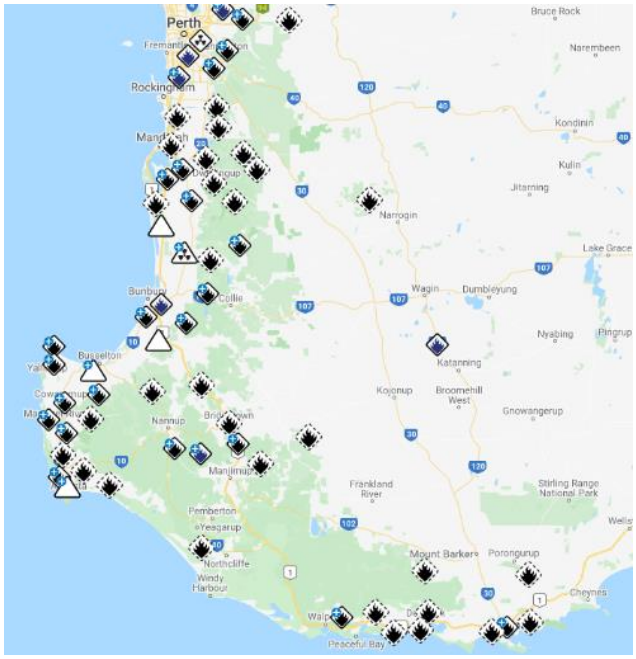
SITE	21 April	
	PM10	PM2.5
CA	13.5	8.7
QR	16.8	10.0
DU	17.2	11.7
SL	20.2	14.5
AR	16.2	11.5
MA	29.9	23.4
BN	46	40.9
BS	7.3	3.3
CO	17.0	NA
GE	20.1	9.7
AL	16.9	NA
KG	8.8	2.1

Description of Event

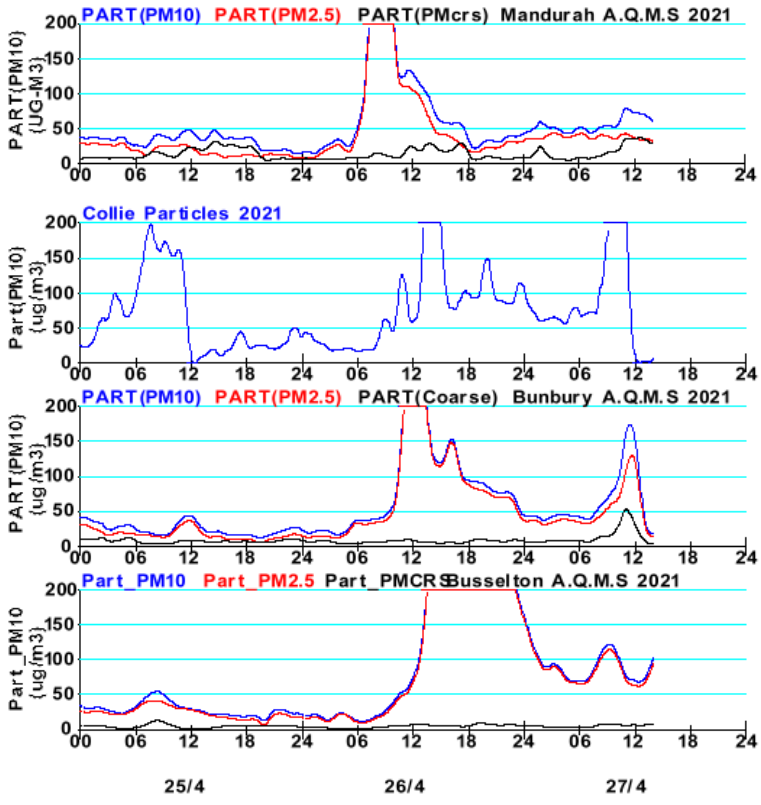
A prescribed burn was conducted, pushing smoke towards Bunbury and elevating $PM_{2.5}$ levels.

Exceptional event PB

25 & 26 April 2021



Several prescribed burns were underway in the south west of the state (https://www.emergency.wa.gov.au/#)



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)

Pollutant

PM_{10} & $PM_{2.5}$

Monitoring Site

Various

NEPM Standard

PM_{10} – 50µg/m^3

$PM_{2.5}$ – 25µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

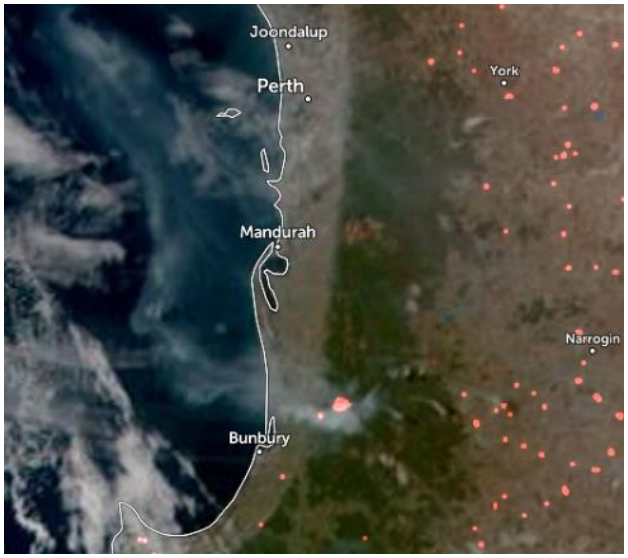
SITE	25 April		26 April	
	PM10	PM2.5	PM10	PM2.5
CA	28.2	22.4	24.2	18.2
QR	NA	NA	NA	NA
DU	33.0	27.8	26.5	21.7
SL	31.3	25.2	30.0	24.6
AR	30.5	24.3	34.2	28.0
MA	32.4	18.1	96.1	83.4
BN	23.9	16.7	89.6	83.1
BS	28.4	23.7	131	126
CO	63.8	NA	84.7	NA
GE	29.2	17.5	32.3	10.4
AL	27.6	NA	20.1	NA
KG	15.8	3.7	17.3	4.7

Description of Event

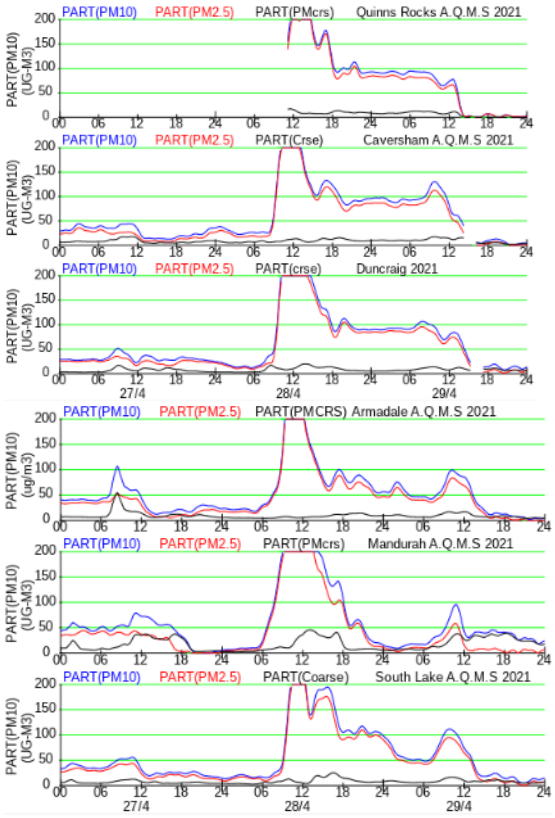
Numerous prescribed burns were undertaken in the South West of the state.

Exceptional events PB

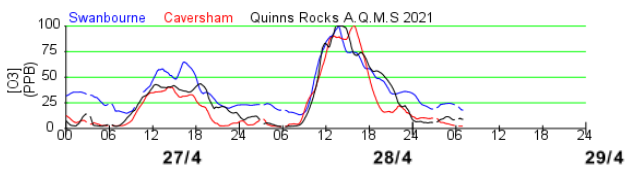
27 & 28 April 2021



Several prescribed burns were underway in the South West of the state (zoom.earth)



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Hourly averaged ozone at various sites

Pollutant

PM_{10}, $PM_{2.5}$ & O_3

Monitoring Site

Various

NEPM Standard

PM_{10} (24hr) – 50 µg/m^3

$PM_{2.5}$ (24hr) – 25 µg/m^3

O_3 (8hr) – 0.065 ppm

Averaging Period

Various

Concentration

SITE	27 April		28 April	
	PM10	PM2.5	PM10	PM2.5
CA	29.1	20.5	97.7	88.3
QR	NA	NA	NA	NA
DU	31.1	24.7	105	96.5
SL	31.9	25.1	101	92.1
AR	36.8	25.2	96.1	88.6
MA	41.5	24.8	103	87.9
BN	43.4	32.2	21.1	13.5
BS	63.4	58.1	13.8	9.9
CO	61.7	NA	31.3	NA
GE	30.3	9.2	36.0	13.6
AL	24.1	NA	16.4	NA
KG	24.4	5.9	22.1	3.8

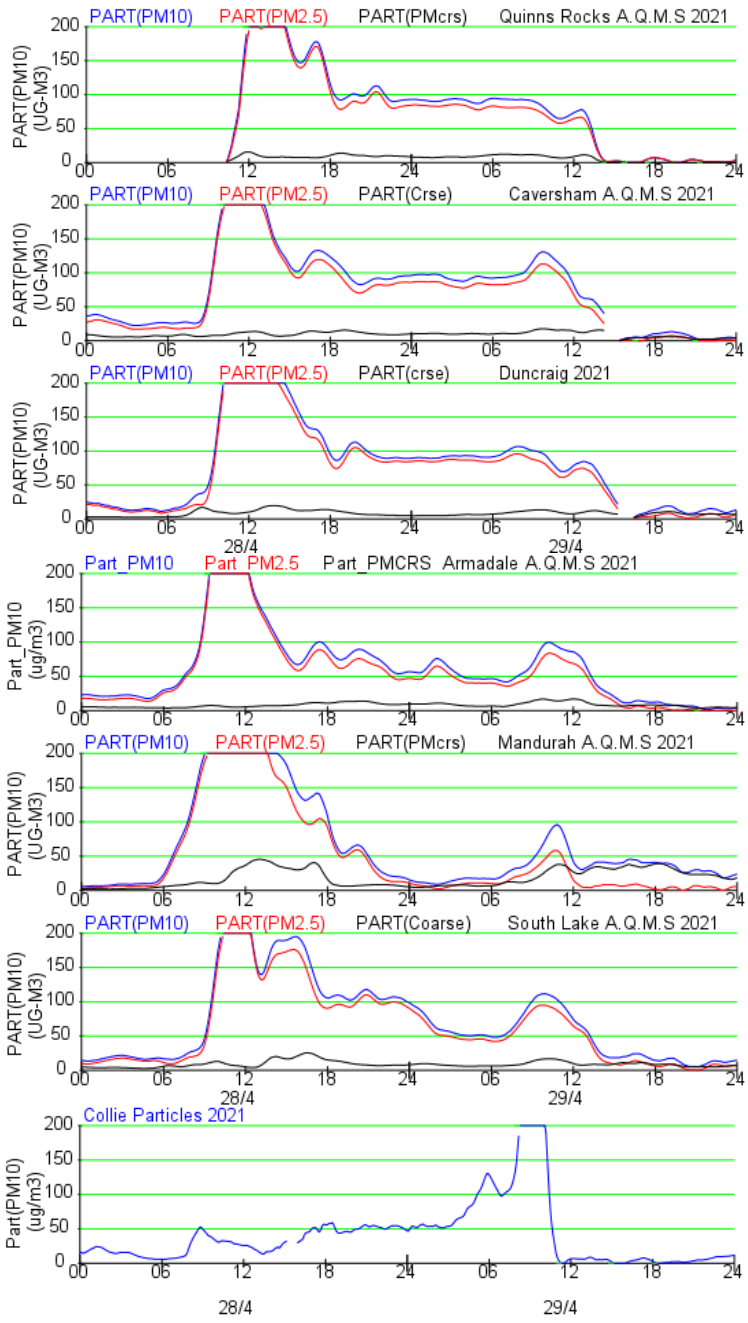
SITE	8hr ozone (ppm)
CA	0.078
QR	0.079
RG	0.065
RO	0.064
SW	0.076
SL	0.059
MA	0.061

Description of Event

Several prescribed burns were undertaken in the South West of the state causing smoke and ozone events.

Exceptional events

29 April 2021



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)

Pollutant

PM_{10} & $PM_{2.5}$

Monitoring Site

Various

NEPM Standard

PM_{10} – 50 µg/m³

$PM_{2.5}$ – 25 µg/m³

Averaging Period

24 hours

Concentration (µg/m³)

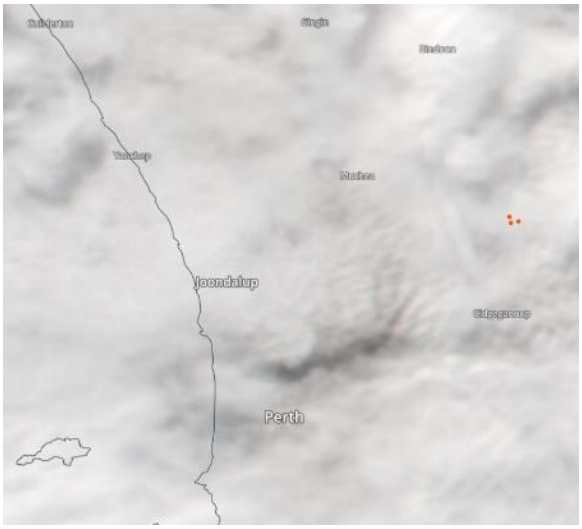
SITE	29 April	
	PM10	PM2.5
CA	61.3	51.8
QR	47.4	42.2
DU	61.7	53.4
SL	45.6	37.0
AR	39.8	31.1
MA	33.6	11.9
BN	30.5	18.1
BS	16.5	9.7
CO	58.8	NA
GE	32.1	15.8
AL	17.9	NA
KG	11.5	2.9

Description of Event

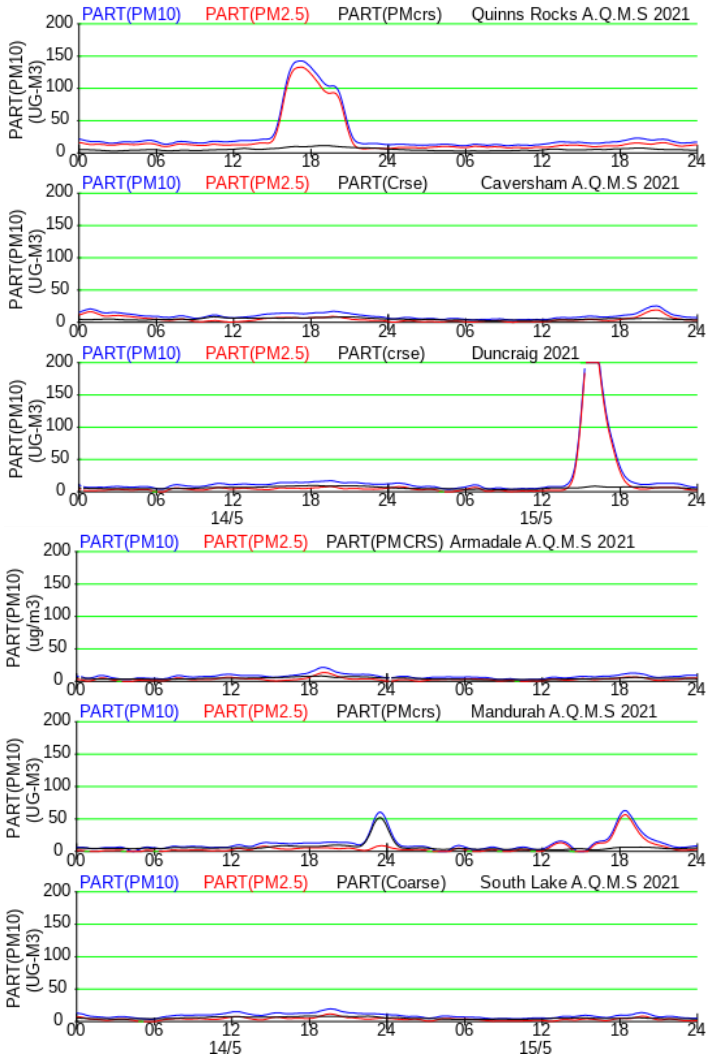
A number of prescribed burns and burn-off operations were undertaken in the South West of the state causing smoke

Exceptional events

14 May 2021



Satellite image https://worldview.earthdata.nasa.gov/



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)

Pollutant

$PM_{2.5}$

Monitoring Site

Quinns Rocks

NEPM Standard

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

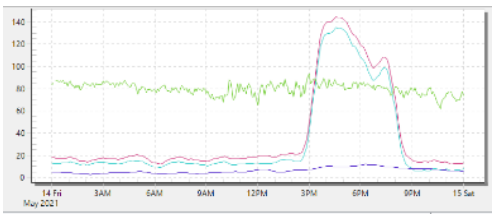
24 hours

Concentration (µg/m^3)

SITE	14 May	
	PM10	PM2.5
CA	11.6	5.6
QR	38.7	32.4
DU	11	4.3
SL	10.7	4.5
AR	8.5	3.5
MA	11.9	2.9
BN	8.6	3.7
BS	7.6	3.9
CO	12.5	NA
GE	23.6	6.4
AL	9.2	NA
KG	6.2	0.9

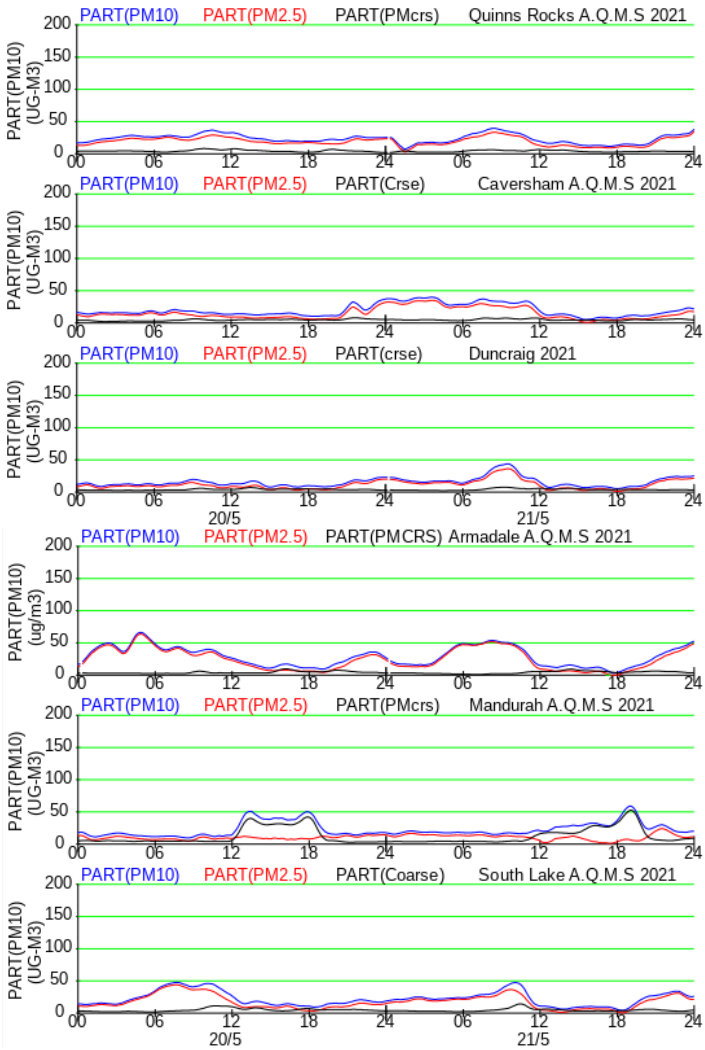
Description of Event

A prescribed burn was likely to have been conducted on the Darling Range. Wind direction analysis indicates prevailing winds would have carried the smoke east to the Quinns Rocks monitoring station. Cloud cover obscured the satellite image of the smoke, however the fire hotspot was detected.



Exceptional event PB

20 May 2021



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)

Pollutant

$PM_{2.5}$

Monitoring Site

Armadale

NEPM Standard

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

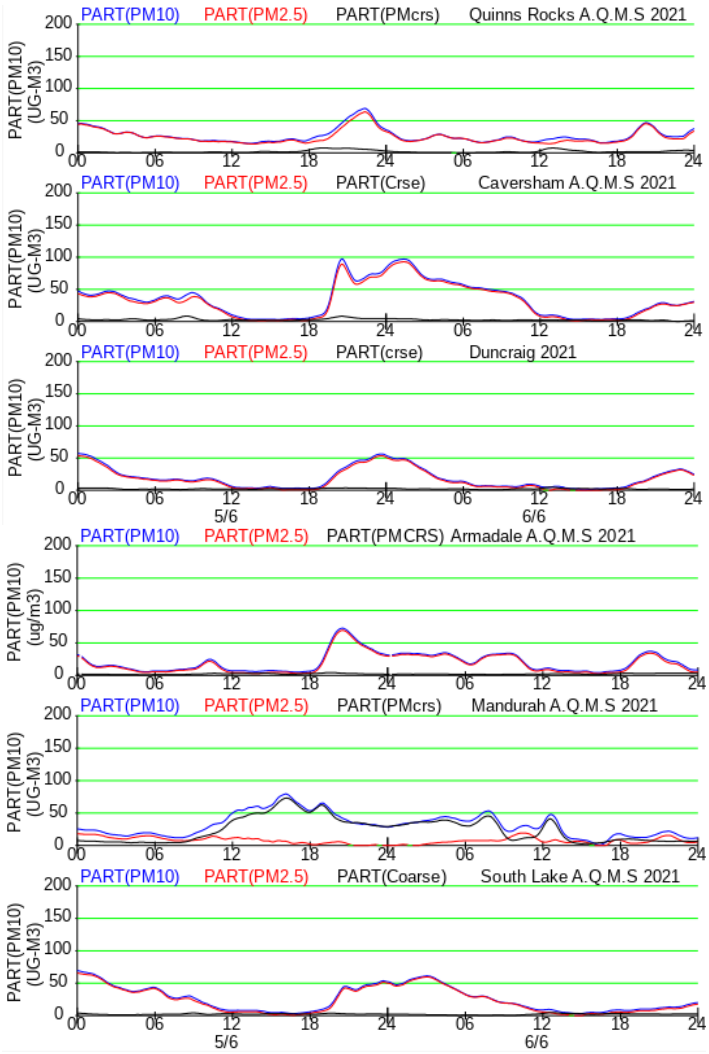
SITE	19 April	
	PM10	PM2.5
CA	17.0	12.4
QR	25.3	20.8
DU	13.3	9.3
SL	22.9	18.0
AR	30.6	26.4
MA	21.7	9.6
BN	16.3	10.5
BS	15.5	11.4
CO	21.1	NA
GE	21.5	8.8
AL	21.8	NA
KG	16.6	4.5

Description of Event

Likely wood heater smoke.

Assessable event WH

5 & 6 June 2021



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)

Pollutant

$PM_{2.5}$

Monitoring Site

Various

NEPM Standard

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

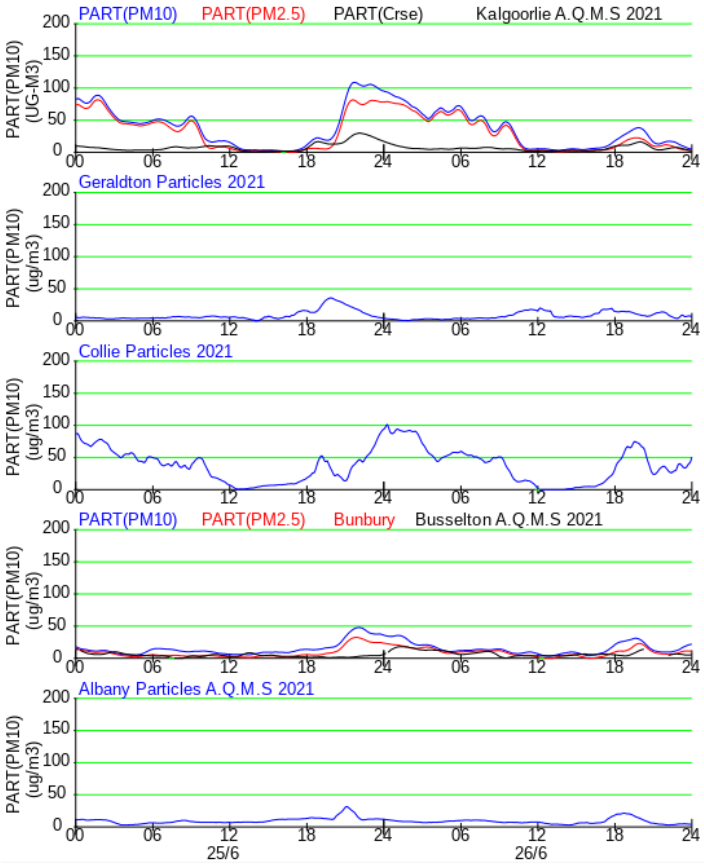
SITE	5 June		6 June	
	PM10	PM2.5	PM10	PM2.5
CA	34.2	30.8	34.9	32.8
QR	29.2	27.0	23.8	21.9
DU	21.2	19.0	15.1	13.1
SL	27.9	25.6	21.8	19.8
AR	19.0	16.8	20.8	18.6
MA	37.0	7.9	25.8	6.6
BN	12.9	4.8	9.9	3.9
BS	8.8	5.1	9.4	4.8
CO	28	NA	NA	NA
GE	10.1	4.8	12.2	6.7
AL	9.0	NA	11.8	NA
KG	28.7	22.3	12	9.1

Description of Event

Likely wood heater smoke.

Assessable events WH

25 & 26 June 2021



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)

Pollutant

$PM_{2.5}$

Monitoring Site

Kalgoorlie

NEPM Standard

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

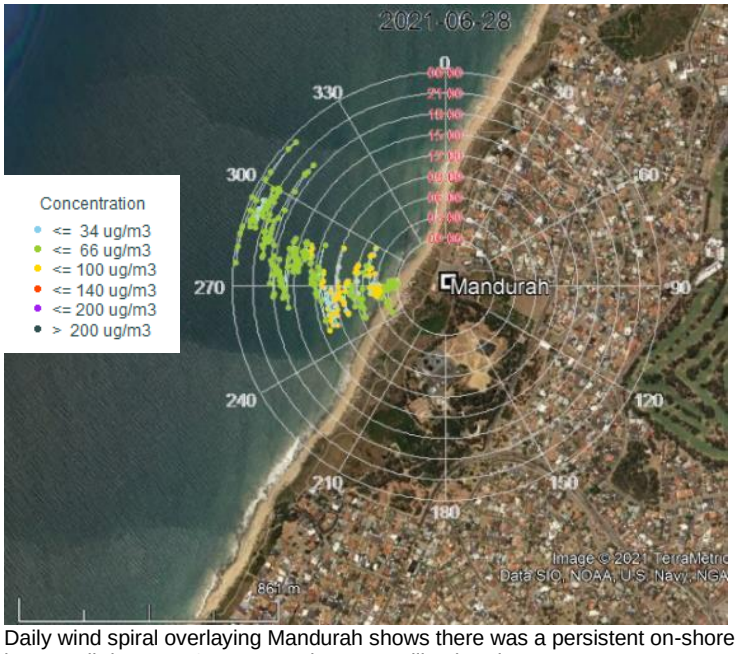
SITE	25 June		26 June	
	PM10	PM2.5	PM10	PM2.5
CA	18.0	13.2	16.3	13.5
QR	15.9	14.7	13.9	13.0
DU	11.7	9.7	13.3	12.1
SL	25.5	22.4	24.7	23.1
AR	9.4	7.7	7.5	5.6
MA	21.7	6.1	11.4	4.7
BN	15.1	8.2	14.7	9.3
BS	10.9	4.0	14.7	7.6
CO	36.2	NA	38.7	NA
GE	9.0	5.4	8.1	3.9
AL	10.1	NA	8.0	NA
KG	42.7	33.9	31.8	26.0

Description of Event

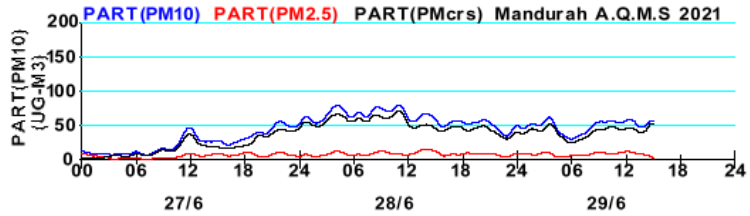
Likely wood heater smoke.

Assessable events WH

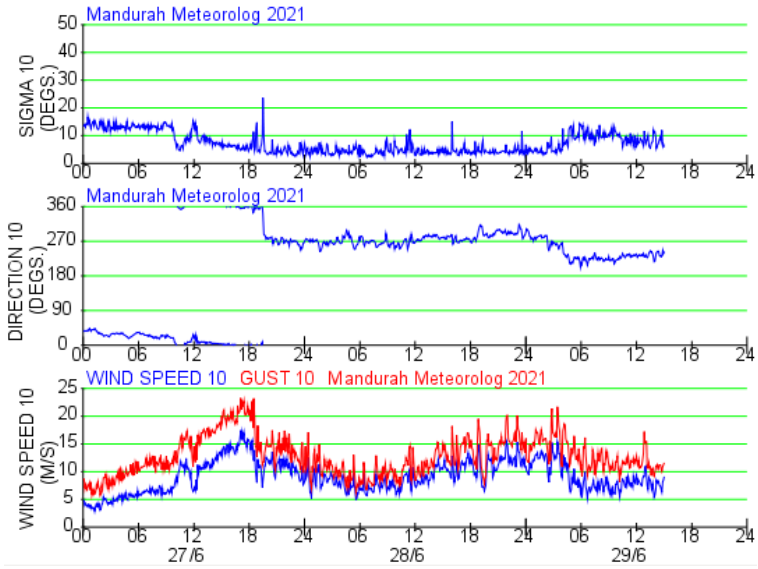
28 June 2021



Daily wind spiral overlaying Mandurah shows there was a persistent on-shore breeze all day. PM10 concentrations are rolling hourly averages



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

$PM_{2.5}$

Monitoring Site

Mandurah

NEPM Standard

PM_{10} – 50 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

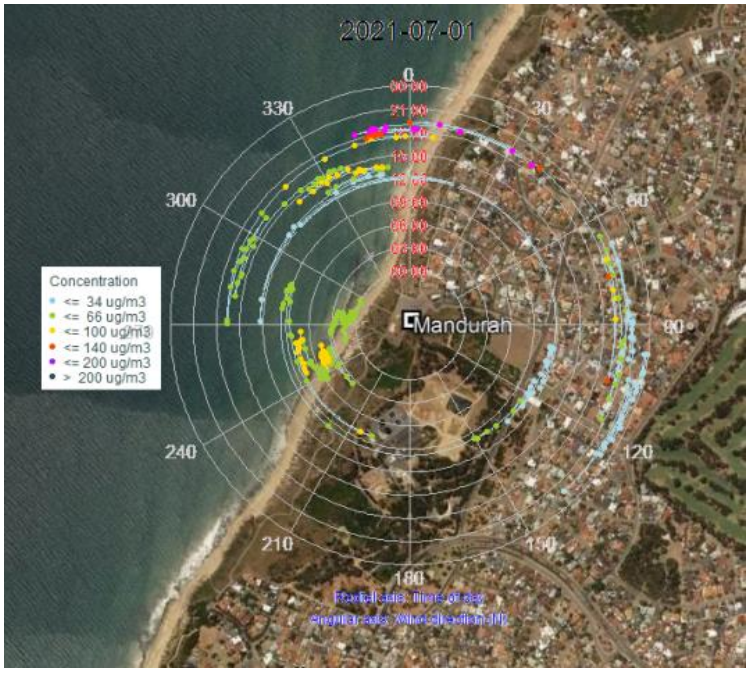
SITE	28 June	
	PM10	PM2.5
CA	9.7	3.4
QR	23.4	11.0
DU	14.0	4.6
SL	15.9	6.5
AR	12.5	4.9
MA	60.3	8.7
BN	21.4	4.9
BS	24.5	6.9
CO	15.8	NA
GE	20.9	7.1
AL	13.4	NA
KG	15.4	9.3

Description of Event

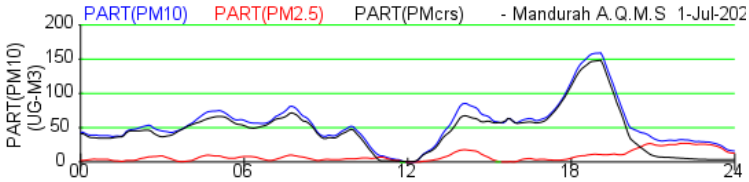
Persistent westerly winds caused marine aerosols to impact Mandurah. The majority of PM_{10} particles were made up of PM_{coarse} (PM_{10} less $PM_{2.5}$)

Assessable event MA

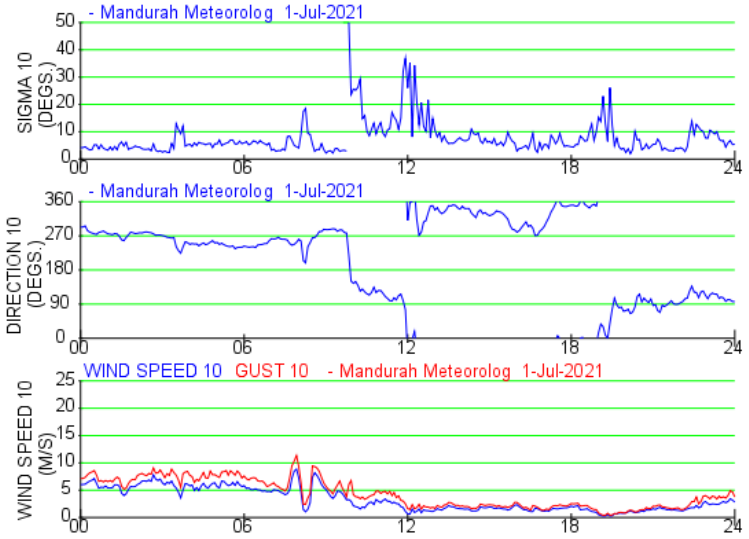
1 July 2021



Daily wind spiral overlaying Mandurah shows there was a persistent on-shore breeze for most of the day. PM_{10} concentrations are rolling hourly averages



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

PM_{10}

Monitoring Site

Mandurah

NEPM Standard

PM_{10} – 50 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

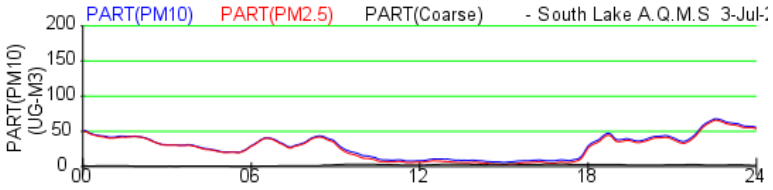
SITE	1 July	
	PM10	PM2.5
CA	13.9	9.2
QR	15.8	12.4
DU	10.8	8.7
SL	13.8	11.3
AR	12.0	9.3
MA	54.5	8.4
BN	11.0	5.3
BS	18.7	13.7
CO	9.2	NA
GE	8.0	4.7
AL	15.4	NA
KG	26.8	21.0

Description of Event

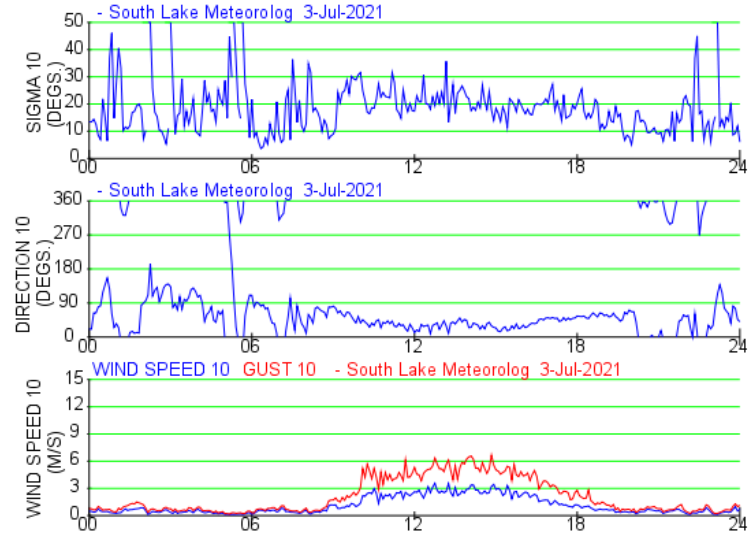
Persistent westerly winds caused marine aerosols to impact Mandurah. The majority of PM_{10} particles were made up of PM_{coarse} (PM_{10} less $PM_{2.5}$)

Assessable event MA

3 July 2021



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

$PM_{2.5}$

Monitoring Site

South Lake

NEPM Standard

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

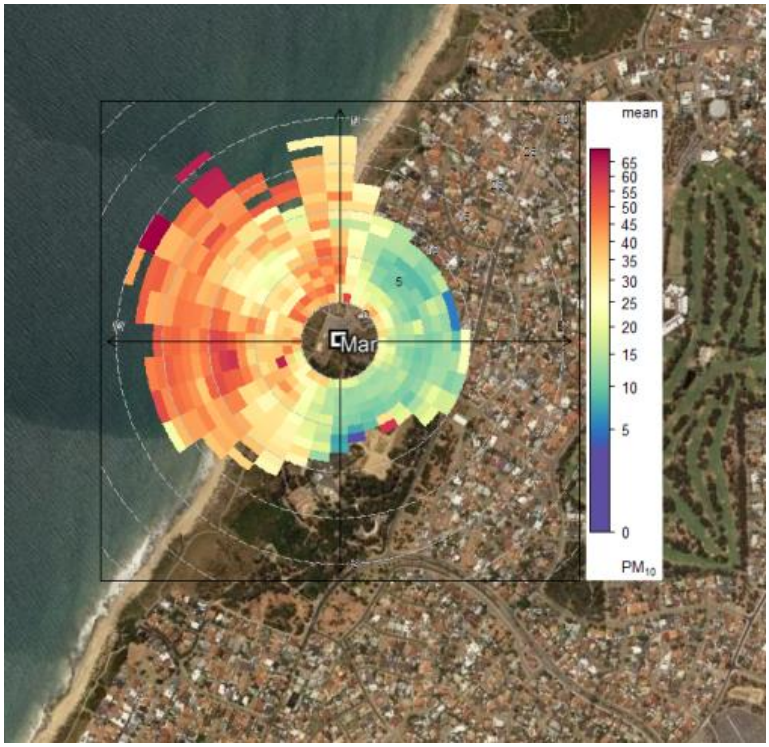
SITE	3 July	
	PM10	PM2.5
CA	17.0	13.9
QR	15.0	13.5
DU	12.8	10.9
SL	29.0	26.9
AR	5.9	4.2
MA	16.9	7.4
BN	16.8	9.2
BS	19.5	13.8
CO	26.5	NA
GE	7.7	5.1
AL	9.9	NA
KG	17.0	13.9

Description of Event

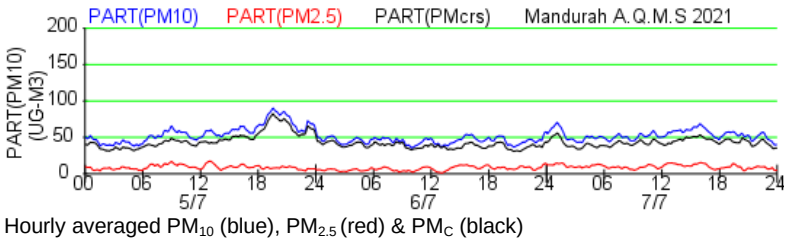
Some overnight wood heater smoke coupled with low wind speeds.

Assessable event WH

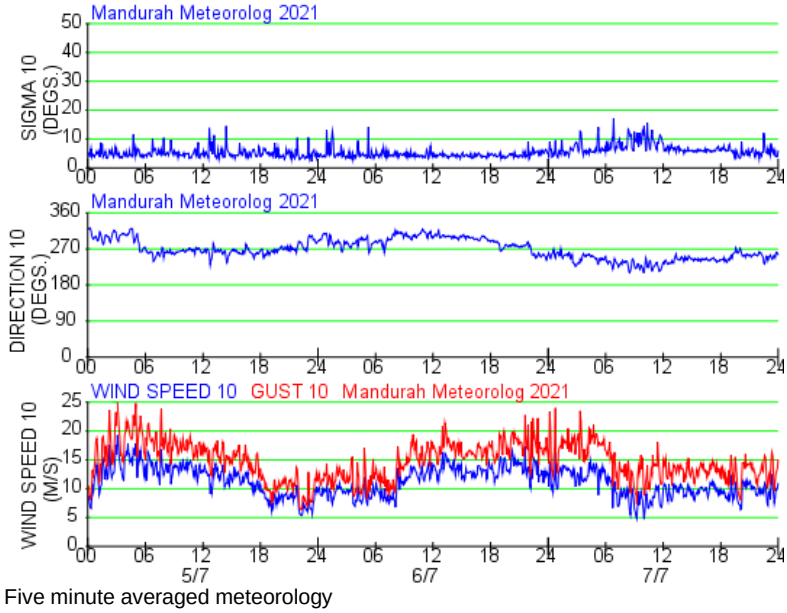
5 & 7 July 2021



Polar frequency plot at Mandurah (1 January to 12 July 2021) showing the mean PM_{10} concentration based on wind direction. High mean concentrations of PM_{10} from marine aerosols at Mandurah are experienced when winds are elevated and on shore.



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

PM_{10}

Monitoring Site

Mandurah

NEPM Standard

PM_{10} – 50 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

SITE	5 July		7 July	
	PM10	PM2.5	PM10	PM2.5
CA	11.1	4.0	11.9	4.5
QR	18.9	8.1	22.1	10.3
DU	11.5	4.0	13.8	4.2
SL	16.0	6.3	15.0	6.2
AR	11.8	4.7	11.5	3.7
MA	56.7	9.0	53.2	10.0
BN	21.7	5.8	17.9	4.8
BS	25.9	11.7	21.3	13.3
CO	15.3	NA	14.8	NA
GE	15.7	5.5	17.6	6.7
AL	7.9	NA	10.6	NA
KG	7.2	2.2	6.3	2.2

Description of Event

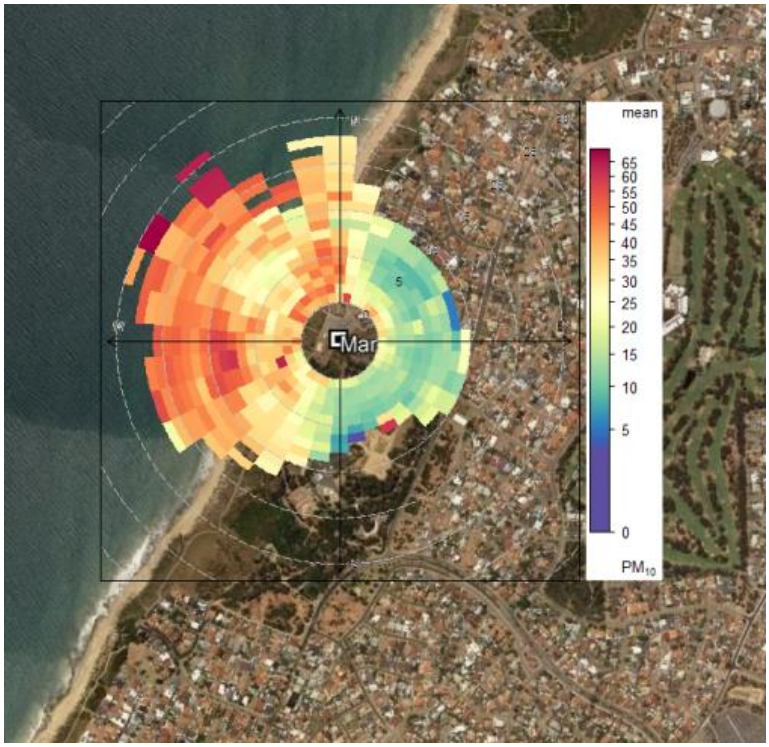
Persistent westerly winds caused marine aerosols to impact Mandurah. The majority of PM_{10} particles were made up of PM_{coarse} (PM_{10} less $PM_{2.5}$).

On 6 July MA PM_{10} concentration was 45.4µg/m^3.

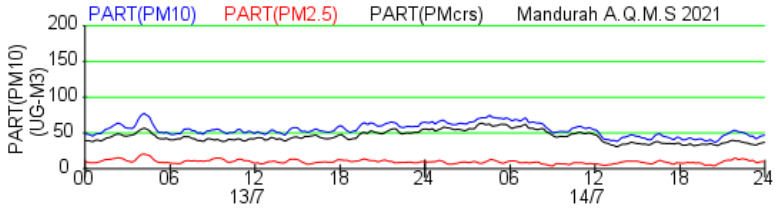
05/07 Assessable event MA

07/07 Assessable event MA

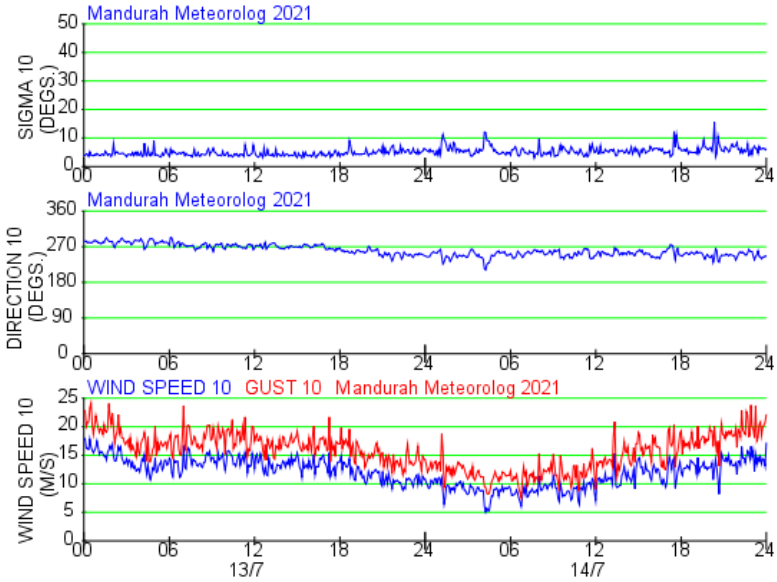
13 & 14 July 2021



Polar frequency plot at Mandurah (1 January to 12 July 2021) showing the mean PM_{10} concentration based on wind direction. High mean concentrations of PM_{10} from marine aerosols at Mandurah are experienced when winds are elevated and on shore.



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

PM_{10}

Monitoring Site

Mandurah

NEPM Standard

PM_{10} – 50 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

SITE	13 July		14 July	
	PM10	PM2.5	PM10	PM2.5
CA	12.0	3.4	9.6	2.8
QR	25.3	12.2	20.8	11.6
DU	16.9	5.7	11.5	2.8
SL	16.8	6.2	13.1	6.0
AR	12.9	3.7	9.5	3.7
MA	55.5	10.7	53.7	8.6
BN	22.4	5.6	17.0	3.7
BS	23.5	12.0	19.0	12.0
CO	15.1	NA	8.5	NA
GE	20.6	7.9	NA	NA
AL	10.9	NA	7.7	NA
KG	6.2	1.9	4.5	1.7

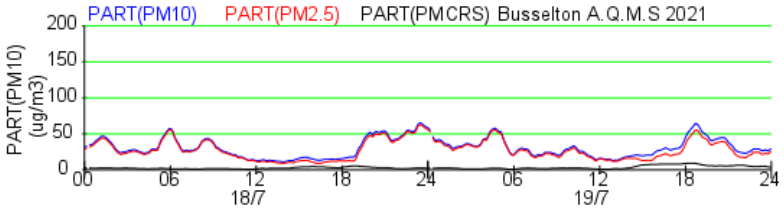
Description of Event

Persistent westerly winds caused marine aerosols to impact Mandurah. The majority of PM_{10} particles were made up of PM_{coarse} (PM_{10} less $PM_{2.5}$).

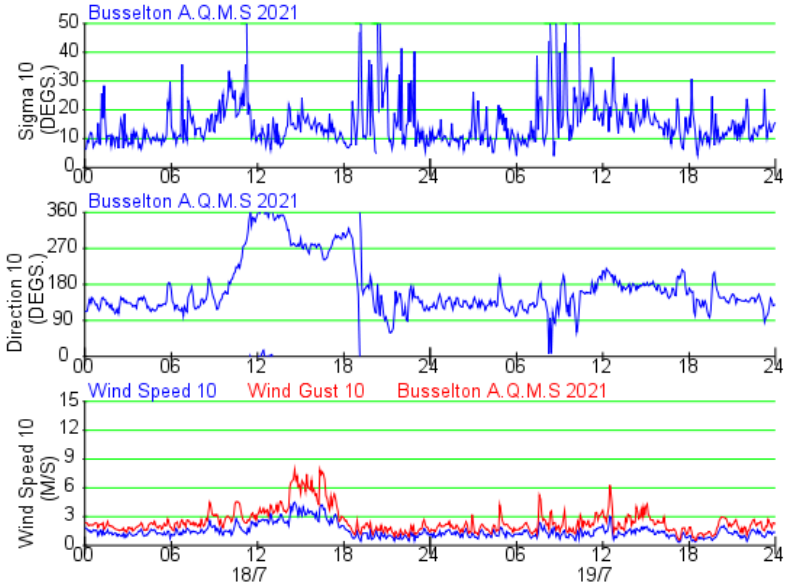
13/07 Assessable event MA

14/07 Assessable event MA

18 & 19 July 2021



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

$PM_{2.5}$

Monitoring Site

Busselton

NEPM Standard

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

SITE	18 July		19 July	
	PM10	PM2.5	PM10	PM2.5
CA	7.2	5.3	11.2	7.9
QR	12.5	9.3	12.9	10.5
DU	6.8	4.1	8.4	5.6
SL	9.8	8.1	15	11.6
AR	9	6.7	11.1	8.1
MA	28.3	4.2	30.5	4.6
BN	15.3	8.2	15.8	10.1
BS	30.2	27.8	30.9	27.2
CO	19.3	NA	15.5	NA
GE	9.5	7.2	5.2	4.6
AL	7.4	NA	12	NA
KG	29.9	22.9	9.5	5.7

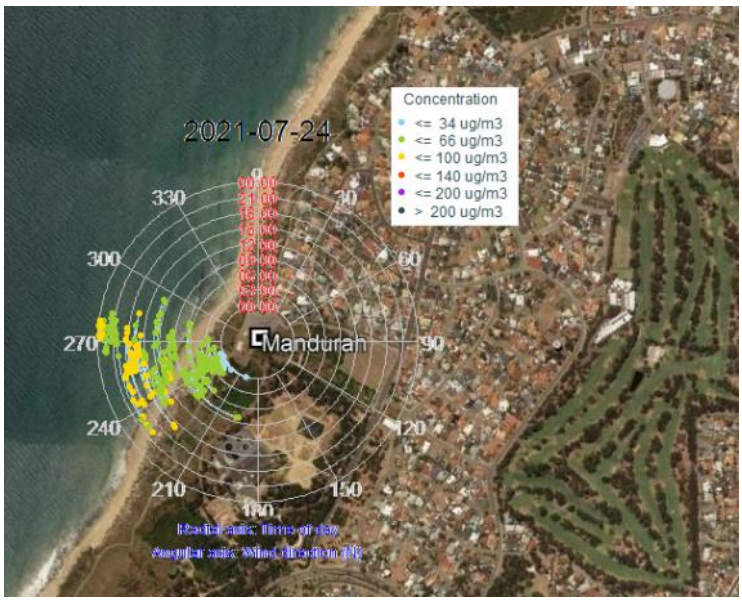
Description of Event

The majority of PM_{10} particles were made up of $PM_{2.5}$. Likely cause was wood heater smoke. No prescribed burns were underway near the site.

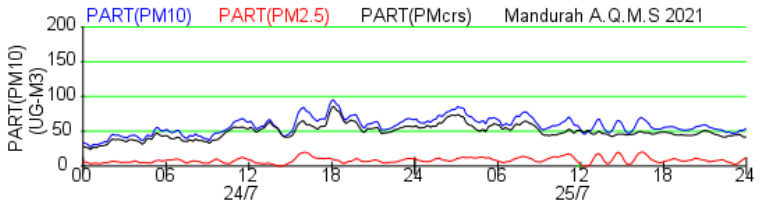
18/07 Assessable event WH

19/07 Assessable event WH

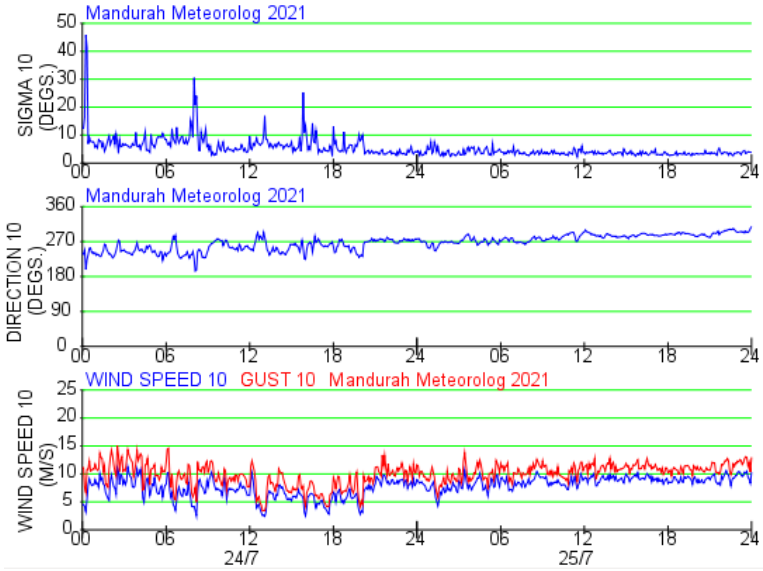
24 & 25 July 2021



Daily wind spiral for 24 July 2021 overlaying Mandurah. For both days there was a persistent on-shore breeze. PM_{10} concentrations are rolling hourly averages



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

PM_{10}

Monitoring Site

Mandurah

NEPM Standard

PM_{10} – 50 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

SITE	24 July		25 July	
	PM10	PM2.5	PM10	PM2.5
CA	10.5	4.9	8.4	3.8
QR	17.7	10.3	16	9.1
DU	9.9	3.7	7.5	2.6
SL	8.8	3.3	11	4.8
AR	10.3	6	10.1	5
MA	55.1	7.1	60.8	9.4
BN	13.5	3.2	19.5	4.3
BS	20.8	13.1	28.8	14
CO	12.1	NA	14.8	NA
GE	14.7	6.9	12.1	6.7
AL	13.7	NA	13.6	NA
KG	7.4	2.9	10.5	7.7

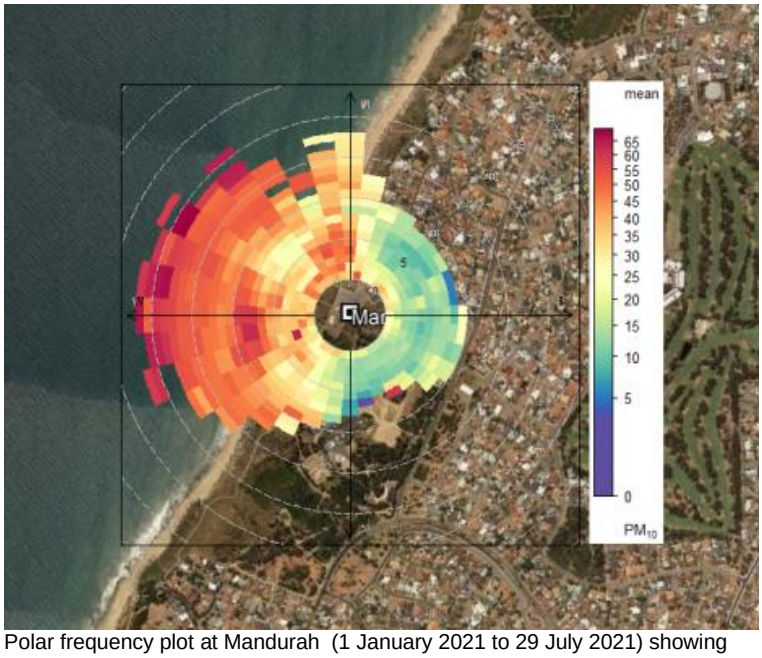
Description of Event

Persistent westerly winds caused marine aerosols to impact Mandurah. The majority of PM_{10} particles were made up of PM_{coarse} (PM_{10} less $PM_{2.5}$).

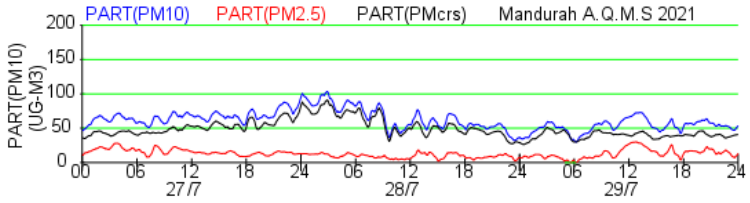
24/07 Assessable event MA

25/07 Assessable event MA

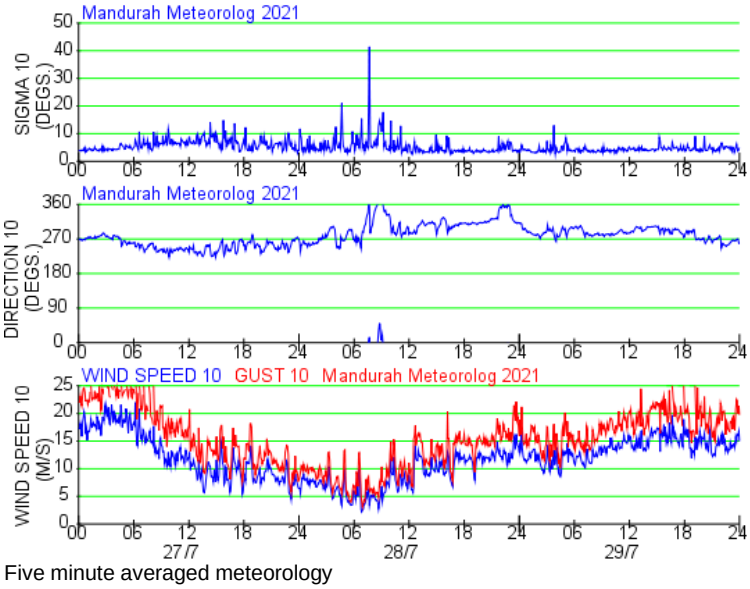
27, 28 & 29 July 2021



Polar frequency plot at Mandurah (1 January 2021 to 29 July 2021) showing the mean PM_{10} concentration based on wind direction. High mean concentrations of PM_{10} from marine aerosols at Mandurah are experienced when winds are elevated and on shore.



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

PM_{10}

Monitoring Site

Mandurah

NEPM Standard

PM_{10} – 50 µg/m³

Averaging Period

24 hours

Concentration (µg/m³)

SITE	27 July		28 July		29 July	
	PM10	PM2.5	PM10	PM2.5	PM10	PM2.5
CA	16.9	5.2	8.2	4.2	18.3	7.3
QR	31.2	14.5	15.9	10.1	28.9	13.5
DU	22.7	7.3	7.8	2.8	16.9	5.1
SL	20.8	7.4	7.6	2.2	20.6	7.6
AR	17.7	6.6	8.2	3.8	16.7	5.8
MA	66.7	15.9	65.3	9.4	52.8	13.2
BN	24.3	6.1	16.6	2.9	30	7.9
BS	28.4	16.5	23.2	13.1	36.9	17.5
CO	18	NA	11.4	NA	18.9	NA
GE	29.4	11.8	21.9	7.4	18.1	7.6
AL	15.8	NA	9.9	NA	12.6	NA
KG	5.5	2	11.6	5.5	5.1	1.9

Description of Event

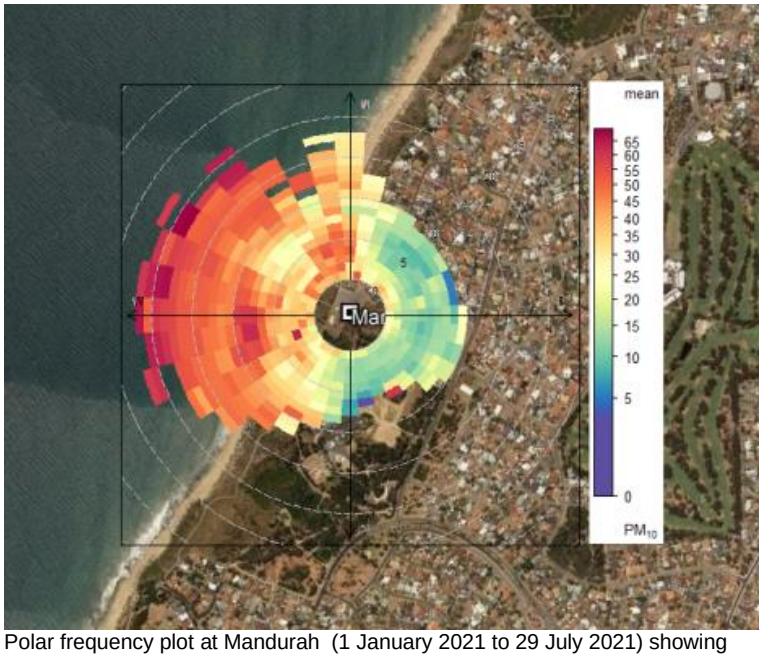
Persistent westerly winds caused marine aerosols to impact Mandurah. The majority of PM_{10} particles were made up of PM_{coarse} (PM_{10} less $PM_{2.5}$).

27/07 Assessable event MA

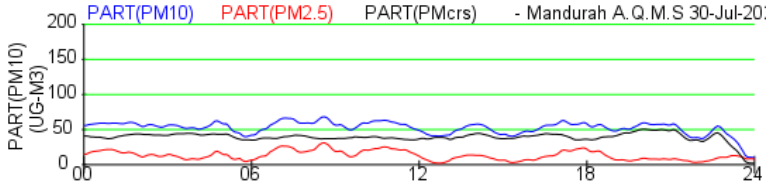
28/07 Assessable event MA

29/07 Assessable event MA

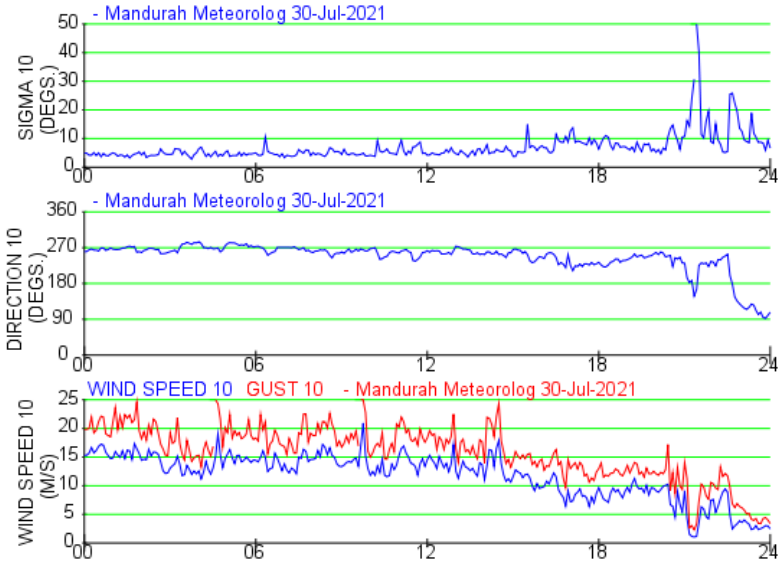
30 July 2021



Polar frequency plot at Mandurah (1 January 2021 to 29 July 2021) showing the mean PM_{10} concentration based on wind direction. High mean concentrations of PM_{10} from marine aerosols at Mandurah are experienced when winds are elevated and on shore.



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

PM_{10}

Monitoring Site

Mandurah

NEPM Standard

PM_{10} – 50 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

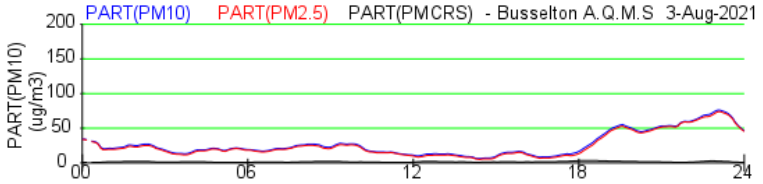
SITE	30 July	
	PM10	PM2.5
CA	11.6	4.7
QR	22.6	11.7
DU	13.5	4.1
SL	13.6	4.8
AR	13.5	6.4
MA	52.5	13.3
BN	18.5	6.6
BS	25	15.8
CO	13.9	NA
GE	20.1	8.4
AL	9.2	NA
KG	NA	NA

Description of Event

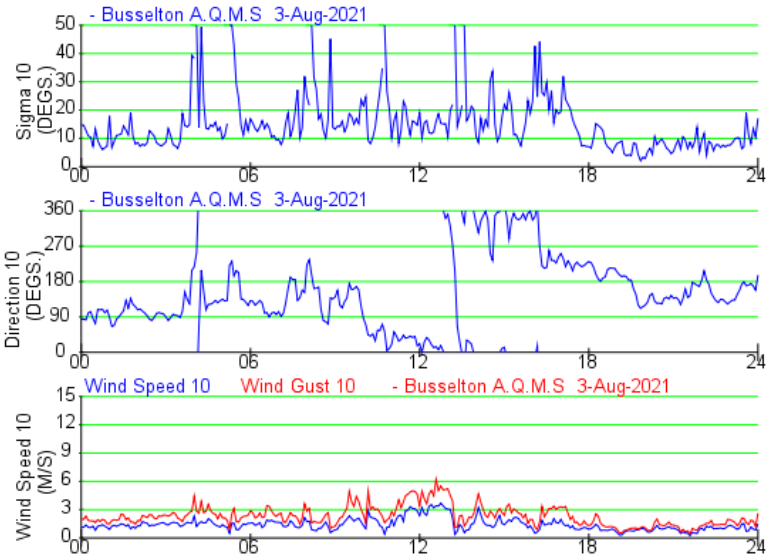
Persistent westerly winds caused marine aerosols to impact Mandurah. The majority of PM_{10} particles were made up of PM_{coarse} (PM_{10} less $PM_{2.5}$).

Assessable event MA

3 August 2021



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

$PM_{2.5}$

Monitoring Site

Busselton

NEPM Standard

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

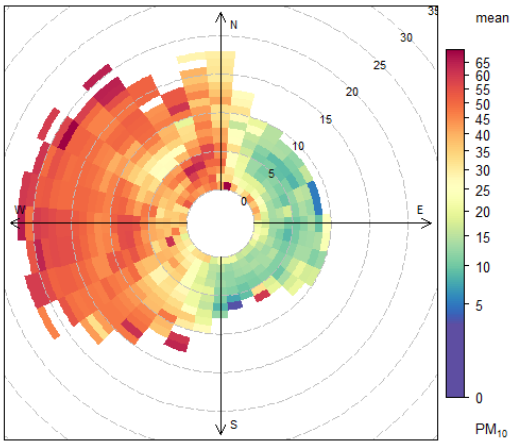
SITE	3 August	
	PM10	PM2.5
CA	12.1	7.3
QR	17.7	13.5
DU	13.5	8.7
SL	15.6	11.2
AR	NA	NA
MA	16.6	6.6
BN	18.7	13.6
BS	26.6	25.1
CO	15.4	NA
GE	9.6	5.3
AL	7.7	NA
KG	14.2	6.5

Description of Event

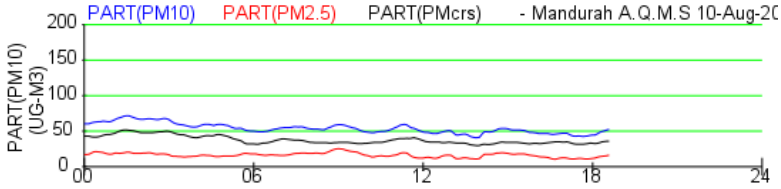
Overnight wood heater smoke. PM_{10} comprised almost totally of $PM_{2.5}$ fraction.

Assessable Event WH

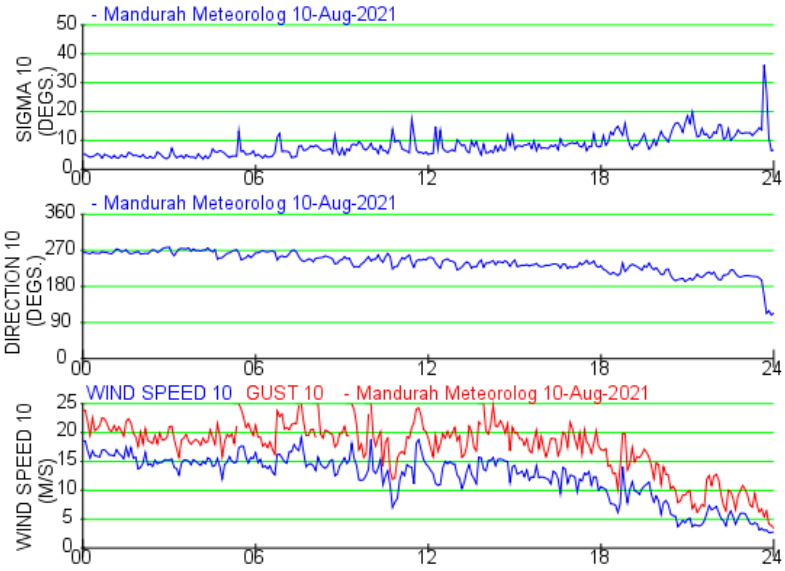
10 August 2021



Polar frequency plot at Mandurah (1 January 2021 to 31 August 2021) showing the mean PM_{10} concentration based on wind direction. High mean concentrations of PM_{10} from marine aerosols at Mandurah are experienced when winds are elevated and on shore.



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

PM_{10}

Monitoring Site

Mandurah

NEPM Standard

PM_{10} – 50 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

SITE	10 August	
	PM10	PM2.5
CA	12.5	5.1
QR	16.8	4.3
DU	17.0	6.2
SL	14.9	4.9
AR	12.4	4.0
MA	54.1	16.4
BN	19.6	6.8
BS	20.1	11.6
CO	13.8	NA
GE	24.2	9.6
AL	8.9	NA
KG	4.9	0

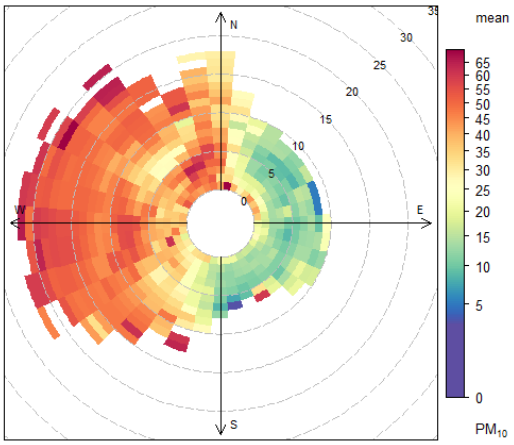
Description of Event

Persistent westerly winds caused marine aerosols to impact Mandurah. The majority of PM_{10} particles were made up of PM_{coarse} (PM_{10} less $PM_{2.5}$).

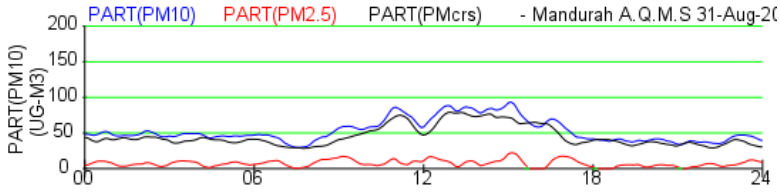
While some data loss occurred in the afternoon, due to >75% data availability a valid daily average can be calculated.

Assessable event MA

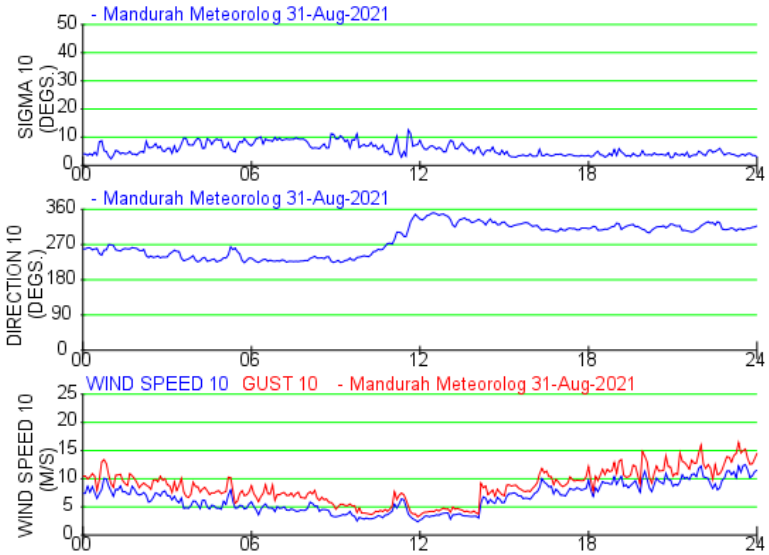
31 August 2021



Polar frequency plot at Mandurah (1 January 2021 to 31 August 2021) showing the mean PM_{10} concentration based on wind direction. High mean concentrations of PM_{10} from marine aerosols at Mandurah are experienced when winds are elevated and on shore.



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

PM_{10}

Monitoring Site

Mandurah

NEPM Standard

PM_{10} – 50 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

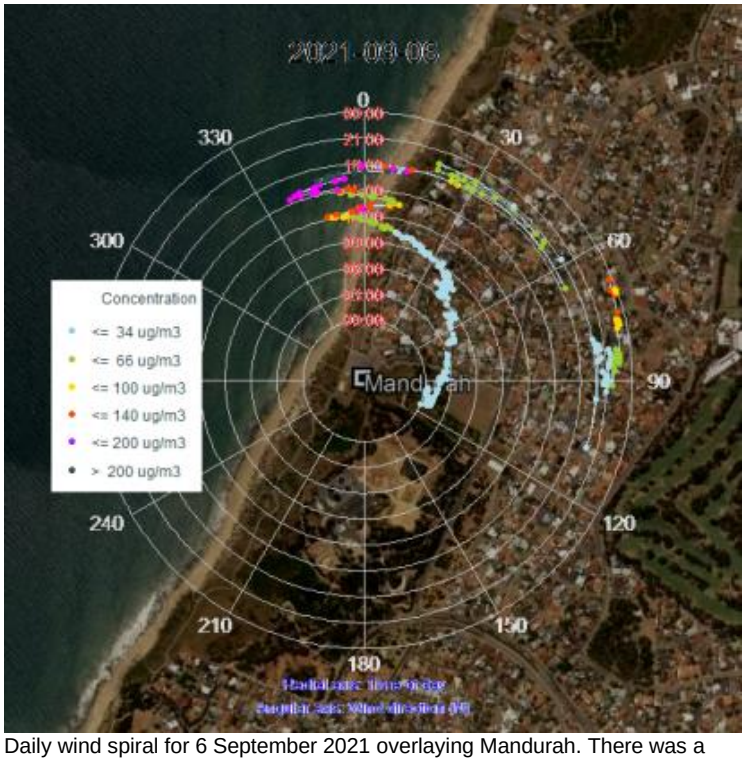
SITE	31 August	
	PM10	PM2.5
CA	6.0	2.3
QR	12.3	5.7
DU	4.5	0.7
SL	6.0	2.9
AR	4.5	1.5
MA	53.0	7.3
BN	10.2	1.4
BS	10.3	2.7
CO	6.7	NA
GE	16.7	8.2
AL	6.3	NA
KG	15.9	6.3

Description of Event

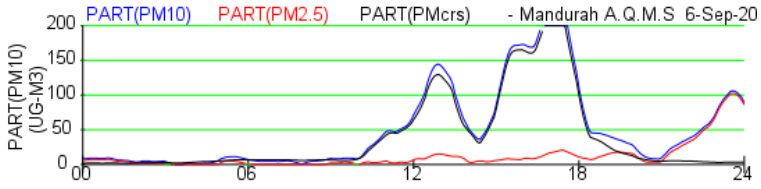
Persistent westerly winds caused marine aerosols to impact Mandurah. The majority of PM_{10} particles were made up of PM_{coarse} (PM_{10} less $PM_{2.5}$).

Assessable event MA

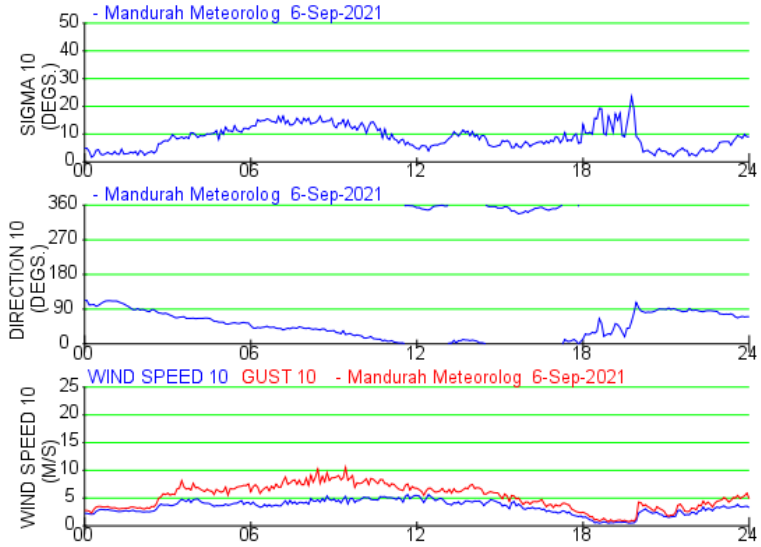
6 September 2021



Daily wind spiral for 6 September 2021 overlaying Mandurah. There was a persistent on-shore northerly breeze in early to late afternoon. PM_{10} concentrations are rolling hourly averages.



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

PM_{10}

Monitoring Site

Mandurah

NEPM Standard

PM_{10} – 50 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

SITE	31 August	
	PM10	PM2.5
CA	8.1	4.1
QR	10.1	6.4
DU	8.0	4.5
SL	9.0	5.5
AR	6.8	3.5
MA	51.5	11.6
BN	14.1	5.8
BS	14.0	5.9
CO	12.6	NA
GE	24.3	6.4
AL	18.2	NA
KG	7.5	1.9

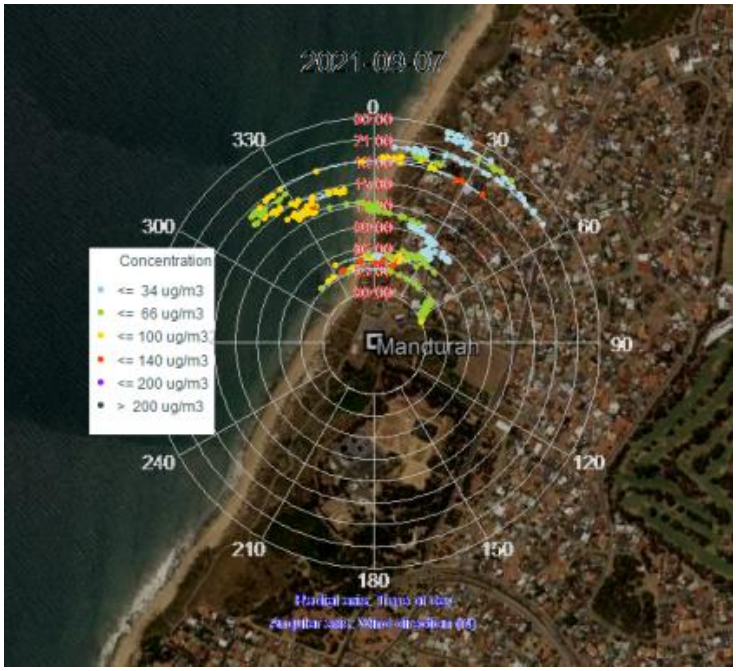
Description of Event

Northerly winds in early to late afternoon caused marine aerosols to impact Mandurah AQMS. The majority of PM_{10} particles were made up of PM_{coarse} (PM_{10} less $PM_{2.5}$).

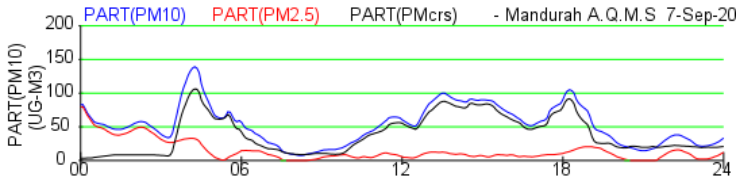
Evening PM was made up of finer particles, possibly local smoke.

Assessable event MA

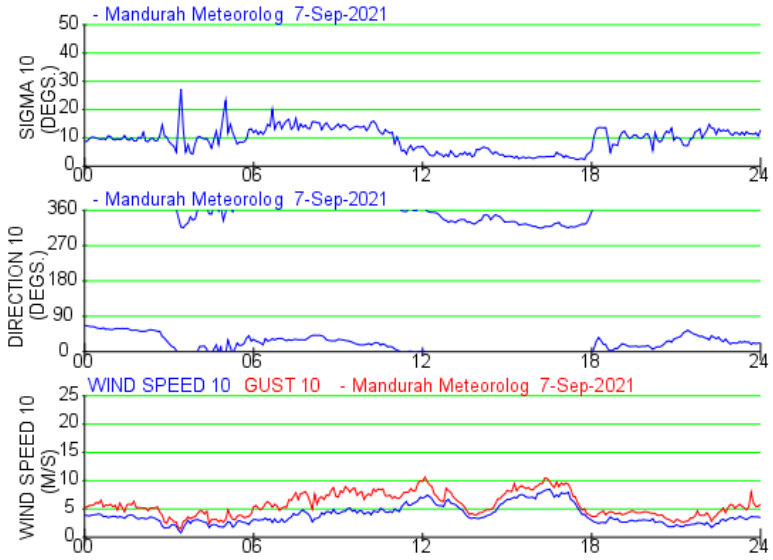
7 September 2021



Daily wind spiral for 6 September 2021 overlaying Mandurah. There was a persistent on-shore northerly breeze in early to late afternoon. PM_{10} concentrations are rolling hourly averages.



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

PM_{10}

Monitoring Site

Mandurah

NEPM Standard

PM_{10} – 50 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

SITE	31 August	
	PM10	PM2.5
CA	16.6	7.2
QR	19.7	11.0
DU	11.4	4.6
SL	12.8	5.8
AR	12.5	5.1
MA	52.9	13.8
BN	19.9	7.0
BS	18.7	6.6
CO	24.3	NA
GE	20.0	6.3
AL	28.4	NA
KG	7.8	1.5

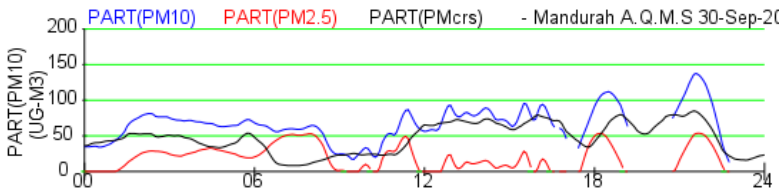
Description of Event

Northerly winds from early morning to late afternoon caused marine aerosols to impact Mandurah AQMS. The majority of PM_{10} particles were made up of PM_{coarse} (PM_{10} less $PM_{2.5}$).

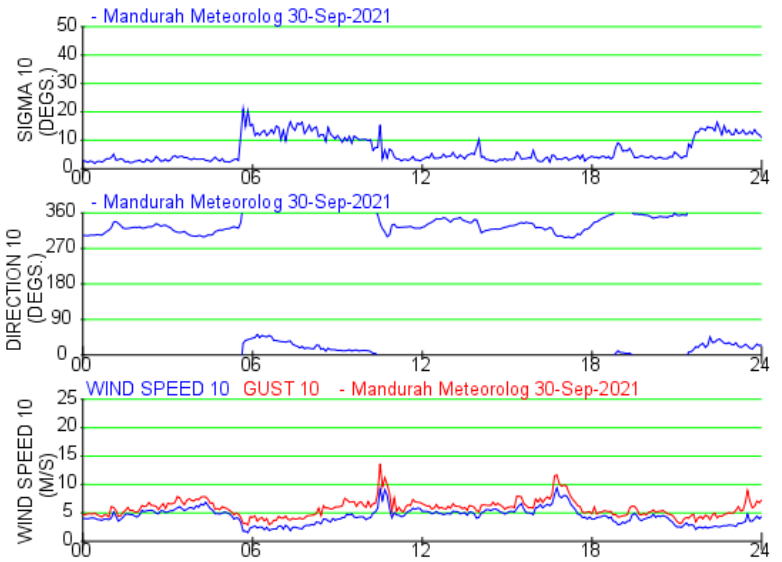
Some early morning PM was made up of finer particles, possibly local smoke.

Assessable event MA

30 September 2021



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

PM_{10}

Monitoring Site

Mandurah

NEPM Standard

PM_{10} – 50 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

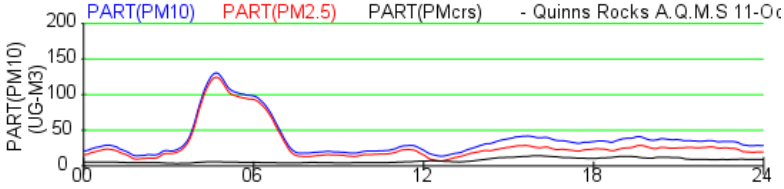
SITE	30 September	
	PM10	PM2.5
CA	11.6	5.3
QR	14.0	6.3
DU	8.5	2.4
SL	10.7	4.1
AR	9.8	3.5
MA	67.1	19.8
BN	13.5	3.2
BS	11.7	2.2
CO	NA	NA
GE	13.9	5.7
AL	12.4	NA
KG	NA	NA

Description of Event

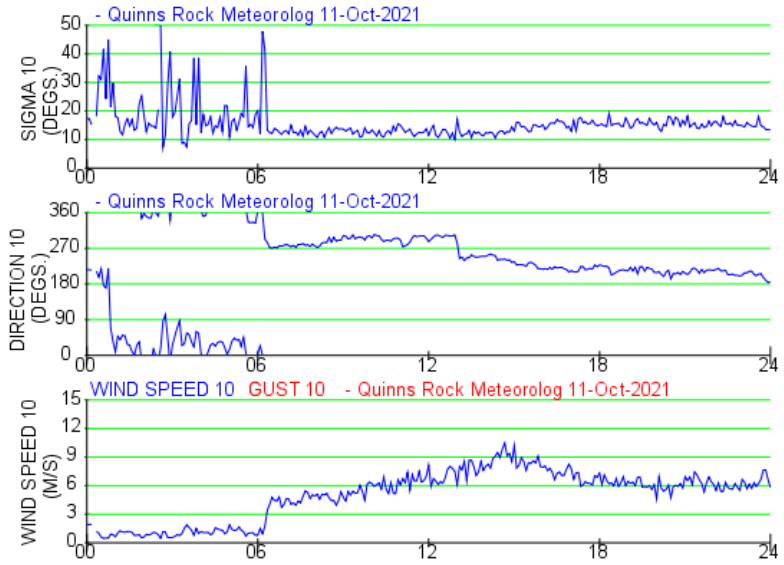
Northerly winds over the day caused marine aerosols to impact Mandurah AQMS. The majority of PM_{10} particles were made up of PM_{coarse} (PM_{10} less $PM_{2.5}$).

Assessable event MA

11 October 2021



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

$PM_{2.5}$

Monitoring Site

Quinns Rocks

NEPM Standard

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

SITE	11 October	
	PM10	PM2.5
CA	15.1	6.9
QR	37.4	29.7
DU	14.1	5.1
SL	14.0	6.8
AR	12.8	6.3
MA	22.4	4.4
BN	13.8	3.8
BS	14.1	6.1
CO	9.2	4.5
GE	19.9	7.2
AL	13.0	NA
KG	NA	NA

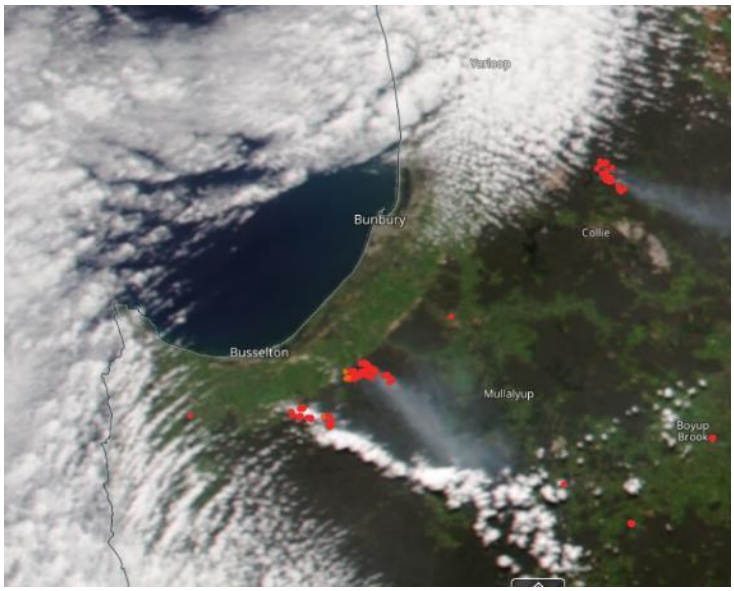
Description of Event

Local smoke event. No Prescribed burns were active in the area at the time.

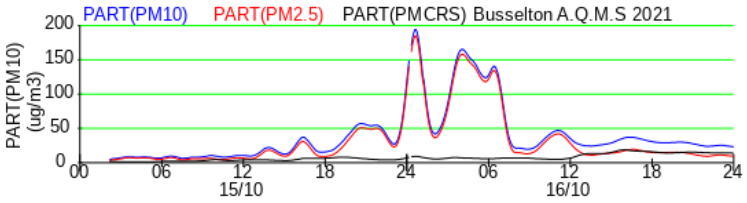
A prescribed burn was active in Yanchep National Park. Some minor smoke influence possible due to northerly winds.

Assessable event

16 October 2021



Satellite image https://worldview.earthdata.nasa.gov/



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)

Pollutant

PM_{10} & $PM_{2.5}$

Monitoring Site

Busselton

NEPM Standard

PM_{10} – 50 µg/m^3

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

SITE	16 October	
	PM10	PM2.5
CA	21.3	10.0
QR	28.6	15.3
DU	21.7	8.7
SL	23.5	12.0
AR	22.0	10.9
MA	49.6	16.5
BN	26.3	13.9
BS	54.3	43.7
CO	21.2	11.2
GE	17.3	7.3
AL	26.2	NA
KG	NA	NA

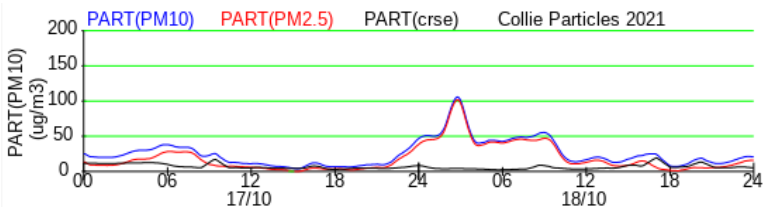
Description of Event

A number of prescribed burns were active in the Witcher Scarp adjacent to Busselton.

Exceptional events PB

18 October 2021

Satellite image https://worldview.earthdata.nasa.gov/



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)

Pollutant

PM_{10} & $PM_{2.5}$

Monitoring Site

Collie

NEPM Standard

PM_{10} – 50 µg/m^3

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

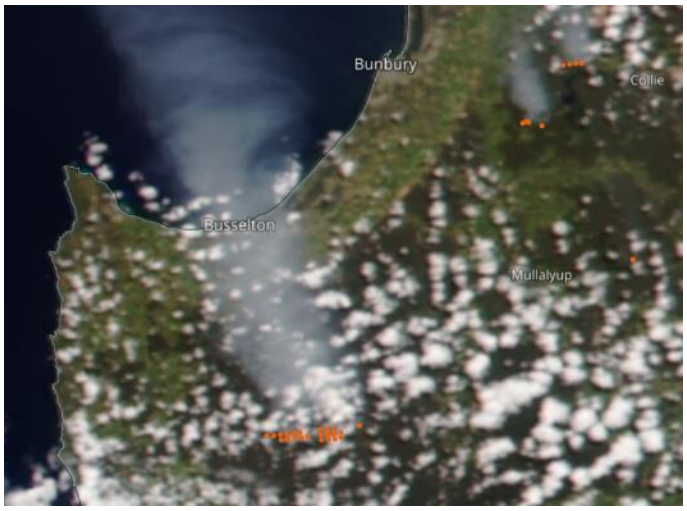
SITE	16 October	
	PM10	PM2.5
CA	10.9	6.2
QR	21.6	17.4
DU	7.5	3.4
SL	11.3	7.1
AR	16.6	12.0
MA	22.2	5.0
BN	14.2	4.2
BS	14.7	7.2
CO	31.8	25.8
GE	10.6	5.0
AL	15.7	NA
KG	NA	NA

Description of Event

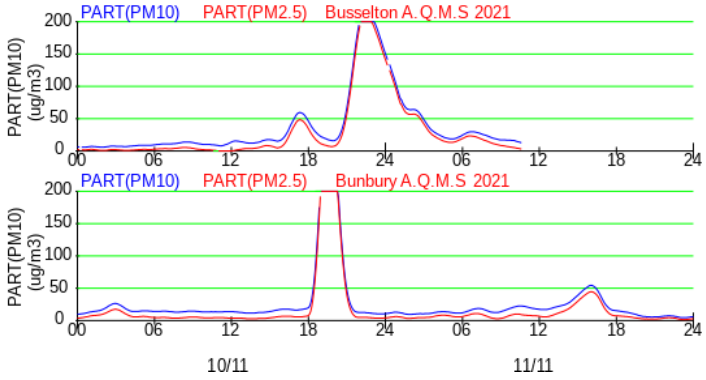
A large number of prescribed burns were active on the Darling Range, including one started two days earlier 2 km south of Collie townsite

Exceptional event PB

10 November 2021



Satellite image https://worldview.earthdata.nasa.gov/



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)

Pollutant

$PM_{2.5}$

Monitoring Site

Bunbury & Busselton

NEPM Standard

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

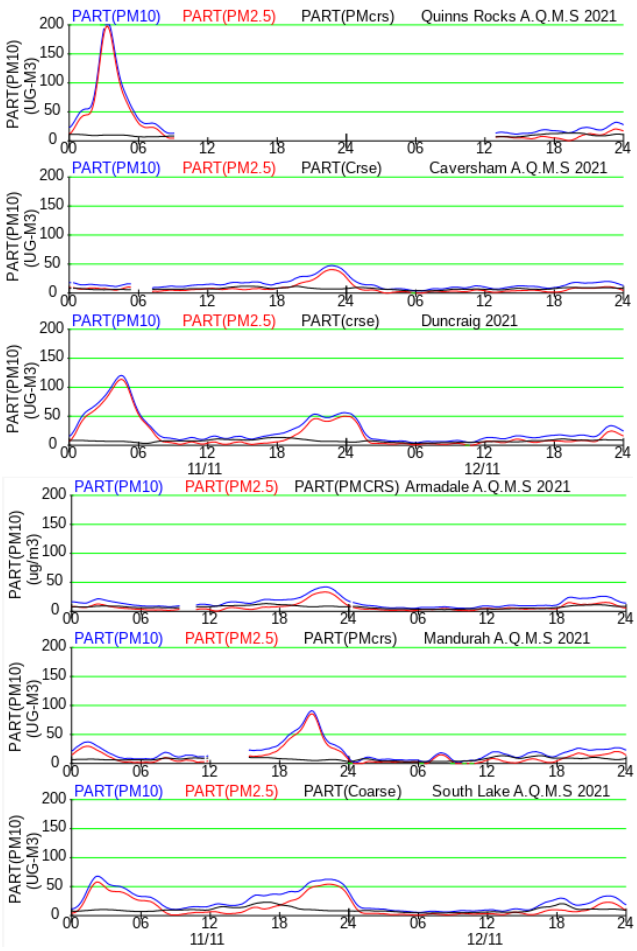
SITE	10 November	
	PM10	PM2.5
CA	12.8	5.7
QR	15.3	7.9
DU	11.4	3.9
SL	12.7	3.7
AR	12.3	4.8
MA	27.3	18.8
BN	37.5	28.1
BS	39.3	30.7
CO	24.5	12
GE	10.1	3.1
AL	14.3	NA
KG	6.7	2.4

Description of Event

A large prescribed burn was undertaken south of Busselton and Bunbury on 10 and 11 November, pushing a large smoke plume north.

Exceptional events PB

11 November 2021



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)

Pollutant

$PM_{2.5}$

Monitoring Site

Duncraig

NEPM Standard

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

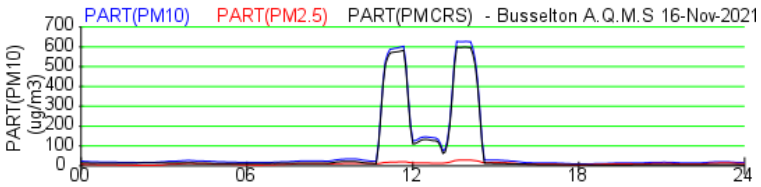
SITE	11 November	
	PM10	PM2.5
CA	19.8	11.8
QR	NA	NA
DU	38.3	30.1
SL	35.8	24.2
AR	18.2	9.5
MA	26.9	19.7
BN	16.8	9.5
BS	NA	NA
CO	15.2	6.4
GE	33.5	21.4
AL	13.7	NA
KG	8.2	2.9

Description of Event

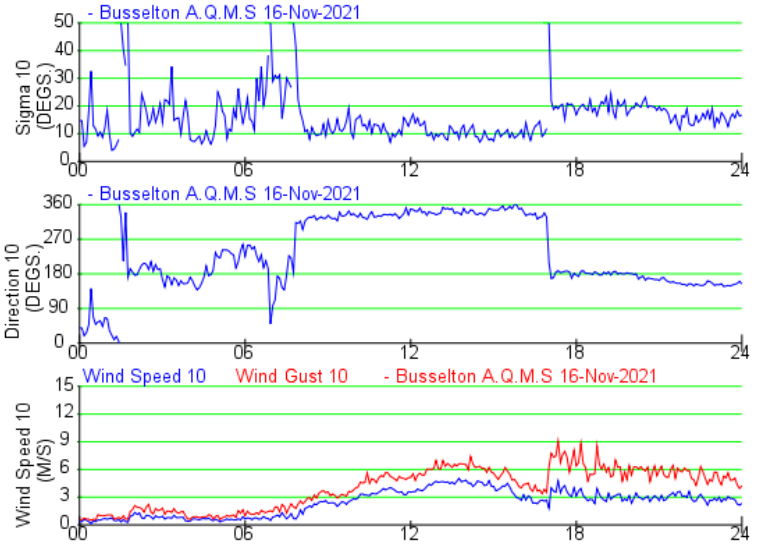
A large prescribed burn was undertaken south of Busselton and Bunbury on 10 and 11 November, pushing a large smoke plume north to the Perth metropolitan area.

Exceptional event PB

16 November 2021



Hourly averaged PM_{10} (blue), $PM_{2.5}$ (red) & PM_C (black)



Five minute averaged meteorology

Pollutant

$PM_{2.5}$

Monitoring Site

Busselton

NEPM Standard

$PM_{2.5}$ – 25 µg/m^3

Averaging Period

24 hours

Concentration (µg/m^3)

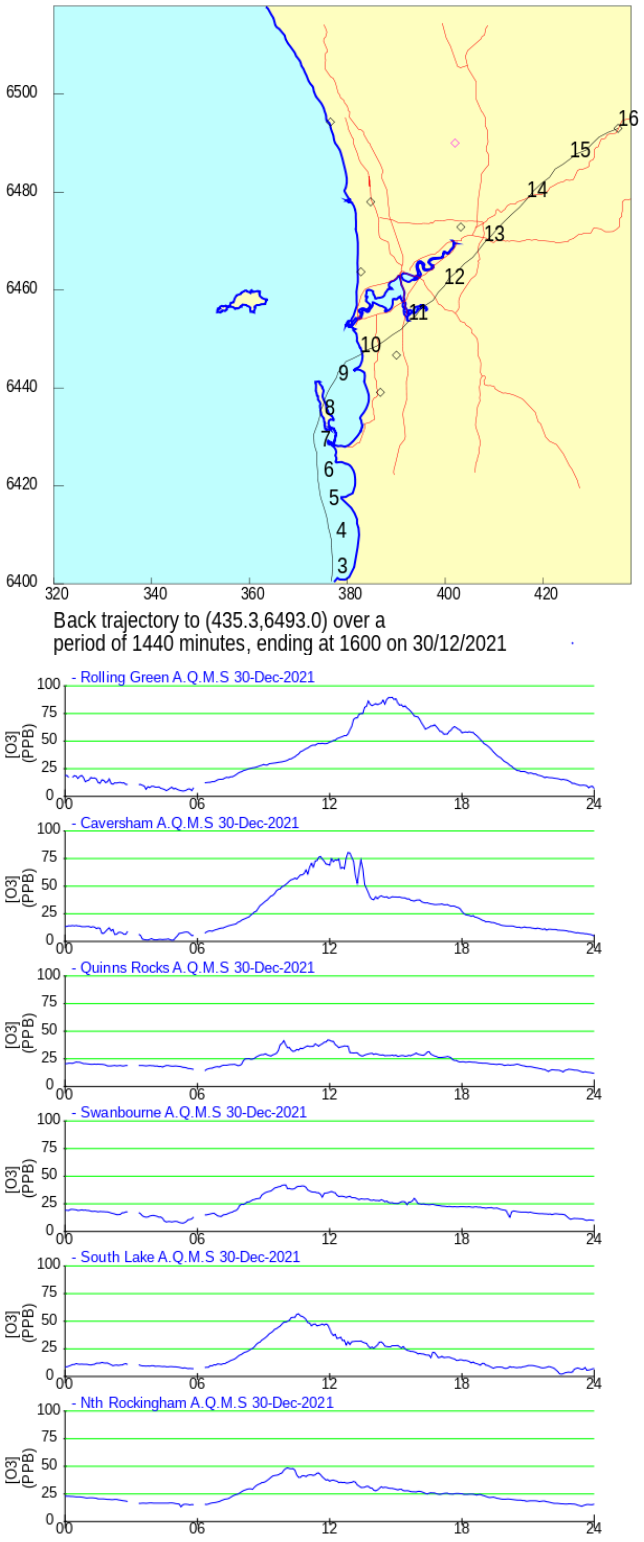
SITE	16 October	
	PM10	PM2.5
CA	15.8	7.6
QR	14.1	4.9
DU	11.7	4.8
SL	16.9	6.6
AR	17.8	7.6
MA	21.0	7.1
BN	19.5	9.0
BS	74.4	10.8
CO	20.0	9.3
GE	17.9	11.5
AL	31.4	NA
KG	12.9	3.2

Description of Event

Local dust event. No prescribed burns were active in the area at the time, and the particle were in the coarse (> $PM_{2.5}$) fraction.
The adjacent Trotting Club secretary advised that several truckloads of track topping were dropped off and they were re-surfacing the track with it.

Assessable event WD

30 December 2021



Five minute averaged ozone

Pollutant

O_3

Monitoring Site

Rolling Green

NEPM Standard

O_3 – 0.065 ppm

Averaging Period

8 hours

Concentration (ppm)

SITE	8hr ozone
CA	0.052
QR	0.032
RG	0.065
RO	0.035
SW	0.032
SL	0.036
MA	0.024

Description of Event

Perth CBD emissions with south-westerly flow resulted in elevated inland ozone concentrations.

Assessable event