



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

REPORT

2016 Western Australia air monitoring report

*Written to comply with the National Environment Protection
(Ambient Air Quality) Measure*

Version: Final

July 2017

Document control

Document version history

Date	Author	Version	Approved by
29/06/17	Arthur Grieco Manager, Air Quality	Final	Dan Volaric, A/Director General
15/06/17	As above	Draft	Kerry Laszig Director, Environmental Sciences

Corporate file information

File number and/or name	File owner or custodian	File location
DWER2014/001782	Arthur Grieco Manager, Air Quality	Booragoon

Copyright © State of Western Australia 2017

Unless otherwise stated, copyright in all materials on this website is the property of the State of Western Australia. In addition to any fair dealings permitted under the provisions of the *Copyright Act 1968*, material on this website may be reproduced or communicated to the public for research, study and private non-commercial use provided that the State of Western Australia is acknowledged as the copyright owner and the material is not altered. Enquiries may be directed to the Department of Water and Environmental Regulation via email info@dwer.wa.gov.au, phone 6467 5000 or post to Locked Bag 33, Cloisters Square, Perth WA 6850.

The publication provided is for your information and interest only. It is not intended to be comprehensive, and does not constitute and must not be relied on as legal advice. You must seek your own specific legal advice tailored to your circumstances. Further information on privacy, disclaimer and copyright is available on the Department's website (www.dwer.wa.gov.au).

Accessibility

This document is available in alternative formats and languages on request.

Contents

Document control	i
Document version history	i
Executive summary	1
Section A – Monitoring summary	2
Current monitoring stations	2
Carbon monoxide (CO)	11
Photochemical oxidants as ozone	11
Nitrogen dioxide (NO ₂)	12
Sulfur dioxide	13
Lead	14
Particles as PM ₁₀	14
Particles as PM _{2.5}	15
Variations to the NEPM.....	16
Exceedence summary	16
Section B – Assessment of compliance with standards and goals	18
Section C – Analysis of air quality monitoring	21
Carbon monoxide (CO)	21
Nitrogen dioxide (NO ₂)	22
Photochemical smog as ozone	23
Sulfur dioxide (SO ₂)	25
Particles as PM ₁₀	27
Particles as PM _{2.5}	29
Section D – Data analysis	31
Maxima and percentiles by pollutant in 2016	31
Maxima and percentiles by site 2007–2016	35
Maxima by pollutant 2007–2016	49
Attachment 1 – Graphical trends	54
Carbon monoxide.....	55
Nitrogen dioxide	56
Ozone	60
Sulfur dioxide	66
Particles as PM ₁₀	69
Particles as PM _{2.5}	73
Attachment 2 – Exceedence summary	76
7 January 2016	77
8 and 9 January 2016	78

2 February 2016.....	79
10 February 2016.....	80
14 February 2016.....	81
03 April 2016.....	82
06 April 2016.....	83
12 May 2016	84
18 May 2016	85
23 October 2016	86
26 October 2016	87
28 October 2016	88
06 November 2016	89
14 November 2016	90
23 November 2016	91
24 November 2016	92
25 November 2016	93
27 November 2016	94
05 December 2016	95
08 December 2016	96
10 December 2016	97
17 December 2016	98
20 December 2016	99

Executive summary

As signatory to the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM), Western Australia (WA) is required to report annually on results of air monitoring.

The Department of Water and Environmental Regulation (DWER) is responsible for the operation and maintenance of 13 air quality monitoring sites in WA with a total capital cost of over \$1.5 million. Eight of these sites – Caversham (Ca), Duncraig (Du), Quinns Rocks (QR), Rolling Green (RG), Rockingham (Ro), South Lake (SL), Swanbourne (Sw) and Wattleup (Wt) – are within the Perth Metropolitan Region and the remaining five are located in Albany (Al), Bunbury (Bn), Busselton (Bs), Collie (Co) and Geraldton (Ge).

During 2016 the AAQ NEPM goal was not met for particulate matter 10 (PM₁₀) particles at Albany (six exceedences), at Collie (one exceedence) and at Geraldton (three exceedences).

Across all monitoring sites there was a total of 35 exceedences in 2016, comprising three of ozone, 16 of PM₁₀ (including six exceptional events) and 16 of particulate matter 2.5 (PM_{2.5}), all due to exceptional events).

Of the 22 particle exceedences that were classed as exceptional events, 11 were due to bushfires and 11 due to prescribed burning activities. These 'exceptional event' exceedences are not included in the NEPM goal assessment.

The PM_{2.5} goal of no exceedences other than those caused by exceptional events was met.

The carbon monoxide, ozone, nitrogen dioxide and sulfur dioxide goal of no more than one exceedence was met.

Section A – Monitoring summary

Current monitoring stations

The DWER monitoring network shown in Figure A1 was the subject of careful design for the purposes of the Perth Photochemical Smog Study, the Perth Haze Study and the management of sulfur dioxide in the Kwinana area.

The network's design was based on the knowledge of emissions sources, pollutant chemistry and important features of the meteorology.

Commonwealth Scientific and Industrial Research Organisation (CSIRO) Atmospheric Research provided advice on monitoring site locations for the Perth Photochemical Smog Study and Perth Haze Study.

The Bunbury station shown in Figure A2 was established in the southwest of the State to monitor fuel reduction burns, and stations in Busselton and Collie were also in operation for that purpose.

The Geraldton station shown in Figure A3 was established in the midwest of the State to monitor windblown crustal material and smoke from bushfires, hazard reduction or stubble burning and possibly wood-fired home heaters. A particle monitoring station was also established in Albany (Figure A4). Table A1 indicates the pollutants monitored at each site.

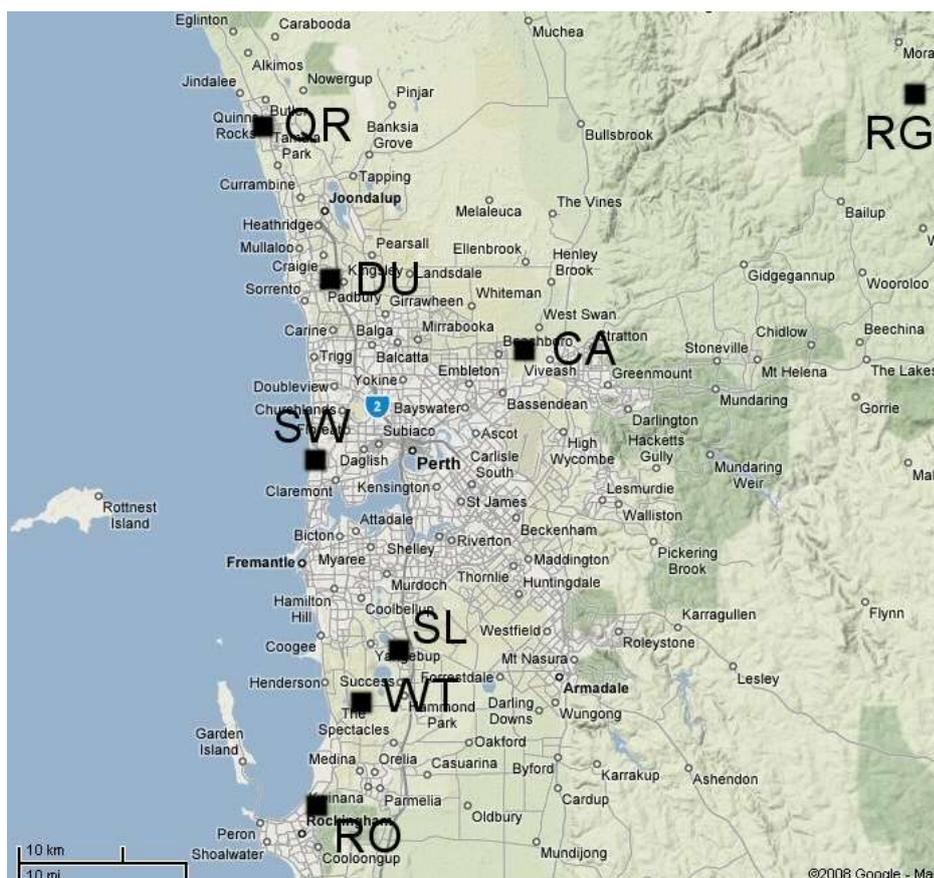


Figure A1: DWER air quality monitoring stations operating in the Perth Metropolitan Region.



Figure A2: DWER air quality monitoring stations operating in Bunbury, Busselton and Collie.



Figure A3: DWER air quality monitoring station operating in Geraldton.



Figure A4: DWER air quality monitoring station operating in Albany.

Table A1: Air quality parameters measured at DWER monitoring stations.

Monitoring site	CO	O ₃	NO ₂	SO ₂	PM ₁₀ TEOM	PM _{2.5} TEOM
AL Albany					07/06 to present	
BN Bunbury					06/99 to present	04/97 to present
BS Busselton						11/06 to present
CA Caversham	08/93 to Present	11/89 to present	09/90 to present		01/04 to present	03/94 to present
CO Collie					02/08 to present	
DU Duncraig	08/95 to Present		08/95 to present		06/96 to present	01/95 to present
GE Geraldton					09/05 to present	
QR Quinns Rocks		11/92 to present	11/92 to present			07/06 to present
RO Rockingham		12/95 to present	12/95 to present	07/88 to present		
RG Rolling Green		01/93 to present	01/93 to present			
SL South Lake	03/00 to Present	04/06 to present				
SW Swanbourne		01/93 to present	03/93 to present			
WT Wattleup				01/88 to present		

DWER has, from time to time, performed campaign monitoring for various projects. While these short-term projects are not reported within this document, detailed reports and/or data can be obtained from www.der.wa.gov.au, by emailing airquality@der.wa.gov.au or by telephoning (08) 6467 5000.

Table A2: Methods used to monitor air quality at DWER monitoring stations.

Pollutant	Standard	Method
Carbon monoxide	AS/NZS 3580.7.1 2011 – Methods for sampling and analysis of ambient air – Determination of carbon monoxide – Direct-reading instrumental method	Gas filter correlation spectrophotometry
Ozone	AS 3580.6.1 2011 – Methods for sampling and analysis of ambient air – Determination of ozone – Direct-reading instrumental method	Ultraviolet absorption
Nitrogen dioxide	AS 3580.5.1 2011 – Methods for sampling and analysis of ambient air – Determination of oxides of nitrogen – Chemiluminescence method	Chemiluminescence
Sulfur dioxide	AS 3580.4.1 2008 – Methods for sampling and analysis of ambient air – Determination of sulfur dioxide – Direct-reading instrumental method	Ultraviolet fluorescence
Particles as PM ₁₀	AS 3580.9.8 2008 – Methods for sampling and analysis of ambient air – 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 2013 – Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM _{2.5} continuous direct mass method using a tapered element oscillating microbalance analyser	Tapered element oscillating microbalance*

*TEOMs within the DWER network are not fitted with filter dynamic measurement systems (FDMS).

Table A3: Monitoring in WA.

Site	CO	O ₃	NO ₂	SO ₂	PM ₁₀	PM _{2.5}
AL – Albany					P/T	
BN – Bunbury					P/T	P/T
BS – Busselton						DWER
CA – Caversham	DWER	P/T	P/T		P/T	P/T
CO – Collie					DWER	
DU – Duncraig	P/T		DWER		P/T	P/T
GE – Geraldton					P/T	
QR – Quinns Rocks		DWER	DWER			DWER
RG – Rolling Green		DWER	DWER			
RO – Rockingham		DWER	DWER	DWER		
SL – South Lake	P/T	P/T	P/T	P	P/T	P/T
SW – Swanbourne		P/T	P/T			
WT – Wattleup				DWER		

Key to symbols:

P Performance monitoring station

T Trend performance monitoring station

DWER Instrument will be maintained by DWER for the foreseeable future

Table A4: Standards for pollutants

Pollutant	Averaging period	Maximum concentration standard	Maximum allowable exceedences (goals)
Carbon monoxide	8 hours	9.0 ppm	1 day a year
Nitrogen dioxide	1 hour	0.12 ppm	1 day a year
	1 year	0.03 ppm	None
Photochemical oxidants (as ozone)	1 hour	0.10 ppm	1 day a year
	4 hours	0.08 ppm	1 day a year
Sulfur dioxide	1 hour	0.20 ppm	1 day a year
	1 day	0.08 ppm	1 day a year
	1 year	0.02 ppm	None
Lead	1 year	0.05 µg/m ³	None
Particles as PM ₁₀	1 day	50 µg/m ³	None
	1 year	25 µg/m ³	None
Particles as PM _{2.5}	1 day	25 µg/m ³	None
	1 year	8 µg/m ³	None

Table A5: Monitoring site description

Site	Description
AL – Albany	Large rural town located 380 kilometres south southwest of Perth with moderate density housing and typical local traffic flows.
BN – Bunbury	Large rural town located 145 kilometres south of Perth with moderate density housing and typical local traffic flows.
BS – Busselton	Small rural town located 185 kilometres south of Perth with moderate density housing and typical local traffic flows.
CA – Caversham	Semi-rural northeast metropolitan suburb located in the Swan Valley – a grape growing region next to the Perth foothills – 14 kilometres northeast of the Perth CBD. The region mainly comprises low density housing and paddocks. Some brick manufacturing occurs in the region.
CO – Collie	Small rural town located within a forested region 152 kilometres south of Perth with moderate density housing and typical traffic flows. Coal mining and power generation industries are located within the region.
DU – Duncraig	North metropolitan suburb located 16 kilometres north northwest of the Perth CBD with moderate/high density housing and moderate to high traffic flow. The site is located 200 metres west of the Mitchell freeway, a main north–south arterial road carrying approximately 98,000 vehicles daily.
GE – Geraldton	Large rural town located 377 kilometres north of Perth in the midwest with moderate density housing and typical traffic flows.
QR – Quinns Rocks	Outer north coastal suburb located 35 kilometres north of Perth with moderate density housing and typical local traffic flows
RG – Rolling Green	Outer east rural suburb located 56 kilometres northeast of Perth with low density rural housing and low traffic flows. The closest road is 80 metres east of the site supporting a traffic flow of 3,200 vehicles per day.
RO – Rockingham	A south coastal site located 35 kilometres south of Perth with moderate density housing and typical traffic flows, and adjacent to the southern border of the Kwinana Industrial Area. A major arterial road carrying 34,700 vehicles per day runs 1 kilometre east of the site.
SL – South Lake	Southeast metropolitan site located 17 kilometres south of Perth with moderate/high density housing and moderate to high traffic flow. The site is located 1.6 kilometres west of the Kwinana freeway, a main north–south arterial road carrying approximately 87,000 vehicles daily and is 4 kilometres northeast of the northern border of the Kwinana industrial area.
SW – Swanbourne	An inner coastal site located on coastal sand dunes 9 kilometres west of the Perth CBD, and 150 metres west of a major north–south arterial road carrying approximately 27,200 vehicles per day.
WT – Wattleup	A south metropolitan site located 25 kilometres south of Perth within a defined buffer area for the Kwinana Industrial Area. Surrounding land uses are retail outlets and market gardens.

Table A6: Screening procedures used to demonstrate whether pollutants are consistently below standards.

Screening procedures
A. Campaign monitoring at a Generally Representative Upper Bound (GRUB) 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 stations to demonstrate that the full number of stations is not required, either to detect exceedences or gain a more representative depiction of pollutant distribution.
C. Use of modelling within a region which will contain one or more GRUB monitoring stations to demonstrate that the full number of stations is not required, either to detect exceedences or gain a more representative depiction of pollutant distribution.
D. In a region with no performance monitoring, use of validated (1) 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 greater population, emissions and pollution potential.
P. Performance monitoring.
T. Trend monitoring.
M. Campaign monitoring.

Table A7: Screening procedures satisfied at each station.

Site	Pop'n ^a	CO	O ₃	NO ₂	SO ₂	Pb	PM ₁₀
Perth and Rockingham	1,740,000				B&C	A	
Mandurah ^b	69,000	P	P	P	F	F	P
Albany	31,000	F	F	F	F	F	
Bunbury	65,000	A&F	E&F	E&F	D&F	F	
Kalgoorlie-Boulder ^c	31,000	M	E&F	E&F	T	F	P
Geraldton	36,000	F	E&F	E&F	D&F	F	

Grey shaded cells represent performance, trend or campaign sites where monitoring is currently underway.

a – 2011 data (www.abs.gov.au)

b – Mandurah station has yet to be established

c – Kalgoorlie station has yet to be established

Details of screening procedures are given in the monitoring plan available at: <http://www.scew.gov.au/files/resources/9947318f-af8c-0b24-d928-04e4d3a4b25c/files/aaqprctp04screeningprocedures200705final.pdf>.

Table A8: Stations site compliance with AS/NZ 3580.1.1 – 2007

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

Carbon monoxide (CO)

Duncraig monitoring station 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 located approximately 200 metres west of the Mitchell freeway, so it is well beyond the distance of roadside measurement. By Perth's standards the site is representative of dense population, and lies in a dunal depression through which the freeway passes, hence the effect of stable air pooling in the depression is likely to lead to elevated concentrations. This feature would be found in many other places across the coastal plain.

South Lake monitoring station lies in a growing urban area and is likely to see moderate levels of CO from wood fires in particular. It is not as close to major roads as the Duncraig site, and is therefore more typical of a population-average site.

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

In summary, WA maintained performance monitoring of CO at the nominated trend stations of Duncraig and South Lake.

Trend analysis for each of these sites shows that, overall, the maximum of the eight-hourly averages at each site have consistently declined between 0.1 and 0.03 ppm per year as shown in Figure A5.

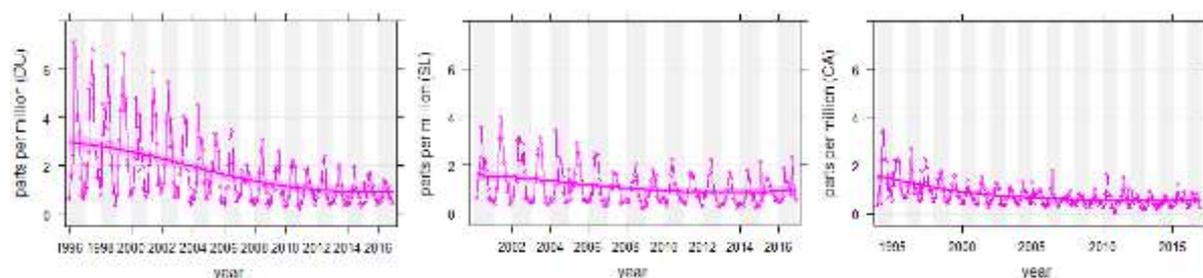


Figure A5: Smoothed trend (dark lines) for CO at Duncraig (left), South Lake (centre) and Caversham (right).

Photochemical oxidants as ozone

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

Given its location, there is reason to be confident that Caversham monitoring station represents an upper bound, middle distance, inland site. Accordingly, Caversham was selected as a performance monitoring station site.

A third performance monitoring station was located at South Lake. It has the following desirable attributes:

- it provides spatial spread of stations (it will measure ozone returning on shore in the southern part of the metropolitan area);
- it is a moderate distance inland in a growing urban area, hence it is well classed as a population average station; and
- it may occasionally detect the interactions of O₃-rich air with the NO_x-rich

plumes from Kwinana industry (potentially giving elevated NO₂ concentrations). Caversham, Swanbourne and South Lake sites are all nominated as trend stations. DWER will continue to maintain the stations at Rockingham, Quinns Rocks and Rolling Green as part of its wider ozone network to enable a better understanding of ozone events.

Long-term analysis is presented in Figure A6. The number of periods when the one hour ozone concentration exceeded the long-term site average at Swanbourne has increased for every five-year period, with the ratio climbing from 0.46 in 1996–00 to 0.54 in 2011–15. In 2016 the ratio at Swanbourne increased to 0.58.

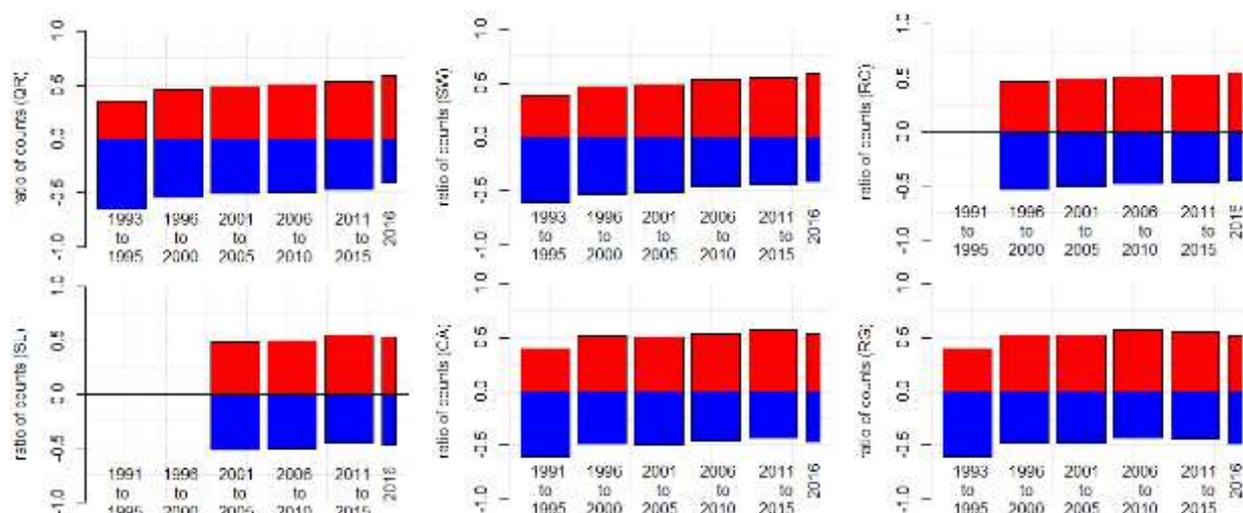


Figure A6: Ratio of the number of hourly averaged ozone concentrations at Quinns Rocks, Swanbourne and Rockingham (top panel) and South Lake, Caversham and Rolling Green (lower panel) that was higher (red) or equal to, or lower (blue) than, the 20-year average concentration for that site.

A similar increasing pattern is evident at the two other coastal sites of Quinns Rocks and Rockingham. The inland sites of Caversham and Rolling Green have a less distinct pattern. South Lake commenced in February 2000 and therefore cannot be directly compared with the others, but is shown in the figure for completeness.

Nitrogen dioxide (NO₂)

Owing to the close chemical reactivity relationship, NO₂ is currently being monitored at all stations where O₃ is monitored. Caversham, Swanbourne and South Lake sites were chosen as performance monitoring stations for NO₂ as they provided a good spatial distribution.

Caversham, Swanbourne and South Lake sites are also trend stations.

DWER will continue to measure NO₂ at Quinns Rocks, Rolling Green and Duncraig as part of its wider network to enable a better understanding of photochemical smog formation.

Figure A7 demonstrates how NO_x (NO + NO₂) monthly means have decreased at all sites. The median of the daily one hour NO maximum has also seen a general decrease over time, with Duncraig experiencing an average of 1.9 ppb per annum decrease since 1996.

A possible unintended result of these decreasing concentrations of oxides of nitrogen is the inability to fully suppress ozone formation by (typically) producing NO₂ (NO + O₃ → NO₂ + O₂). The general build-up in O₃ therefore commences earlier (and therefore closer to populated areas) than it otherwise would.

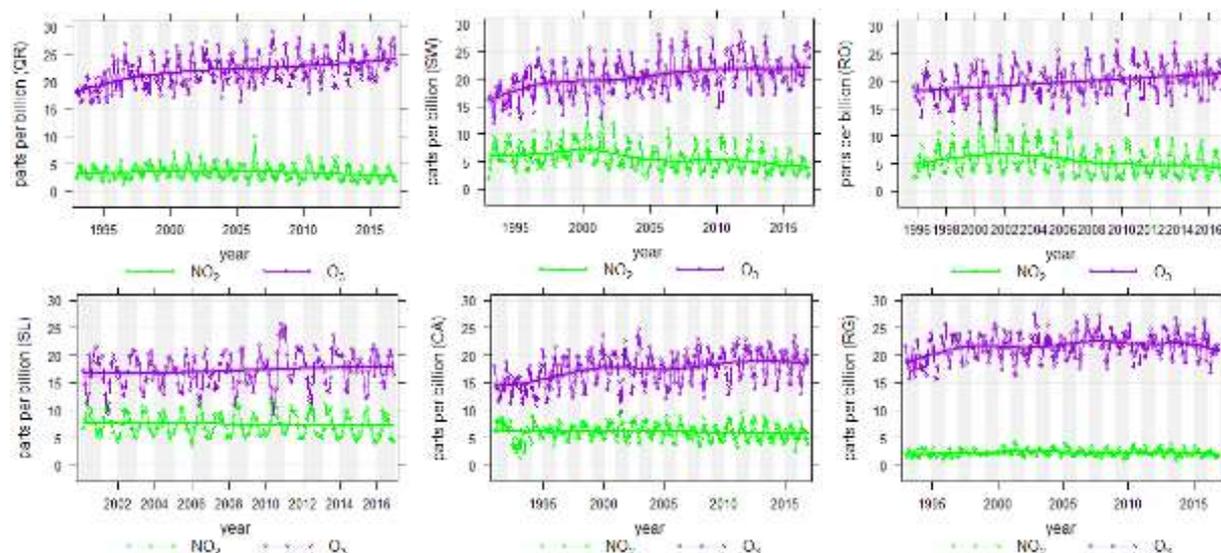


Figure A7: Smoothed trend (dark lines) at Quinns Rocks, Swanbourne and Rockingham (top panel) and South Lake, Caversham and Rolling Green (lower panel) using the monthly mean concentration of NO_x (green) and O₃ (violet).

Sulfur dioxide

DWER operates one performance monitoring station at South Lake for sulfur dioxide, while maintaining a source management network which includes Wattleup and Rockingham monitoring stations.

South Lake site is an upper bound performance monitoring station for sulfur dioxide, and a trend station. South Lake is near the southern extent of the main urban population and downwind of Kwinana in sea breeze conditions.

Heavy industries in Kwinana are the only significant sources of sulfur dioxide in the Perth/Kwinana/Rockingham region. Concentrations of sulfur dioxide have reduced markedly since the late 1970s due to the conversion from high to low sulfur fuels and the installation of sulfur dioxide control technologies. Emissions are controlled through conditions of licences issued by the DWER under Part V of the *Environmental Protection Act 1986*, in concert with the *Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999* (EPP), to ensure ambient concentrations do not exceed ambient standards set in the EPP.

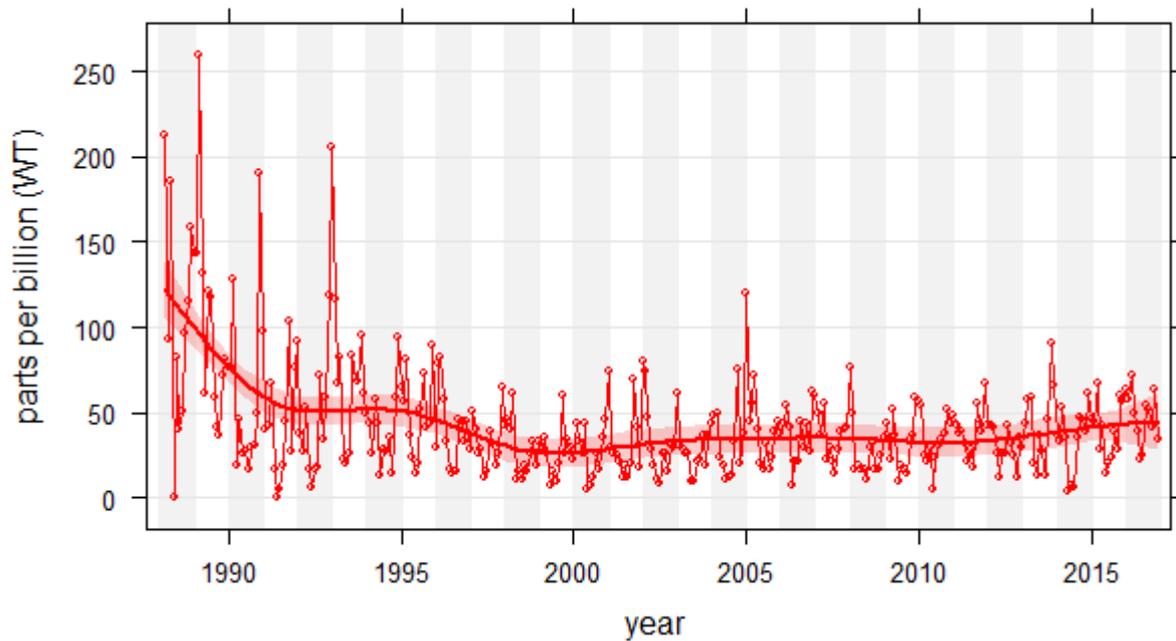


Figure A8: Trend line for maximum hourly averaged sulfur dioxide concentration at Wattleup, located within the Kwinana Industrial Buffer.

Lead

Since 1995, lead levels within the Perth CBD have been below 60 per cent of the 0.5 $\mu\text{g}/\text{m}^3$ annual NEPM standard. In 2001, the average lead level in Perth was 0.022 $\mu\text{g}/\text{m}^3$, less than 5 per cent of the NEPM standard.

In accordance with National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 4, Screening Procedures, and the WA Monitoring Plan, a performance monitoring station for lead has not been maintained since 2001.

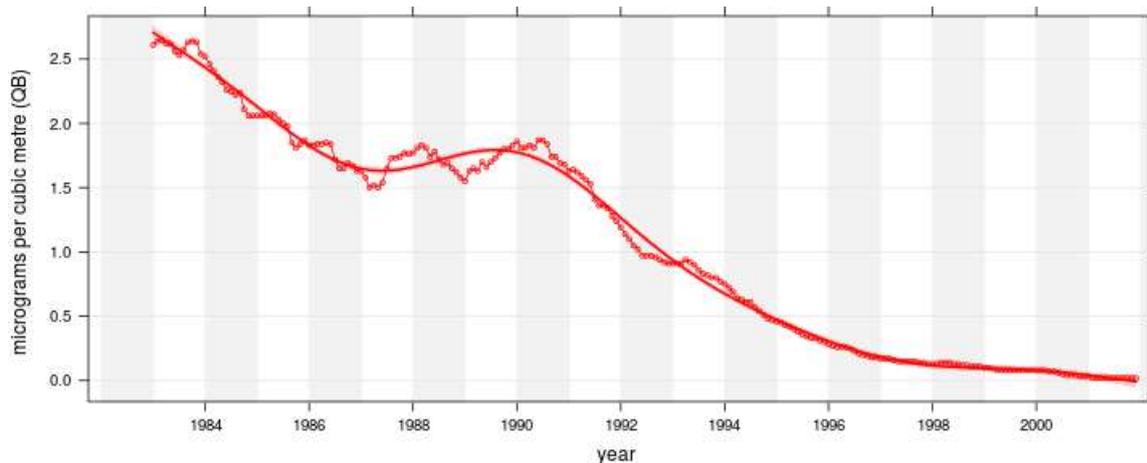


Figure A9: Trend line for annual moving averaged lead concentration within the Perth CBD.

Particles as PM₁₀

Duncraig site is an upper bound performance monitoring station site for PM₁₀. High levels of PM₁₀ here are caused by a combination of vehicle and domestic wood heater emissions during strongly stable meteorological conditions.

Likewise, the site at South Lake measures significant PM₁₀ concentrations arising from wood fires.

Duncraig and South Lake sites are both nominated as trend stations.

Campaign monitoring stations were established at Geraldton in September 2005, Albany in July 2006 and Collie in February 2008.

All Tapered Element Oscillating Microbalances (TEOMs) used by DWER are operated continuously and unadjusted for temperature. All TEOM data presented in this report has the manufacturer's recommended equivalency factor of $1.03x + 3.00$ applied.

A frequency distribution, such as that shown in Figure 10, can indicate how the ratio of $PM_{2.5}:PM_{10}$ differs over three metropolitan sites, and also provides some information 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, while a lower ratio of $PM_{2.5}:PM_{10}$ may indicate anthropogenic dust or crustal materials.

The lower (blue) plots in Figure A10 represent periods where the one hour averaged PM_{10} exceeded an arbitrary concentration of $50 \mu\text{g}/\text{m}^3$. This cut-off was chosen to limit the analysis to those at the higher end of the spectrum. Whereas Duncraig exhibits a higher number of high-ratio events, both Caversham and South Lake display a higher number of low-ratio events. These differences can be explained based on the site locations.

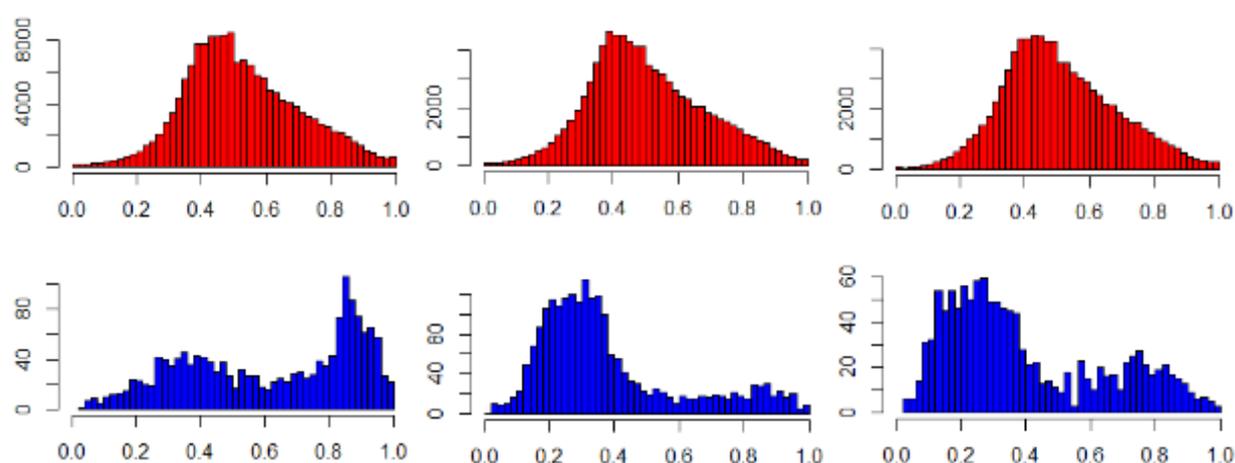


Figure A10: Frequency distribution of $PM_{2.5}:PM_{10}$ ratios of hourly averages at Duncraig (left), South Lake (centre) and Caversham (right) since installation using all data (top) and data where hourly averaged PM_{10} was greater than, or equal to, $50 \mu\text{g}/\text{m}^3$ (bottom).

Duncraig is located 3.5 km from the coast within a moderate/high density housing area with no industry close by and will therefore be predominantly influenced by vehicles, sea salt and smoke from the occasional bush fire. One therefore expects to see a larger proportion of high $PM_{2.5}:PM_{10}$ ratio which is a characteristic of combustion products. Caversham is in a semi-rural setting northeast of Perth CBD and has a number of vineyards and some brick manufacturing close by. These two industries combine to more likely produce coarse fraction particles producing a lower $PM_{2.5}:PM_{10}$ ratio. South Lake, located within a moderate/high density housing area, is close to the Kwinana Industrial Area, market gardens and a cement manufacturing plant, providing more opportunity to be influenced by lower $PM_{2.5}:PM_{10}$ ratios.

Particles as $PM_{2.5}$

To make assessments against the NEPM standard, four $PM_{2.5}$ TEOMs were installed in the greater Perth Metropolitan Region at Quinns Rocks, Caversham, Duncraig and South Lake, and one each in Bunbury and Busselton. All will remain in use at these locations indefinitely with the intention of developing trend data.

All Tapered Element Oscillating Microbalances (TEOMs) used by DWER are operated continuously (unadjusted for temperature).

All TEOM data presented in this report has the manufacturer's recommended equivalency factor of $1.03x + 3.00$ applied.

Variations to the NEPM

In February 2016, the AAQ NEPM was varied to, among other things:

- provide for a PM₁₀ annual standard of 25 µg/m³;
- create two standards for PM_{2.5} of 25 µg/m³ averaged over 24 hours, and 8 µg/m³ averaged over one year;
- remove the five allowable exceedences for PM₁₀ one-day average standards when determining compliance with the NEPM goal; and
- allow for exceptional events when determining compliance for one-day PM₁₀ and PM_{2.5} with the NEPM goal. An exceptional event means a fire or dust occurrence that adversely affects air quality at a particular location, and causes an exceedence of one-day average standards in excess of normal historical fluctuations and background levels, and is directly related to: bushfire; jurisdiction authorised hazard reduction burning; or continental scale windblown dust. For the purpose of reporting compliance against PM₁₀ and PM_{2.5} one-day average standards, jurisdictions are required to exclude monitoring data that has been determined as being directly associated with an exceptional event. For the purpose of reporting compliance against PM₁₀ and PM_{2.5}, one-year average standards, jurisdictions are required to include all measured data, including monitoring data that is directly associated with an exceptional event.

This report has been prepared to comply with these NEPM reporting requirements.

Exceedence summary

There were a number of exceedences of O₃, PM_{2.5} and PM₁₀ in 2016. The NEPM goal for particles was not met at Albany, Collie and Geraldton. Detailed summaries of all exceedences are provided in Attachment 2.

Table A9: Air NEPM standard exceedences recorded during 2016.

Site	Pollutant	Concentration ^{1,2}	Date/Time	Event cause
Albany	PM ₁₀	53.7 µg/m ³	14/11/2016	AS
Albany	PM ₁₀	59.1 µg/m ³	24/11/2016	AS
Albany	PM ₁₀	94.9 µg/m ³	25/11/2016	AS
Albany	PM ₁₀	68.9 µg/m ³	10/12/2016	AS
Albany	PM ₁₀	88.4 µg/m ³	17/12/2016	AS
Albany	PM ₁₀	51.2 µg/m ³	20/12/2016	AS
Bunbury	PM ₁₀	67.1 µg/m ³	08/01/2016	BF
Bunbury	PM _{2.5}	44.9 µg/m ³	08/01/2016	BF
Bunbury	PM ₁₀	74.6 µg/m ³	09/01/2016	BF
Bunbury	PM _{2.5}	61.5 µg/m ³	09/01/2016	BF
Bunbury	PM _{2.5}	39.9 µg/m ³	23/10/2016	PB
Bunbury	PM _{2.5}	26.3 µg/m ³	23/11/2016	PB

Site	Pollutant	Concentration ^{1,2}	Date/Time	Event cause
Bunbury	PM _{2.5}	34.5 µg/m ³	27/11/2016	BF
Bunbury	PM _{2.5}	33.0 µg/m ³	08/12/2016	PB
Busselton	PM _{2.5}	50.9 µg/m ³	08/01/2016	BF
Busselton	PM _{2.5}	61.1 µg/m ³	09/01/2016	BF
Busselton	PM _{2.5}	27.5 µg/m ³	03/04/2016	PB
Busselton	PM _{2.5}	39.0 µg/m ³	08/12/2016	PB
Caversham	O ₃	0.085 ppm (4hr av.)	10/02/2016 1600	AS
Collie	PM ₁₀	89.9 µg/m ³	02/02/2016	AS
Collie	PM ₁₀	51.9 µg/m ³	28/10/2016	PB
Collie	PM ₁₀	50.5 µg/m ³	06/11/2016	PB
Collie	PM ₁₀	84.3 µg/m ³	23/11/2016	PB
Collie	PM ₁₀	60.5 µg/m ³	27/11/2016	BF
Duncraig	PM _{2.5}	27.0 µg/m ³	27/11/2016	BF
Geraldton	PM ₁₀	58.2 µg/m ³	14/02/2016	AS
Geraldton	PM ₁₀	66.0 µg/m ³	06/04/2016	AS
Geraldton	PM ₁₀	55.4 µg/m ³	05/12/2016	AS
Quinns Rocks	PM _{2.5}	28.8 µg/m ³	18/05/2016	PB
Quinns Rocks	PM _{2.5}	25.3 µg/m ³	27/11/2016	BF
South Lake	PM _{2.5}	30.4 µg/m ³	12/05/2016	PB
South Lake	PM _{2.5}	28.9 µg/m ³	26/10/2016	PB
South Lake	PM _{2.5}	29.0 µg/m ³	27/11/2016	BF
Swanbourne	O ₃	0.103 ppm (1hr av.)	07/01/2016 1800	AS
Swanbourne	O ₃	0.081 ppm (4hr av.)	07/01/2016 2100	AS

1. All concentrations are 24-hour averages (midnight to midnight) unless otherwise stated.

2. All TEOMs used by DWER are operated continuously (unadjusted for temperature) and have the manufacturer's recommended equivalency factor of 1.03x + 3.00 applied. All particle concentrations are displayed as a daily average.

AS Assessable event

BF Bushfire (exceptional event)

PB Prescribed burning activities (exceptional event)

Section B – Assessment of compliance with standards and goals

Table B1: 2016 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 exceedences (days)	Performance against the standards and goal
	Q1	Q2	Q3	Q4	Annual		
Perth region							
Caversham (Northeast Metro)	99.2	99.5	98.4	99.8	99.2	0	Met
Duncraig (North Metro)	100	99.9	99.9	99.5	99.8	0	Met
South Lake (Southeast Metro)	99.6	99.9	99.7	99.8	99.8	0	Met

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

Table B2: 2016 compliance summary for nitrogen dioxide.

*AAQ NEPM standard
0.12 ppm (one-hour average)
0.03 ppm (one-year average)*

Regional performance monitoring station	Data availability rates (% of hours)					Annual mean (ppm)	Number of exceedences (days)	Performance against the standards and goal	
	Q1	Q2	Q3	Q4	Annual			1-hour	1-year
Perth region									
Caversham (Northeast Metro)	99.1	99.5	99.7	99.8	99.5	0.006	0	Met	Met
Duncraig (North Metro)	99.9	99.9	99.8	99.5	99.8	0.006	0	Met	Met
Quinns Rocks (Outer North Coast)	96.2	95.4	99.9	99.9	97.8	0.003	0	Met	Met
Rockingham (South Coast)	98.7	99.1	99.8	99.5	99.3	0.004	0	Met	Met
Rolling Green (Outer East Rural)	92.9	98.3	99.8	98.9	97.5	0.002	0	Met	Met
South Lake (Southeast Metro)	99.4	99.9	99.3	81.4	95.0	0.007	0	Met	Met
Swanbourne (Inner West Coast)	97.3	99.9	97.3	89.9	96.1	0.004	0	Met	Met

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

Table B3: 2016 compliance summary for ozone.

AAQ NEPM standard
0.10 ppm (one-hour average)
0.08 ppm (four-hour average)

Regional performance monitoring station	Data availability rates (% of hours)					Number of exceedences (days)		Performance against the standards and goal	
	Q1	Q2	Q3	Q4	Annual	1-hour	4-hour	1-hour	4-hour
Perth region									
Caversham (Northeast Metro)	99.3	99.5	99.8	99.8	99.6	0	1	Met	Met
Quinns Rocks (Outer North Coast)	96.2	98.6	100	99.9	98.7	0	0	Met	Met
Rockingham (South Coast)	98.9	98.9	99.9	97.4	98.8	0	0	Met	Met
Rolling Green (Outer East Rural)	93.1	98.2	99.8	99.0	97.5	0	0	Met	Met
South Lake (Southeast Metro)	99.3	100	99.6	99.6	99.6	0	0	Met	Met
Swanbourne (Inner West Coast)	100	100	97.0	97.9	98.7	1	1	Met	Met

Performance against the standards and goal: "met", "not met", "not demonstrated".

Table B4: 2016 compliance summary for sulfur dioxide.

AAQ NEPM standard
0.20 ppm (one-hour average)
0.08 ppm (24-hour average)
0.02 ppm (one-year average)

Regional performance monitoring station	Data availability rates (% of hours)					Annual mean	Number of exceedences (days)		Performance against the standards and goal		
	Q1	Q2	Q3	Q4	Annual	(ppm)	1-hour	24-hour	1-hour	24-hour	1-year
Perth region											
Rockingham (South Coast)	96.2	95.6	95.2	97.4	96.1	0.001	0	0	Met	Met	Met
South Lake (Southeast Metro)	97.3	97.5	97.1	97.7	97.4	0.003	0	0	Met	Met	Met
Wattleup (South Metro)	94.2	94.6	93.3	96.1	94.5	0.001	0	0	met	met	met

Performance against the standards and goal: "met", "not met", "not demonstrated".

Table B5: 2016 compliance summary for particles as PM₁₀.

AAQ NEPM standard
 50 µg/m³ (24-hour average)
 25 µg/m³ (annual average)

Regional performance monitoring station	Data availability rates (% of days)					Number of exceedences (days)	Performance against the standards and goal	
	Q1	Q2	Q3	Q4	Annual		24-hour	Annual
Perth region								
Caversham (Northeast Metro)	97.7	99.5	99.7	99.6	99.1	0	Met	Met
Duncraig (North Metro)	99.7	99.8	99.5	99.3	99.6	0	Met	Met
South Lake (Southeast Metro)	99.1	99.9	99.6	99.6	99.5	0	Met	Met
Southwest region								
Albany	90.9	99.8	91.7	99.8	95.5	6	Not met	Met
Bunbury	99.7	90.8	100	99.5	97.5	2	Met	Met
Collie	99.5	99.7	99.3	99.4	99.5	5	Not met	Met
Midwest region								
Geraldton	93.5	99.9	93.5	99.8	96.7	3	Not met	Met

Performance against the standards and goal: "met", "not met", "not demonstrated".

Table B6: 2016 compliance summary for particles as PM_{2.5}.

AAQ NEPM standard
 25 µg/m³ (24-hour average)
 8 µg/m³ (annual average)

Regional performance monitoring station	Data availability rates (% of days)					Number of exceedences (Days)	Performance against the standards and goal	
	Q1	Q2	Q3	Q4	Annual		24-hour	annual
Perth region								
Caversham (Northeast Metro)	99.1	99.5	99.8	99.7	99.5	0	Met	Met
Duncraig (North Metro)	99.5	98.9	99.5	99.4	99.4	1	Met	Met
Quinns Rocks (Outer North Coast)	96.2	98.6	100	99.9	98.7	2	Met	Met
South Lake (Southeast Metro)	99.5	99.9	99.6	99.6	99.6	3	Met	Met
Southwest region								
Bunbury	99.9	99.8	99.9	99.4	99.7	6	Met	Not met
Busselton	99.5	99.7	99.8	98.8	99.5	4	Met	Not met

Section C – Analysis of air quality monitoring

Carbon monoxide (CO)

The NEPM standard for carbon monoxide of 9.0 ppm averaged over eight hours was not exceeded at any site during 2016. The NEPM goal of no more than one exceedence at each site was met. Table C1 contains the summary statistics for daily peak eight-hour CO in WA.

Table C1: 2016 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		2nd highest (ppm)	2nd highest	
			(date)	(time)		(date)	(time)
Perth region							
Caversham (Northeast Metro)	99.2	0.9	23/10/2016	0500	0.8	26/06/2016	0400
Duncraig (North Metro)	99.8	1.4	20/05/2016	0800	1.3	01/07/2016	0500
South Lake (Southeast Metro)	99.8	2.3	26/10/2016	1200	1.8	12/05/2016	0900

Nitrogen dioxide (NO₂)

The NEPM standard for nitrogen dioxide of 0.12 ppm averaged over one hour and the 0.03 ppm annual average were not exceeded at any site during 2016. The NEPM goal of no more than one exceedence at each site was met. Table C2 contains the summary statistics for daily peak one-hour NO₂ in WA.

Table C2: 2016 summary statistics for daily peak one-hour nitrogen dioxide.

*AAQ NEPM standard
0.12 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 (Northeast Metro)	99.5	0.036	09/02/2016	2200	0.033	30/06/2016	2000
Duncraig (North Metro)	99.8	0.033	12/10/2016	2000	0.031	13/08/2016	2100
Quinns Rocks (Outer North Coast)	97.8	0.029	19/07/2016	1900	0.029	11/10/2016	2200
Rockingham (South Coast)	99.3	0.029	01/07/2016	1900	0.028	20/07/2016	0800
Rolling Green (Outer East Rural)	97.5	0.023	26/01/2016	2100	0.021	20/03/2016	2000
South Lake (Southeast Metro)	95.0	0.038	12/10/2016	2000	0.033	12/05/2016	0900
Swanbourne (Inner West Coast)	96.1	0.030	19/07/2016	2100	0.029	29/09/2016	2300

Photochemical smog as ozone

The NEPM standard for ozone of 0.10 ppm averaged over one hour was exceeded once during 2016. The NEPM goal of no more than one exceedence at each site was met. Table C3 contains the summary statistics for daily peak one-hour O₃ in WA.

Table C3: 2016 summary statistics for daily peak one-hour ozone.

*AAQ NEPM standard
0.10 ppm (one-hour average)*

Regional performance monitoring station	Data availability rates (%)	Highest (ppm)	Highest		2nd highest (ppm)	2nd highest	
			(date)	(time)		(date)	(time)
Perth region							
Caversham (Northeast Metro)	99.6	0.096	10/02/2016	1400	0.084	27/11/2016	1200
Quinns Rocks (Outer North Coast)	98.7	0.089	10/02/2016	1400	0.073	08/02/2016	1800
Rockingham (South Coast)	98.8	0.087	10/02/2016	1300	0.074	09/03/2016	1400
Rolling Green (Outer East Rural)	97.5	0.075	10/02/2016	1700	0.073	06/01/2016	1700
South Lake (South East Metro)	99.6	0.091	10/02/2016	1300	0.076	09/02/2016	1300
Swanbourne (Inner West Coast)	98.7	0.103	07/01/2016	1800	0.074	21/12/2016	1800

Bold numerals indicate where a relevant standard has been exceeded.

The NEPM standard for ozone of 0.08 ppm averaged over four hours was exceeded twice during 2016. The NEPM goal of no more than one exceedence at each site was met. Table C4 contains the summary statistics for daily peak four-hour O₃ in WA.

Table C4: 2016 summary statistics for daily peak four-hour ozone.

*AAQ NEPM standard
0.08 ppm (four-hour average)*

Regional performance monitoring station	Data availability rates (%)	Highest (ppm)	Highest (date) (time)		2nd highest (ppm)	2nd highest (date) (time)	
Perth region							
Caversham (Northeast Metro)	99.6	0.085	10/02/2016	1600	0.071	27/11/2016	1300
Quinns Rocks (Outer North Coast)	98.7	0.079	10/02/2016	1700	0.072	08/02/2016	2100
Rockingham (South Coast)	98.8	0.079	10/02/2016	1500	0.070	08/02/2016	1800
Rolling Green (Outer East Rural)	97.5	0.066	10/02/2016	1800	0.065	11/02/2016	1700
South Lake (Southeast Metro)	99.6	0.080	10/02/2016	1400	0.066	09/02/2016	1400
Swanbourne (Inner West Coast)	98.7	0.081	07/01/2016	2100	0.073	10/02/2016	1600

Bold numerals indicate where a relevant standard has been exceeded.

Sulfur dioxide (SO₂)

The NEPM standard for sulfur dioxide of 0.20 ppm averaged over one hour was not exceeded at any site during 2016. The NEPM goal of no more than one exceedance at each site was met. Table C5 contains the summary statistics for daily peak one-hour SO₂ in WA.

Table C5: 2016 summary statistics for daily peak one-hour sulfur dioxide.

*AAQ NEPM standard
0.20 ppm (one-hour average)*

Regional performance monitoring station	Data availability rates (%)	Highest (ppm)	Highest		2nd highest (ppm)	2nd highest	
			(date)	(time)		(date)	(time)
Perth region							
Rockingham (South Coast)	96.1	0.064	17/08/2016	0500	0.057	15/11/2016	0800
South Lake (Southeast Metro)	97.4	0.034	09/02/2016	2000	0.031	26/02/2016	1700
Wattleup (South Metro)	94.5	0.072	02/03/2016	1500	0.064	25/11/2016	1600

The NEPM standard for sulfur dioxide of 0.08 ppm averaged over 24 hours was not exceeded at any site during 2016. The NEPM goal of no more than one exceedance at each site was met. Table C6 contains the summary statistics for daily peak 24-hour SO₂ in WA.

Table C6: 2016 summary statistics for 24-hour sulfur dioxide.

*AAQ NEPM standard
0.08 ppm (24-hour average)*

Regional performance monitoring station	Data availability rates (%)	Highest (ppm)	Highest		2nd highest (ppm)	2nd highest	
			(date)	(time)		(date)	(time)
Perth region							
Rockingham (South Coast)	96.1	0.014	07/07/2016	2400	0.012	27/06/2016	2400
South Lake (Southeast Metro)	97.4	0.010	27/11/2016	2400	0.008	13/10/2016	2400
Wattleup (South Metro)	94.5	0.011	02/03/2016	2400	0.009	05/09/2016	2400

The NEPM standard for sulfur dioxide of 0.02 ppm averaged over one year was not exceeded at any site during 2016. Table C7 contains the summary statistics for annual SO₂ in WA.

Table C7: 2016 summary statistics for annual sulfur dioxide.

*AAQ NEPM standard
0.02 ppm (annual average)*

Regional performance monitoring station	Data availability rates (%)	Annual average (ppm)
Perth region		
Rockingham (South Coast)	96.1	0.001
South Lake (Southeast Metro)	97.4	0.003
Wattleup (South Metro)	94.5	0.001

Particles as PM₁₀

The NEPM standard for particles as PM₁₀ of 50 µg/m³ averaged over 24 hours was exceeded a number of times as detailed in Table A9 during 2016. The NEPM goal was not met at Albany, Collie and Geraldton. Table C8 contains the summary statistics for daily peak 24-hour PM₁₀ in WA.

Table C8: 2016 summary statistics for 24-hour particles as PM₁₀.

*AAQ NEPM Standard
50 µg/m³ (24-hour average)*

Regional performance monitoring station	Data availability rates (%)	Highest (µg/m ³)	Highest		6 th Highest (µg/m ³)	6 th Highest	
			(date)	(time)		(date)	(time)
Perth region							
Caversham ¹ (Northeast Metro)	99.1	38.1	27/11/2016	2400	33.2	06/01/2016	2400
Duncraig ¹ (North Metro)	99.6	40.0	27/11/2016	2400	31.1	15/11/2016	2400
South Lake ¹ (Southeast Metro)	99.5	47.0	27/11/2016	2400	35.4	06/01/2016	2400
Southwest region							
Albany ¹	95.5	94.9	25/11/2016	2400	51.2	20/12/2016	2400
Bunbury ¹	97.5	74.6	09/01/2016	2400	35.1	23/11/2016	2400
Collie ¹	99.5	89.9	02/02/2016	2400	48.4	12/10/2016	2400
Midwest region							
Geraldton ¹	96.7	66.0	06/04/2016	2400	45.8	20/12/2016	2400

1. Tapered Element Oscillating Microbalance (TEOM) operating continuously (unadjusted for temperature) and includes the manufacturer's recommended equivalency factor of 1.03x + 3.00.

Bold numerals indicate where a relevant standard has been exceeded.

The NEPM standard for particles as PM₁₀ of 25 micrograms per cubic metre averaged over one year was met at all sites during 2016. Table C8a contains the summary statistics for annual PM_{2.5} in WA.

Table C8a: 2016 summary statistics for annual particles as PM₁₀.

*AAQ NEPM standard
25 µg/m³ (annual average)*

Regional performance monitoring station	Data availability rates (%)	Annual average (µg/m ³)
Perth region		
Caversham ¹ (Northeast Metro)	99.1	15.0
Duncraig ¹ (North Metro)	99.6	14.4
South Lake ¹ (Southeast Metro)	99.5	15.7
Southwest region		
Albany ¹	95.5	17.5
Bunbury ¹	97.5	16.5
Collie ¹	99.5	19.3
Midwest region		
Geraldton ¹	96.7	18.8

1. TEOM operating continuously (unadjusted for temperature) and includes the manufacturer's recommended equivalency factor of 1.03x + 3.00.

Particles as PM_{2.5}

The NEPM standard for particles as PM_{2.5} of 25 micrograms per cubic metre averaged over 24 hours was exceeded a number of times as detailed in Table A9 during 2016. The NEPM goal was met at all sites. Table C9 contains the summary statistics for daily peak 24-hour PM_{2.5} in WA.

Table C9: 2016 summary statistics for 24-hour particles as PM_{2.5}

AAQ NEPM standard
25 µg/m³ (24-hour average)

Regional Performance Monitoring Station	Data availability rates (%)	Highest (µg/m ³)	Highest		6 th highest (µg/m ³)	6th highest	
			(date)	(time)		(date)	(time)
Perth region							
Caversham ¹ (Northeast Metro)	99.5	24.1	27/11/2016	2400	16.0	06/01/2016	2400
Duncraig ¹ (North Metro)	99.4	27.0	27/11/2016	2400	15.7	11/12/2016	2400
Quinns Rocks ¹ (Outer North Coast)	98.7	28.8	18/05/2016	2400	15.5	24/04/2016	2400
South Lake ¹ (Southeast Metro)	99.6	30.4	12/05/2016	2400	16.7	06/01/2016	2400
Southwest region							
Bunbury ¹	99.7	61.5	09/01/2016	2400	26.3	23/11/2016	2400
Busselton ¹	99.5	61.1	09/01/2016	2400	20.0	09/04/2016	2400

1. TEOM operating continuously (unadjusted for temperature) and includes the manufacturer's recommended equivalency factor of 1.03x + 3.00.

Bold numerals indicate where a relevant standard has been exceeded.

The NEPM standard for particles as PM_{2.5} of 8 micrograms per cubic metre averaged over one year was not met at all sites during 2016. Table C10 contains the summary statistics for annual PM_{2.5} in WA.

Table C10: 2016 summary statistics for annual particles as PM_{2.5}.

*AAQ NEPM standard
8 µg/m³ (annual average)*

Regional performance monitoring station	Data availability rates (%)	Annual average (µg/m ³)
Perth region		
Caversham ¹ (Northeast Metro)	99.5	7.7
Duncraig ¹ (North Metro)	99.4	7.5
Quinns Rocks ¹ (Outer North Coast)	98.7	7.5
South Lake ¹ (Southeast Metro)	99.6	8.0
Southwest region		
Bunbury ¹	99.7	8.4
Busselton ¹	99.5	8.1

1. TEOM operating continuously (unadjusted for temperature) and includes the manufacturer's recommended equivalency factor of 1.03x + 3.00.

Bold numerals indicate where a relevant standard has been exceeded.

Section D – Data analysis

Maxima and percentiles by pollutant in 2016

Table D1: 2016 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 (Northeast Metro)	99.2	0.9	0.6	0.6	0.5	0.4	0.2	0.1
Duncraig (North Metro)	99.8	1.4	1.2	1.1	0.8	0.7	0.4	0.3
South Lake (Southeast Metro)	99.8	2.3	1.3	1.1	0.9	0.7	0.5	0.3

Table D2: 2016 percentiles of daily peak one-hour nitrogen dioxide concentrations.

*AAQ NEPM standard
0.12 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 (Northeast Metro)	99.5	0.036	0.032	0.030	0.026	0.024	0.019	0.014
Duncraig (North Metro)	99.8	0.033	0.029	0.028	0.026	0.024	0.020	0.015
Quinns Rocks (Outer North Coast)	97.8	0.029	0.026	0.024	0.022	0.020	0.014	0.008
Rockingham (South Coast)	99.3	0.029	0.027	0.026	0.024	0.022	0.017	0.010
Rolling Green (Outer East Rural)	97.5	0.023	0.016	0.016	0.013	0.012	0.009	0.006
South Lake (Southeast Metro)	95.0	0.038	0.030	0.029	0.027	0.025	0.021	0.015
Swanbourne (Inner West Coast)	96.1	0.030	0.028	0.026	0.024	0.020	0.015	0.010

Table D3: 2016 percentiles of daily peak one-hour ozone 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								
Caversham (Northeast Metro)	99.6	0.096	0.066	0.062	0.053	0.046	0.034	0.030
Quinns Rocks (Outer North Coast)	98.7	0.089	0.066	0.061	0.056	0.048	0.038	0.035
Rockingham (South Coast)	98.8	0.087	0.064	0.060	0.051	0.044	0.035	0.032
Rolling Green (Outer East Rural)	97.5	0.075	0.070	0.063	0.053	0.047	0.034	0.030
South Lake (Southeast Metro)	99.6	0.091	0.065	0.056	0.050	0.043	0.032	0.029
Swanbourne (Inner West Coast)	98.7	0.103	0.067	0.064	0.054	0.046	0.037	0.032

Bold numerals indicate where a relevant standard has been exceeded.

Table D4: 2016 percentiles of daily peak four-hour ozone concentrations

*AAQ NEPM standard
0.08 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 (Northeast Metro)	99.6	0.085	0.062	0.053	0.046	0.042	0.032	0.028
Quinns Rocks (Outer North Coast)	98.7	0.079	0.060	0.058	0.050	0.044	0.036	0.033
Rockingham (South Coast)	98.8	0.079	0.060	0.057	0.048	0.041	0.034	0.031
Rolling Green (Outer East Rural)	97.5	0.066	0.059	0.056	0.047	0.042	0.032	0.029
South Lake (Southeast Metro)	99.6	0.080	0.054	0.051	0.044	0.038	0.031	0.027
Swanbourne (Inner West Coast)	98.7	0.081	0.062	0.057	0.050	0.042	0.035	0.031

Bold numerals indicate where a relevant standard has been exceeded.

Table D5: 2016 percentiles of daily peak one-hour sulfur dioxide concentrations.

*AAQ NEPM standard
0.20 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)	96.1	0.064	0.041	0.035	0.020	0.013	0.005	0.002
South Lake (Southeast Metro)	97.4	0.034	0.020	0.017	0.014	0.011	0.008	0.005
Wattleup (South Metro)	94.5	0.072	0.055	0.048	0.033	0.025	0.013	0.005

Table D6: 2016 percentiles of daily peak 24-hour sulfur dioxide concentrations.

*AAQ NEPM standard
0.08 ppm (24-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)	96.1	0.014	0.010	0.007	0.004	0.002	0.001	0.001
South Lake (Southeast Metro)	97.4	0.010	0.007	0.007	0.006	0.005	0.004	0.003
Wattleup (South Metro)	94.5	0.011	0.006	0.005	0.004	0.003	0.002	0.001

Table D7: 2016 percentiles of daily peak 24-hour particles as PM₁₀ concentrations.

*AAQ NEPM standard
50 µg/m³ (24-hour average)*

Regional performance monitoring station	Data availability rates (%)	Max conc. (µg/m ³)	99 th percentile (µg/m ³)	98 th percentile (µg/m ³)	95 th percentile (µg/m ³)	90 th percentile (µg/m ³)	75 th percentile (µg/m ³)	50 th percentile (µg/m ³)
Perth region								
Caversham (Northeast Metro)	99.1	38.1	33.7	31.5	26.4	22.8	18.5	14.0
Duncraig (North Metro)	99.6	40.0	34.2	29.7	25.8	21.8	17.4	13.2
South Lake (Southeast Metro)	99.5	47.0	38.7	33.4	28.9	24.3	18.9	14.6
Southwest region								
Albany	95.5	94.9	56.5	45.2	35.1	28.7	21.4	15.1
Bunbury	97.5	74.6	44.4	33.0	28.6	24.9	19.1	15.1
Collie	99.5	89.9	51.0	46.9	38.6	30.4	23.0	17.5
Midwest region								
Geraldton	96.7	66.0	49.3	42.1	37.3	32.1	24.3	16.3

Bold numerals indicate where a relevant standard has been exceeded.

Table D8: 2016 percentiles of daily peak 24-hour particles as PM_{2.5} concentrations.

*AAQ NEPM standard
25 µg/m³ (24-hour average)*

Regional performance monitoring station	Data availability rates (%)	Max conc. (µg/m ³)	99 th percentile (µg/m ³)	98 th percentile (µg/m ³)	95 th percentile (µg/m ³)	90 th percentile (µg/m ³)	75 th percentile (µg/m ³)	50 th percentile (µg/m ³)
Perth region								
Caversham (Northeast Metro)	99.5	24.1	17.0	14.2	12.6	10.9	8.8	7.1
Duncraig (North Metro)	99.4	27.0	15.9	15.4	12.0	10.9	8.8	7.1
Quinns Rocks (Outer North Coast)	98.7	28.8	18.4	14.8	12.7	10.8	8.5	7.0
South Lake (Southeast Metro)	99.6	30.4	17.2	15.3	13.1	11.6	9.2	7.4
Southwest region								
Bunbury	99.7	61.5	33.6	22.4	14.9	12.2	9.3	7.5
Busselton	99.5	61.1	22.8	17.5	13.7	11.3	9.2	7.1

Bold numerals indicate where a relevant standard has been exceeded.

Maxima and percentiles by site 2007–2016

Table D9: Daily peak eight-hour carbon monoxide at Caversham (2007–2016).

Trend station/region: Caversham

AAQ NEPM standard
9.0 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	98.2	0	0.9	0.6	0.6	0.5	0.4
2008	99.5	0	0.8	0.7	0.7	0.6	0.5
2009	99.2	0	1.0	0.6	0.5	0.4	0.4
2010	85.0	0	1.6	0.8	0.7	0.6	0.5
2011	98.2	0	1.5	1.2	1.0	0.6	0.5
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

Table D10: Daily peak eight-hour carbon monoxide at Duncraig (2007–2016) .

Trend station/region: Duncraig

AAQ NEPM standard
9.0 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	99.5	0	2.0	1.6	1.4	1.2	0.8
2008	99.0	0	3.1	1.9	1.7	1.4	1.0
2009	98.2	0	2.6	1.7	1.4	1.0	0.7
2010	87.5	0	2.3	2.0	1.8	1.5	1.1
2011	99.3	0	1.9	1.3	1.2	1.0	0.7
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

Table D11: Daily peak eight-hour carbon monoxide at South Lake (2007–2016).

Trend station/region: South Lake

AAQ NEPM standard
9.0 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	99.3	0	1.7	1.4	1.2	1.0	0.8
2008	99.6	0	2.0	1.6	1.4	1.2	0.9
2009	99.3	0	1.8	1.4	1.1	0.9	0.7
2010	87.8	0	2.2	1.6	1.5	1.2	0.9
2011	98.3	0	1.7	1.5	1.3	1.0	0.8
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

Table D12: Daily peak one-hour nitrogen dioxide at Caversham (2007–2016).
Trend station/region: Caversham

 AAQ NEPM standard
 0.12 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	98.5	0	0.044	0.037	0.033	0.028	0.026
2008	99.5	0	0.036	0.033	0.032	0.028	0.026
2009	99.3	0	0.044	0.034	0.033	0.028	0.026
2010	84.9	0	0.054	0.040	0.037	0.032	0.029
2011	99.5	0	0.035	0.031	0.029	0.027	0.025
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

Table D13: Daily peak one-hour nitrogen dioxide at Duncraig (2007–2016).
Trend station/region: Duncraig

 AAQ NEPM standard
 0.12 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	99.6	0	0.053	0.034	0.032	0.030	0.028
2008	97.7	0	0.038	0.034	0.030	0.029	0.027
2009	98.5	0	0.042	0.037	0.034	0.030	0.027
2010	87.5	0	0.038	0.035	0.033	0.030	0.028
2011	99.3	0	0.035	0.032	0.030	0.028	0.027
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

Table D14: Daily peak one-hour nitrogen dioxide at Quinns Rocks (2007–2016).
Trend station/region: Quinns Rocks

 AAQ NEPM standard
 0.12 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	99.5	0	0.035	0.031	0.029	0.028	0.025
2008	96.1	0	0.037	0.033	0.032	0.028	0.025
2009	99.0	0	0.034	0.032	0.031	0.027	0.024
2010	88.8	0	0.040	0.032	0.032	0.030	0.027
2011	99.0	0	0.031	0.028	0.027	0.025	0.022
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

Table D15: Daily peak one-hour nitrogen dioxide at Rockingham (2007–2016).
Trend station/region: Rockingham

 AAQ NEPM standard
 0.12 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	99.4	0	0.040	0.034	0.030	0.028	0.025
2008	99.3	0	0.031	0.028	0.027	0.025	0.024
2009	98.6	0	0.031	0.029	0.028	0.026	0.024
2010	88.7	0	0.036	0.032	0.030	0.028	0.026
2011	96.6	0	0.034	0.028	0.027	0.025	0.022
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

Table D16: Daily peak one-hour nitrogen dioxide at Rolling Green (2007–2016).
Trend station/region: Rolling Green

 AAQ NEPM standard
 0.12 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	98.8	0	0.020	0.019	0.018	0.016	0.014
2008	99.3	0	0.023	0.020	0.019	0.016	0.015
2009	99.5	0	0.035	0.023	0.019	0.017	0.015
2010	87.5	0	0.030	0.022	0.019	0.017	0.016
2011	97.1	0	0.023	0.019	0.018	0.015	0.013
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

Table D17: Daily peak one-hour nitrogen dioxide at South Lake (2007–2016).
Trend station/region: South Lake

 AAQ NEPM standard
 0.12 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	99.1	0	0.057	0.041	0.038	0.032	0.029
2008	99.6	0	0.044	0.040	0.038	0.033	0.030
2009	99.3	0	0.048	0.039	0.036	0.033	0.029
2010	87.8	0	0.058	0.045	0.040	0.036	0.030
2011	96.1	0	0.041	0.033	0.032	0.030	0.028
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

Table D18: Daily peak one-hour nitrogen dioxide at Swanbourne (2007–2016).
Trend station/region: Swanbourne

 AAQ NEPM standard
 0.12 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	98.7	0	0.038	0.033	0.032	0.030	0.027
2008	98.2	0	0.035	0.034	0.033	0.031	0.029
2009	99.2	0	0.037	0.034	0.032	0.028	0.026
2010	86.6	0	0.038	0.033	0.032	0.031	0.029
2011	99.4	0	0.032	0.029	0.028	0.026	0.024
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

Table D19: Daily peak one-hour ozone at Caversham (2007–2016).
Trend station/region: Caversham

 AAQ NEPM standard
 0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	98.6	0	0.085	0.073	0.066	0.059	0.047
2008	99.5	0	0.083	0.067	0.066	0.053	0.046
2009	99.3	1	0.104	0.072	0.067	0.056	0.050
2010	84.5	0	0.082	0.069	0.059	0.055	0.046
2011	99.2	0	0.077	0.070	0.067	0.054	0.045
2012	97.5	0	0.098	0.078	0.064	0.052	0.047
2013	95.7	1	0.101	0.074	0.070	0.056	0.051
2014	96.3	0	0.091	0.065	0.058	0.052	0.047
2015	95.4	1	0.103	0.080	0.077	0.062	0.052
2016	99.6	0	0.096	0.066	0.062	0.053	0.046

Bold numerals indicate where a relevant standard has been exceeded.

Table D20: Daily peak one-hour ozone at Quinns Rocks (2007–2016).
Trend station/region: Quinns Rocks

 AAQ NEPM standard
 0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	98.8	0	0.081	0.061	0.057	0.050	0.045
2008	99.4	0	0.083	0.073	0.060	0.052	0.043
2009	94.3	0	0.070	0.063	0.061	0.053	0.045
2010	88.7	0	0.091	0.061	0.058	0.054	0.048
2011	99.1	0	0.083	0.068	0.057	0.051	0.045
2012	95.7	1	0.130	0.073	0.069	0.058	0.048
2013	99.2	0	0.087	0.077	0.066	0.058	0.050
2014	99.3	0	0.073	0.065	0.062	0.052	0.045
2015	98.9	0	0.083	0.070	0.064	0.057	0.049
2016	98.7	0	0.089	0.066	0.061	0.056	0.048

Bold numerals indicate where a relevant standard has been exceeded.

Table D21: Daily peak one-hour ozone at Rockingham (2007–2016).
Trend station/region: Rockingham

 AAQ NEPM standard
 0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	99.5	0	0.084	0.065	0.056	0.049	0.042
2008	99.4	0	0.077	0.063	0.053	0.045	0.038
2009	99.0	0	0.078	0.064	0.054	0.048	0.041
2010	88.2	0	0.067	0.060	0.057	0.052	0.044
2011	94.9	0	0.065	0.062	0.057	0.048	0.043
2012	99.0	0	0.095	0.073	0.064	0.053	0.044
2013	98.8	0	0.084	0.068	0.065	0.052	0.044
2014	99.0	0	0.076	0.060	0.053	0.047	0.039
2015	98.9	0	0.069	0.062	0.061	0.052	0.045
2016	98.8	0	0.087	0.064	0.060	0.051	0.044

Table D22: Daily peak one-hour ozone at Rolling Green (2007–2016).
Trend station/region: Rolling Green

 AAQ NEPM standard
 0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	98.9	0	0.095	0.081	0.078	0.062	0.053
2008	99.5	0	0.087	0.080	0.071	0.056	0.047
2009	99.5	1	0.103	0.081	0.069	0.059	0.052
2010	85.6	0	0.088	0.077	0.070	0.056	0.046
2011	95.9	0	0.073	0.068	0.060	0.052	0.043
2012	91.8	1	0.103	0.074	0.066	0.055	0.045
2013	96.8	0	0.099	0.078	0.071	0.061	0.049
2014	98.1	0	0.080	0.069	0.063	0.056	0.047
2015	99.2	1	0.105	0.078	0.073	0.062	0.055
2016	97.5	0	0.075	0.070	0.063	0.053	0.047

Bold numerals indicate where a relevant standard has been exceeded.

Table D23: Daily peak one-hour ozone at South Lake (2007–2016).
Trend station/region: South Lake

 AAQ NEPM standard
 0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	99.4	0	0.067	0.056	0.053	0.047	0.040
2008	99.6	0	0.082	0.061	0.056	0.044	0.037
2009	99.4	0	0.065	0.057	0.053	0.045	0.039
2010	88.0	0	0.070	0.067	0.062	0.052	0.045
2011	99.4	0	0.076	0.064	0.057	0.050	0.044
2012	98.2	0	0.085	0.065	0.062	0.051	0.041
2013	98.6	0	0.087	0.074	0.062	0.054	0.043
2014	99.4	0	0.065	0.059	0.056	0.046	0.041
2015	98.8	0	0.067	0.063	0.060	0.051	0.042
2016	99.6	0	0.091	0.065	0.056	0.050	0.043

Table D24: Daily peak one-hour ozone at Swanbourne (2007–2016).**Trend station/region: Swanbourne**AAQ NEPM standard
0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	99.3	0	0.077	0.064	0.057	0.051	0.044
2008	98.2	0	0.076	0.067	0.060	0.048	0.042
2009	99.6	0	0.068	0.063	0.059	0.053	0.044
2010	86.6	0	0.066	0.059	0.056	0.050	0.044
2011	99.6	0	0.085	0.069	0.061	0.051	0.046
2012	98.2	1	0.128	0.074	0.067	0.056	0.047
2013	99.8	0	0.083	0.069	0.064	0.052	0.045
2014	97.8	0	0.066	0.056	0.053	0.048	0.042
2015	99.9	0	0.074	0.066	0.061	0.056	0.044
2016	98.7	1	0.103	0.067	0.064	0.054	0.046

Bold numerals indicate where a relevant standard has been exceeded.

Table D25: Daily peak four-hour ozone at Caversham (2007–2016).**Trend station/region: Caversham**AAQ NEPM standard
0.08 ppm (four-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	98.6	0	0.073	0.062	0.058	0.049	0.042
2008	99.5	0	0.076	0.061	0.056	0.047	0.041
2009	99.3	1	0.092	0.067	0.057	0.051	0.043
2010	84.5	0	0.072	0.056	0.052	0.047	0.041
2011	99.2	0	0.063	0.061	0.056	0.049	0.041
2012	97.5	2	0.086	0.070	0.056	0.047	0.041
2013	95.7	0	0.075	0.065	0.060	0.049	0.044
2014	96.3	0	0.073	0.055	0.050	0.046	0.041
2015	95.4	1	0.084	0.070	0.067	0.054	0.046
2016	99.6	1	0.085	0.062	0.053	0.046	0.042

Bold numerals indicate where a relevant standard has been exceeded.

Table D26: Daily peak four-hour ozone at Quinns Rocks (2007–2016).**Trend station/region: Quinns Rocks**AAQ NEPM standard
0.08 ppm (four-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	98.8	0	0.075	0.056	0.053	0.046	0.041
2008	99.4	0	0.073	0.061	0.055	0.046	0.041
2009	94.3	0	0.062	0.056	0.054	0.048	0.040
2010	88.7	0	0.065	0.056	0.052	0.048	0.042
2011	99.1	0	0.075	0.060	0.052	0.047	0.041
2012	95.7	2	0.108	0.065	0.061	0.051	0.043
2013	99.2	0	0.079	0.068	0.061	0.051	0.045
2014	99.3	0	0.062	0.057	0.051	0.046	0.042
2015	98.9	0	0.071	0.063	0.059	0.053	0.042
2016	98.7	0	0.079	0.060	0.058	0.050	0.044

Bold numerals indicate where a relevant standard has been exceeded.

Table D27: Daily peak four-hour ozone at Rockingham (2007–2016).
Trend station/region: Rockingham

 AAQ NEPM standard
 0.08 ppm (four-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	99.5	0	0.079	0.057	0.052	0.046	0.038
2008	99.4	0	0.072	0.058	0.049	0.042	0.036
2009	99.0	0	0.066	0.058	0.051	0.045	0.039
2010	88.2	0	0.064	0.054	0.053	0.046	0.041
2011	94.9	0	0.061	0.058	0.053	0.045	0.040
2012	99.0	0	0.079	0.065	0.060	0.048	0.040
2013	98.8	0	0.075	0.064	0.057	0.047	0.042
2014	99.0	0	0.067	0.051	0.048	0.043	0.037
2015	98.9	0	0.064	0.056	0.055	0.047	0.041
2016	98.8	0	0.079	0.060	0.057	0.048	0.041

Table D28: Daily peak four-hour ozone at Rolling Green (2007–2016).
Trend station/region: Rolling Green

 AAQ NEPM standard
 0.08 ppm (four-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	98.9	0	0.080	0.070	0.066	0.053	0.046
2008	99.5	0	0.075	0.065	0.062	0.051	0.043
2009	99.5	2	0.083	0.064	0.057	0.051	0.043
2010	85.6	0	0.080	0.065	0.056	0.049	0.042
2011	95.9	0	0.061	0.055	0.051	0.045	0.040
2012	91.8	1	0.081	0.064	0.058	0.049	0.042
2013	96.8	1	0.083	0.065	0.059	0.051	0.045
2014	98.1	0	0.070	0.058	0.054	0.048	0.042
2015	99.2	1	0.093	0.068	0.063	0.054	0.049
2016	97.5	0	0.066	0.059	0.056	0.047	0.042

Bold numerals indicate where a relevant standard has been exceeded.

Table D29: Daily peak four-hour ozone at South Lake (2007–2016).
Trend station/region: South Lake

 AAQ NEPM standard
 0.08 ppm (four-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	99.4	0	0.059	0.051	0.048	0.042	0.037
2008	99.6	0	0.067	0.051	0.046	0.040	0.034
2009	99.4	0	0.057	0.053	0.048	0.040	0.036
2010	88.0	0	0.061	0.055	0.053	0.046	0.042
2011	99.4	0	0.064	0.056	0.051	0.046	0.039
2012	98.2	0	0.080	0.060	0.054	0.046	0.037
2013	98.6	0	0.074	0.063	0.057	0.048	0.039
2014	99.4	0	0.058	0.053	0.049	0.042	0.037
2015	98.8	0	0.060	0.055	0.053	0.045	0.037
2016	99.6	0	0.080	0.054	0.051	0.044	0.038

Table D30: Daily peak four-hour ozone at Swanbourne (2007–2016).**Trend station/region: Swanbourne**AAQ NEPM standard
0.08 ppm (four-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	99.3	0	0.067	0.054	0.051	0.048	0.042
2008	98.2	0	0.070	0.060	0.053	0.045	0.039
2009	99.6	0	0.063	0.058	0.054	0.046	0.039
2010	86.6	0	0.055	0.053	0.050	0.044	0.040
2011	99.6	0	0.073	0.059	0.056	0.047	0.043
2012	98.2	1	0.108	0.064	0.061	0.051	0.042
2013	99.8	0	0.068	0.063	0.056	0.048	0.042
2014	97.8	0	0.057	0.050	0.049	0.043	0.038
2015	99.9	0	0.067	0.058	0.056	0.049	0.039
2016	98.7	1	0.081	0.062	0.057	0.050	0.042

Bold numerals indicate where a relevant standard has been exceeded.

Table D31: Daily peak one-hour sulfur dioxide at Rockingham (2007–2016).**Trend station/region: Rockingham**AAQ NEPM standard
0.20 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	98.6	0	0.041	0.025	0.020	0.013	0.008
2008	98.3	0	0.079	0.026	0.019	0.015	0.008
2009	98.7	0	0.032	0.022	0.017	0.010	0.007
2010	89.9	0	0.037	0.022	0.019	0.013	0.009
2011	93.7	0	0.040	0.029	0.024	0.017	0.010
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

Table D32: Daily peak one-hour sulfur dioxide at South Lake (2007–2016).**Trend station/region: South Lake**AAQ NEPM standard
0.20 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	99.4	0	0.040	0.032	0.028	0.019	0.012
2008	99.6	0	0.046	0.025	0.020	0.014	0.010
2009	98.4	0	0.036	0.033	0.029	0.018	0.015
2010	87.8	0	0.073	0.036	0.033	0.025	0.017
2011	95.7	0	0.044	0.029	0.026	0.017	0.012
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

Table D33: Daily peak one-hour sulfur dioxide at Wattleup (2007–2016).**Trend station/region: Wattleup***AAQ NEPM standard
0.20 ppm (one-hour average)*

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	93.3	0	0.060	0.045	0.040	0.034	0.025
2008	89.6	0	0.077	0.034	0.028	0.022	0.016
2009	95.6	0	0.059	0.039	0.036	0.029	0.022
2010	86.8	0	0.057	0.049	0.043	0.036	0.023
2011	94.3	0	0.067	0.049	0.042	0.032	0.026
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

Table D34: Daily peak 24-hour sulfur dioxide at Rockingham (2007–2016).**Trend station/region: Rockingham***AAQ NEPM standard
0.08 ppm (24-hour average)*

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	98.6	0	0.012	0.005	0.004	0.003	0.002
2008	98.3	0	0.007	0.005	0.004	0.002	0.001
2009	98.7	0	0.008	0.003	0.002	0.001	0.001
2010	89.9	0	0.007	0.004	0.003	0.002	0.002
2011	93.7	0	0.008	0.006	0.006	0.003	0.002
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

Table D35: Daily peak 24-hour sulfur dioxide at South Lake (2007–2016).**Trend station/region: South Lake***AAQ NEPM standard
0.08 ppm (24-hour average)*

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	99.4	0	0.006	0.004	0.003	0.002	0.002
2008	99.6	0	0.005	0.003	0.003	0.002	0.001
2009	98.4	0	0.006	0.005	0.003	0.003	0.002
2010	87.8	0	0.009	0.005	0.004	0.003	0.002
2011	95.7	0	0.006	0.004	0.003	0.002	0.002
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

Table D36: Daily peak 24-hour sulfur dioxide at Wattleup (2007–2016).**Trend station/region: Wattleup**AAQ NEPM standard
0.08 ppm (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2007	93.3	0	0.010	0.008	0.007	0.005	0.004
2008	89.6	0	0.011	0.005	0.004	0.003	0.002
2009	95.6	0	0.008	0.005	0.005	0.004	0.003
2010	86.8	0	0.010	0.008	0.006	0.005	0.003
2011	94.3	0	0.008	0.006	0.005	0.004	0.003
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

Table D37: Daily peak 24-hour particles as PM₁₀ at Caversham (2007–2016).**Trend station/region: Caversham**AAQ NEPM standard
50 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (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)
2007	98.4	1	58.8	39.7	35.9	30.3	26.1
2008	99.3	0	39.1	37.0	32.5	26.1	22.5
2009	99.4	0	45.7	37.2	32.4	29.0	25.8
2010	99.5	1	63.4	40.7	36.1	30.5	26.3
2011	99.1	1	76.1	33.2	30.2	27.3	23.8
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

Bold numerals indicate where a relevant standard has been exceeded.

Table D38: Daily peak 24-hour particles as PM₁₀ at Duncraig (2007–2016).**Trend station/region: Duncraig**AAQ NEPM standard
50 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (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)
2007	99.7	0	40.3	31.8	29.4	25.8	22.0
2008	99.2	0	46.9	34.4	31.1	25.8	21.9
2009	99.2	0	45.5	36.2	30.4	24.5	22.6
2010	99.4	0	47.9	33.1	30.8	25.1	22.7
2011	99.3	1	65.9	30.1	29.5	25.7	23.2
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

Bold numerals indicate where a relevant standard has been exceeded.

Table D39: Daily peak 24-hour particles as PM₁₀ at South Lake (2007–2016).
Trend station/region: South Lake

 AAQ NEPM standard
 50 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (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)
2007	97.9	1	56.7	37.7	36.0	32.9	26.7
2008	99.6	1	55.0	39.9	36.1	30.3	25.8
2009	99.5	0	49.0	38.7	34.3	30.8	27.5
2010	99.7	4	61.0	46.7	39.8	33.9	28.5
2011	99.2	1	66.2	35.8	31.5	28.1	24.8
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

Bold numerals indicate where a relevant standard has been exceeded.

Table D40: Daily peak 24-hour particles as PM₁₀ at Bunbury (2007–2016).
Trend station/region: Bunbury

 AAQ NEPM standard
 50 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (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)
2007	99.6	0	46.5	32.8	29.6	27.1	24.5
2008	99.4	0	39.1	31.4	30.3	27.3	23.7
2009	99.5	1	53.8	40.3	36.0	29.5	25.4
2010	99.1	2	134.0	37.6	36.0	29.3	25.3
2011	99.6	2	68.4	39.3	33.8	28.0	23.8
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

Bold numerals indicate where a relevant standard has been exceeded.

Table D41: Daily peak 24-hour particles as PM₁₀ at Albany (2007–2016).
Trend station/region: Albany

 AAQ NEPM standard
 50 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (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)
2007	99.8	1	55.7	31.3	28.0	24.7	22.1
2008	99.2	2	56.3	34.1	32.8	26.1	22.7
2009	97.7	0	36.7	32.3	28.7	24.5	21.4
2010	99.8	1	52.5	36.1	33.2	27.3	25.3
2011	99.3	0	37.3	33.6	30.6	26.3	22.0
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

Bold numerals indicate where a relevant standard has been exceeded.

Table D42: Daily peak 24-hour particles as PM₁₀ at Geraldton (2007–2016).
Trend station/region: Geraldton

 AAQ NEPM standard
 50 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (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)
2007	99.7	10	116.3	87.2	67.9	44.7	36.4
2008	98.9	10	150.7	105.2	58.1	45.9	38.6
2009	99.6	14	128.9	69.2	58.6	48.5	40.3
2010	97.7	4	55.6	49.3	47.8	41.6	37.9
2011	98.6	3	63.0	45.4	40.2	35.8	32.2
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

Bold numerals indicate where a relevant standard has been exceeded.

Table D43: Daily peak 24-hour particles as PM₁₀ at Collie (2007–2016).
Trend station/region: Collie

 AAQ NEPM standard
 50 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (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)
2007	0.0	0					
2008	87.6	7	85.9	56.7	50.1	37.4	30.5
2009	99.5	3	80.4	47.3	46.2	38.0	31.3
2010	99.7	16	163.0	86.7	67.3	46.1	34.9
2011	97.6	4	61.5	52.1	40.4	32.0	29.2
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

Bold numerals indicate where a relevant standard has been exceeded.

Table D44: Daily peak 24-hour particles as PM_{2.5} at Caversham (2007–2016).
Trend station/region: Caversham

 AAQ NEPM standard
 25 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (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)
2007	98.4	0	24.5	15.1	14.0	12.1	10.7
2008	99.4	1	26.3	15.2	14.0	11.7	10.6
2009	99.5	2	25.5	19.4	17.3	12.9	11.0
2010	99.1	3	45.2	21.9	16.2	13.7	12.1
2011	99.4	1	41.5	12.4	11.7	10.8	9.8
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

Bold numerals indicate where a relevant standard has been exceeded.

Table D45: Daily peak 24-hour particles as PM_{2.5} at Duncraig (2007–2016).**Trend station/region: Duncraig**AAQ NEPM standard
25 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (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)
2007	99.6	0	19.6	14.2	13.5	11.6	10.1
2008	99.3	1	38.3	18.0	15.9	12.6	11.1
2009	99.4	3	32.7	22.1	17.5	13.2	11.5
2010	99.3	3	36.4	20.1	15.9	13.7	12.0
2011	99.4	1	52.1	14.7	13.4	11.5	10.4
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

Bold numerals indicate where a relevant standard has been exceeded.

Table D46: Daily peak 24-hour particles as PM_{2.5} at Quinns Rocks (2007–2016).**Trend station/region: Quinns Rocks**AAQ NEPM standard
25 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (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)
2007	99.7	0	19.9	15.4	13.7	12.1	10.1
2008	99.3	1	53.3	17.3	15.4	12.8	11.3
2009	99.8	2	31.3	20.7	15.2	12.7	11.3
2010	99.6	3	33.7	17.6	14.5	12.0	10.9
2011	99.0	2	43.2	17.3	14.6	11.6	10.1
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

Bold numerals indicate where a relevant standard has been exceeded.

Table D47: Daily peak 24-hour particles as PM_{2.5} at South Lake (2007–2016).**Trend station/region: South Lake**AAQ NEPM standard
25 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (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)
2007	98.9	0	21.2	15.6	12.9	11.8	10.5
2008	99.4	1	45.2	18.2	14.1	12.7	11.2
2009	99.3	3	32.0	22.8	19.1	14.1	11.7
2010	99.5	2	40.0	22.0	19.2	15.9	13.2
2011	99.2	1	48.2	16.2	15.3	13.1	11.5
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

Bold numerals indicate where a relevant standard has been exceeded.

Table D48: Daily peak 24-hour particles as PM_{2.5} at Bunbury (2007–2016).
Trend station/region: Bunbury
*AAQ NEPM standard
25 µg/m³ (24-hour average)*

Year	Data recovery (%)	No. of exceedences (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)
2007	99.4	3	34.5	21.2	17.8	13.2	10.7
2008	99.7	2	27.8	21.0	18.6	13.2	11.4
2009	99.5	7	40.0	26.6	22.3	16.9	12.6
2010	98.6	7	115.3	28.4	24.2	14.8	12.2
2011	98.9	5	45.5	26.6	18.7	13.2	11.2
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

Bold numerals indicate where a relevant standard has been exceeded.

Table D49: Daily peak 24-hour particles as PM_{2.5} at Busselton (2007–2016).
Trend station/region: Busselton
*AAQ NEPM standard
25 µg/m³ (24-hour average)*

Year	Data recovery (%)	No. of exceedences (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)
2007	99.4	2	51.1	15.6	14.3	11.7	9.9
2008	99.3	3	35.6	20.5	15.5	11.9	10.5
2009	99.8	12	69.0	45.0	31.6	17.7	14.0
2010	99.4	7	62.5	31.6	22.9	15.7	11.6
2011	99.8	6	85.2	36.7	20.5	13.9	11.4
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

Bold numerals indicate where a relevant standard has been exceeded.

Maxima by pollutant 2007–2016

Table D50: Annual daily peak eight-hour carbon monoxide concentrations (ppm) for 2007–2016.

*AAQ NEPM standard
9.0 ppm (eight-hour average)*

Regional performance monitoring station	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Perth region										
Caversham (Northeast Metro)	0.9	0.8	1.0	1.6	1.5	0.9	0.9	0.7	1.2	0.9
Duncraig (North Metro)	2.0	3.1	2.6	2.3	1.9	2.4	2.1	1.9	1.7	1.4
South Lake (Southeast Metro)	1.7	2.0	1.8	2.2	1.7	2.2	1.7	1.8	1.9	2.3

Table D51: Annual daily peak one-hour nitrogen dioxide concentrations (ppm) for 2007–2016.

*AAQ NEPM standard
0.12 ppm (one-hour average)*

Regional performance monitoring station	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Perth region										
Caversham (Northeast Metro)	0.044	0.036	0.044	0.054	0.035	0.037	0.043	0.033	0.041	0.036
Duncraig (North Metro)	0.053	0.038	0.042	0.038	0.035	0.047	0.040	0.048	0.036	0.033
Quinns Rocks (Outer North Coast)	0.035	0.037	0.034	0.040	0.031	0.041	0.032	0.031	0.030	0.029
Rockingham (South Coast)	0.040	0.031	0.031	0.036	0.034	0.053	0.035	0.034	0.062	0.029
Rolling Green (Outer East Rural)	0.020	0.023	0.035	0.030	0.023	0.029	0.030	0.021	0.023	0.023
South Lake (Southeast Metro)	0.057	0.044	0.048	0.058	0.041	0.046	0.043	0.034	0.043	0.038
Swanbourne (Inner West Coast)	0.038	0.035	0.037	0.038	0.032	0.045	0.037	0.036	0.036	0.030

Table D52: Annual daily peak one-hour ozone concentrations (ppm) for 2007–2016.

*AAQ NEPM standard
0.10 ppm (one-hour average)*

Regional performance monitoring station	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Perth region										
Caversham (Northeast Metro)	0.085	0.083	0.104	0.082	0.077	0.098	0.101	0.091	0.103	0.096
Quinns Rocks (Outer North Coast)	0.081	0.083	0.070	0.091	0.083	0.130	0.087	0.073	0.083	0.089
Rockingham (South Coast)	0.084	0.077	0.078	0.067	0.065	0.095	0.084	0.076	0.069	0.087
Rolling Green (Outer East Rural)	0.095	0.087	0.103	0.088	0.073	0.103	0.099	0.080	0.105	0.075
South Lake (Southeast Metro)	0.067	0.082	0.065	0.070	0.076	0.085	0.087	0.065	0.067	0.091
Swanbourne (Inner West Coast)	0.077	0.076	0.068	0.066	0.085	0.128	0.083	0.066	0.074	0.103

Bold numerals indicate where a relevant standard has been exceeded.

For explanation of exceedences in previous years, please refer to the relevant year report.

Table D53: Annual daily peak four-hour ozone concentrations (ppm) for 2007–2016.

*AAQ NEPM standard
0.08 ppm (four-hour average)*

Regional performance monitoring station	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Perth region										
Caversham (Northeast Metro)	0.073	0.076	0.092	0.072	0.063	0.086	0.075	0.073	0.084	0.085
Quinns Rocks (Outer North Coast)	0.075	0.073	0.062	0.065	0.075	0.108	0.079	0.062	0.071	0.079
Rockingham (South Coast)	0.079	0.072	0.066	0.064	0.061	0.079	0.075	0.067	0.064	0.079
Rolling Green (Outer East Rural)	0.080	0.075	0.083	0.080	0.061	0.081	0.083	0.070	0.093	0.066
South Lake (Southeast Metro)	0.059	0.067	0.057	0.061	0.064	0.080	0.074	0.058	0.060	0.080
Swanbourne (Inner West Coast)	0.067	0.070	0.063	0.055	0.073	0.108	0.068	0.057	0.067	0.081

Bold numerals indicate where a relevant standard has been exceeded.

For explanation of exceedences in previous years, please refer to the relevant year report.

Table D54: Annual daily peak one-hour sulfur dioxide concentrations (ppm) for 2007–2016.

*AAQ NEPM standard
0.20 ppm (one-hour average)*

Regional performance monitoring station	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Perth region										
Rockingham (South Coast)	0.041	0.079	0.032	0.037	0.040	0.040	0.037	0.036	0.051	0.064
South Lake (Southeast Metro)	0.040	0.046	0.036	0.073	0.044	0.039	0.044	0.051	0.037	0.034
Wattleup (South Metro)	0.060	0.077	0.059	0.057	0.067	0.043	0.090	0.061	0.067	0.072

Table D55: Annual daily peak 24-hour sulfur dioxide concentrations (ppm) for 2007–2016.

*AAQ NEPM standard
0.08 ppm (24-hour average)*

Regional performance monitoring station	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Perth region										
Rockingham (South Coast)	0.012	0.007	0.008	0.007	0.008	0.006	0.007	0.007	0.013	0.014
South Lake (Southeast Metro)	0.006	0.005	0.006	0.009	0.006	0.006	0.014	0.010	0.007	0.010
Wattleup (South Metro)	0.010	0.011	0.008	0.010	0.008	0.008	0.010	0.008	0.009	0.011

Table D56: Annual daily peak 24-hour particles as PM₁₀ concentrations (µg/m³) for 2007–2016.

Regional performance monitoring station	AAQ NEPM standard 50 µg/m ³ (24-hour average)									
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Perth region										
Caversham (Northeast Metro)	58.8	39.1	45.7	63.4	76.1	68.7	62.4	52.6	46.8	38.1
Duncraig (North Metro)	40.3	46.9	45.5	47.9	65.9	89.5	37.6	53.0	82.7	40.0
South Lake (Southeast Metro)	56.7	55.0	49.0	61.0	66.2	81.5	38.8	44.5	53.3	47.0
Southwest region										
Bunbury	46.5	39.1	53.8	134.0	68.4	53.5	46.8	44.5	62.9	74.6
Collie	-	85.9	80.4	163.0	61.5	91.7	61.6	73.3	111.9	89.9
Albany	55.7	56.3	36.7	52.5	37.3	37.0	110.8	43.5	76.7	94.9
Midwest region										
Geraldton	116.3	150.7	128.9	55.6	63.0	61.5	63.1	55.7	68.1	66.0

Bold numerals indicate where a relevant standard has been exceeded.

For explanation of this year's exceedences, please see [Table A9](#) of this report.

For explanation of exceedences in previous years, please refer to the relevant year report.

Table D57: Annual daily peak 24-hour particles as PM_{2.5} concentrations (µg/m³) for 2007–2016.

Regional performance monitoring station	AAQ NEPM standard 25 µg/m ³ (24-hour average)									
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Perth region										
Caversham (Northeast Metro)	24.5	26.3	25.5	45.2	41.5	45.9	22.6	39.3	30.0	24.1
Duncraig (North Metro)	19.6	38.3	32.7	36.4	52.1	77.3	18.7	47.6	35.8	27.0
Quinns Rocks (Outer North Coast)	19.9	53.3	31.3	33.7	43.2	74.5	19.3	39.5	37.9	28.8
South Lake (Southeast Metro)	21.2	45.2	32.0	40.0	48.2	71.6	17.1	29.8	34.5	30.4
Southwest region										
Bunbury	34.5	27.8	40.0	115.3	45.5	43.0	38.3	34.6	52.1	61.5
Busselton	51.1	35.6	69.0	62.5	85.2	78.0	17.9	25.1	37.8	61.1

Bold numerals indicate where a relevant standard has been exceeded.

For explanation of this year's exceedences, please see [Table A9](#) of this report.

For explanation of exceedences in previous years, please refer to the relevant year report.

Table D58: Annual averaged particles as PM₁₀ concentrations (µg/m³) for 2007–2016.

Regional performance monitoring station	AAQ NEPM standard 25 µg/m ³ (annual average)									
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Perth region										
Caversham (Northeast Metro)	16.4	14.5	17.1	17.0	16.2	16.8	15.4	17.4	16.7	15.0
Duncraig (North Metro)	15.3	15.0	15.9	15.8	15.3	16.2	15.5	15.5	16.5	14.4
South Lake (Southeast Metro)	17.7	16.3	17.7	19.0	16.3	16.9	16.6	17.4	17.9	15.8
Southwest region										
Bunbury	17.2	15.8	17.6	17.6	17.0	17.5	16.8	16.1	17.5	16.5
Collie	-	19.2	20.0	22.8	19.6	20.0	20.1	19.2	22.4	19.3
Albany	14.2	14.6	14.3	15.9	14.5	15.0	15.4	16.0	15.9	17.5
Midwest region										
Geraldton	23.0	22.4	23.9	21.7	19.6	21.3	20.9	22.3	20.2	18.8

Table D58a: Annual averaged particles as PM_{2.5} concentrations (µg/m³) for 2007–2016.

Regional performance monitoring station	AAQ NEPM standard 8 µg/m ³ (annual average)									
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Perth region										
Caversham (Northeast Metro)	7.5	7.1	7.8	8.2	7.0	7.8	7.9	8.1	8.5	7.7
Duncraig (North Metro)	7.3	7.7	8.2	8.2	7.8	8.2	7.6	7.6	8.4	7.5
Quinns Rocks (Outer North Coast)	6.9	7.2	7.8	7.8	7.2	7.9	7.8	8.0	8.3	7.5
South Lake (Southeast Metro)	7.6	7.7	8.2	8.7	7.8	8.9	8.0	8.1	8.8	8.0
Southwest region										
Bunbury	7.8	7.6	8.3	9.2	8.0	8.6	7.8	7.8	9.3	8.4
Busselton	7.4	7.3	9.0	8.5	8.5	8.6	7.7	7.2	8.6	8.1

Bold numerals indicate where a relevant standard has been exceeded.

Attachment 1 – Graphical trends

This attachment provides graphical representations of tables D9 to D49 of Section D.

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

Based on 100 per cent data recovery and a normal year (that is 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)

Carbon monoxide

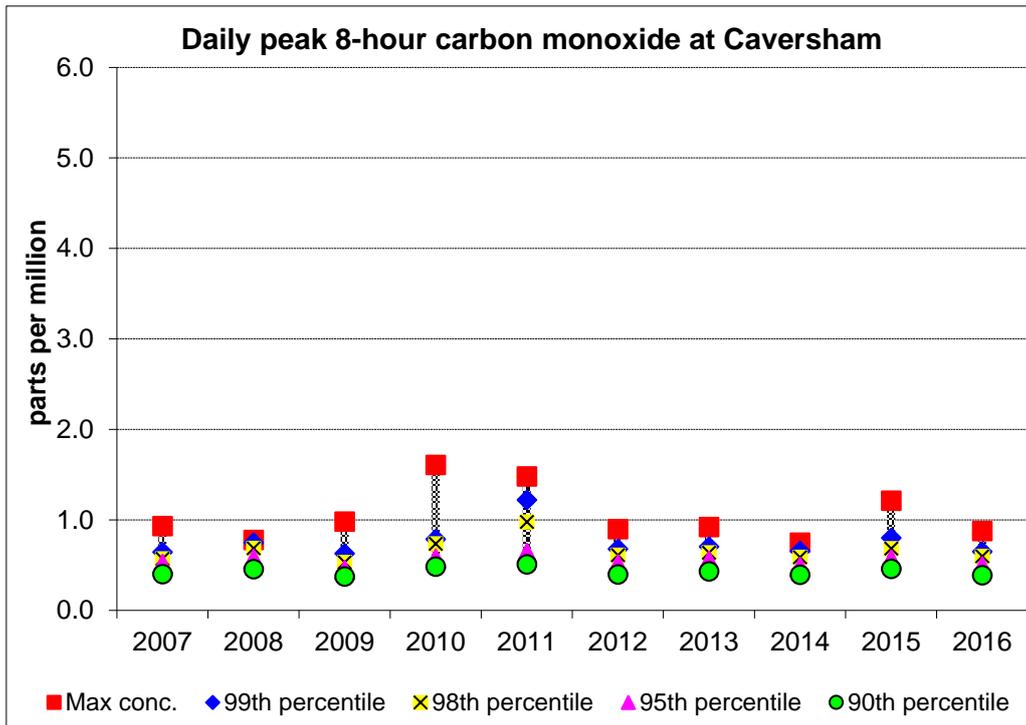


Figure A1-1 – eight-hour carbon monoxide at Caversham

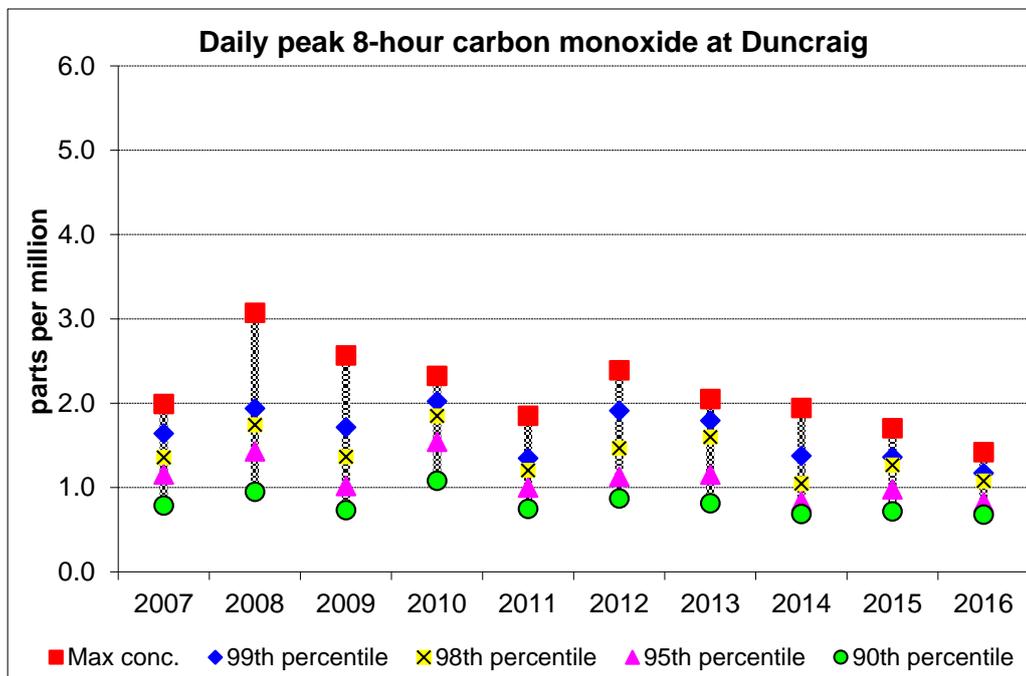


Figure A1-2 – eight-hour carbon monoxide at Duncraig

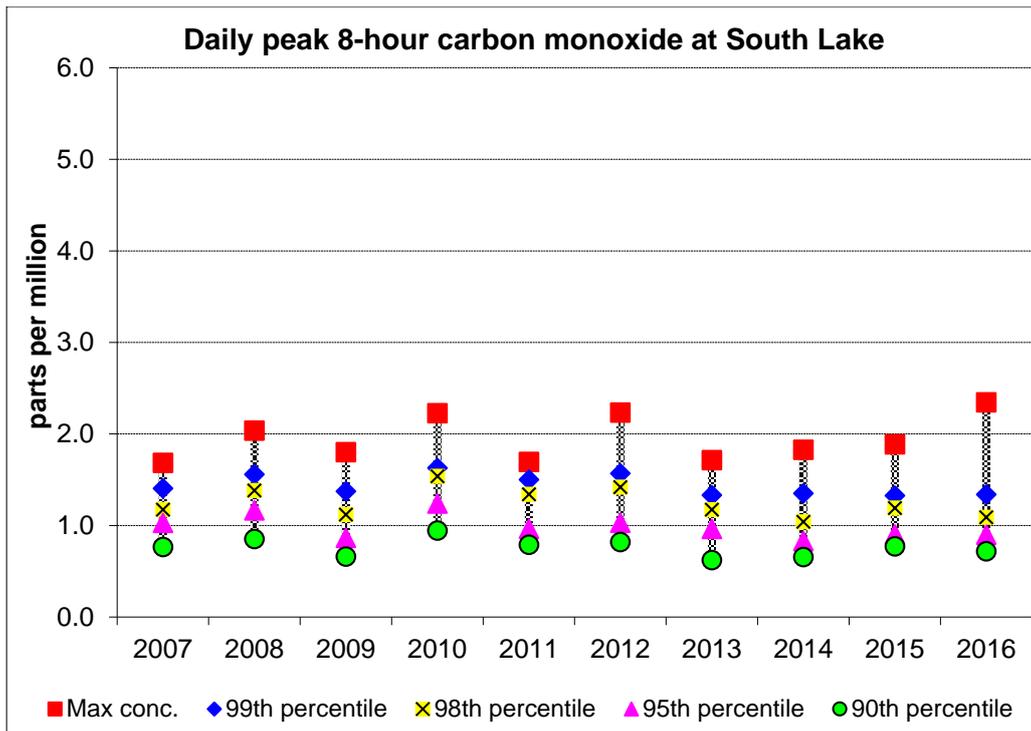


Figure A1-3 – eight-hour carbon monoxide at South Lake

Nitrogen dioxide

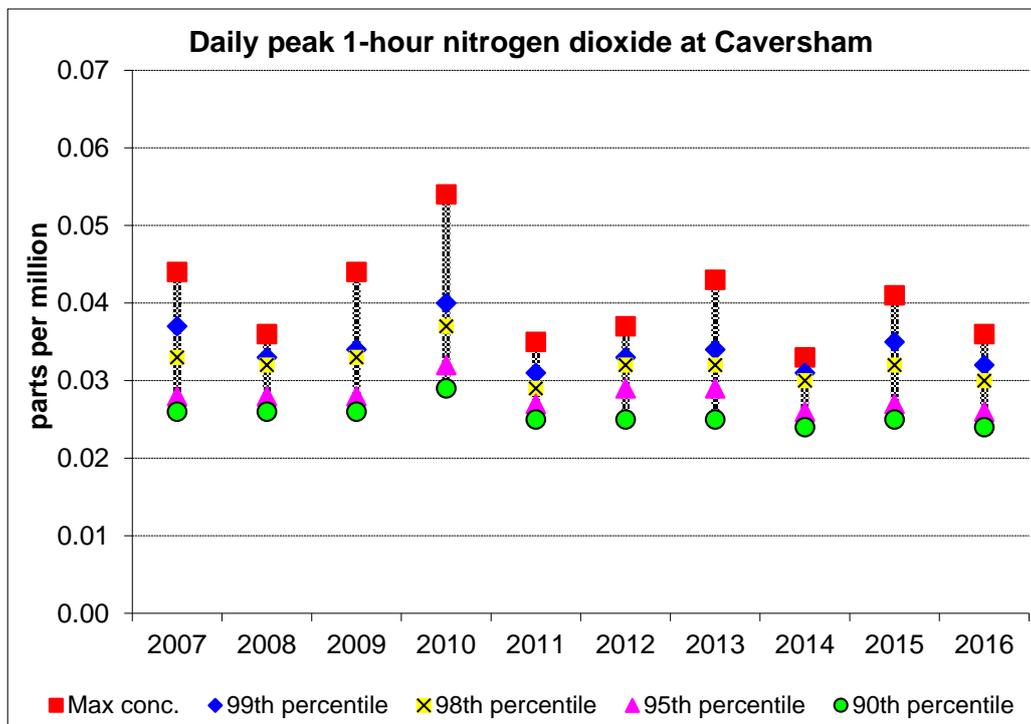


Figure A1-4 – one-hour nitrogen dioxide at Caversham

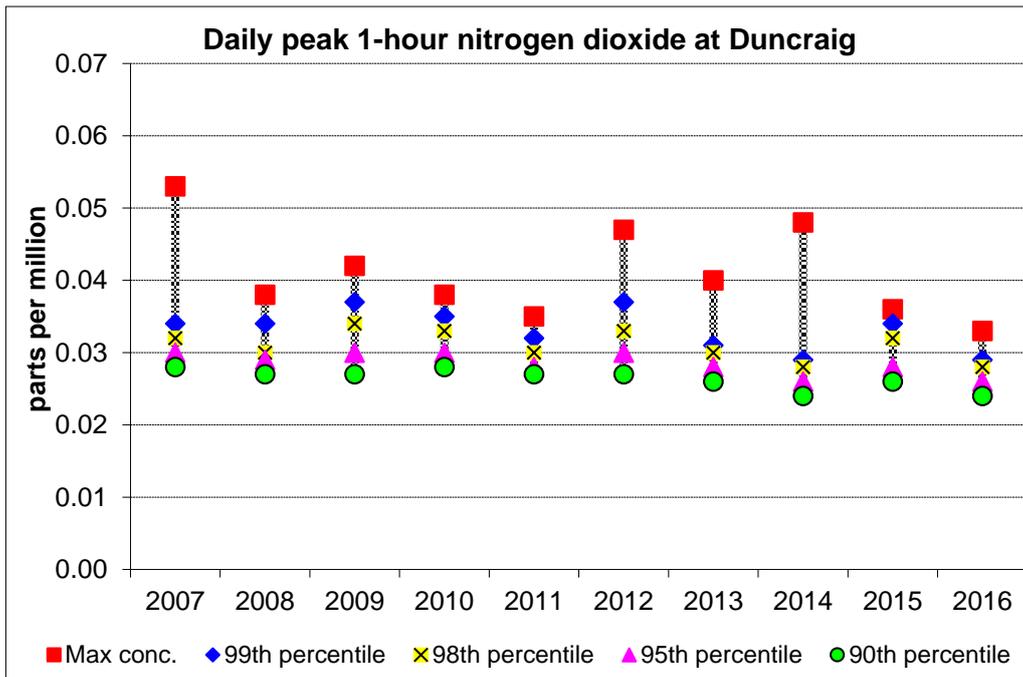


Figure A1-5 – one-hour nitrogen dioxide at Duncraig

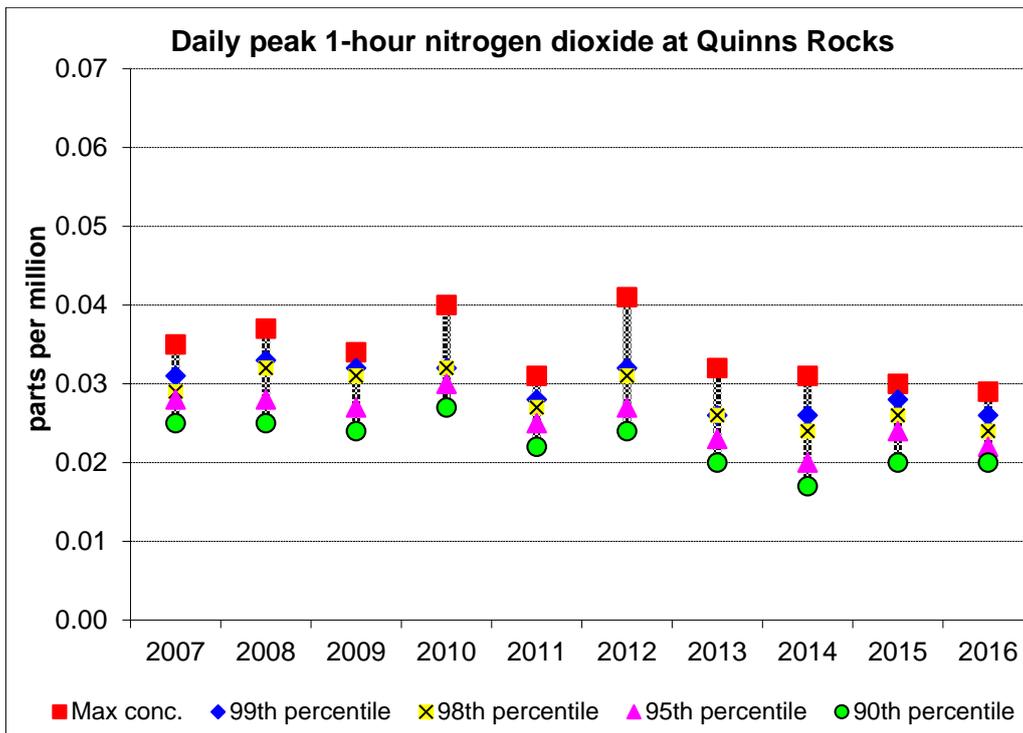


Figure A1-6 – one-hour nitrogen dioxide at Quinns Rocks

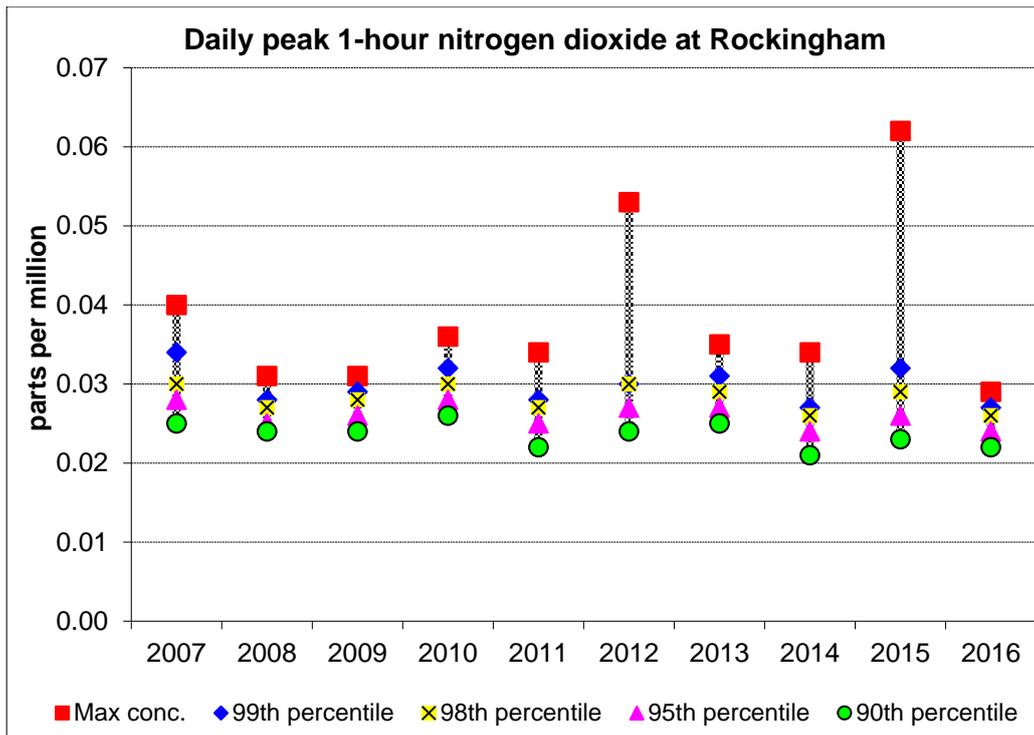


Figure A1-7 – one-hour nitrogen dioxide at Rockingham

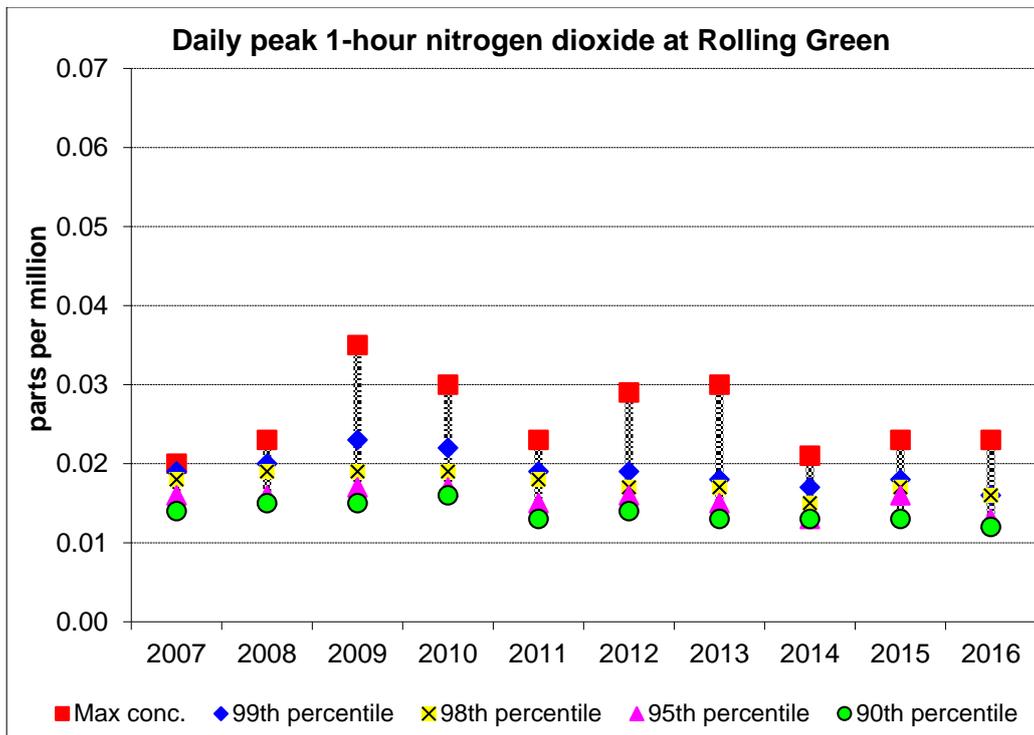


Figure A1-8 – one-hour nitrogen dioxide at Rolling Green

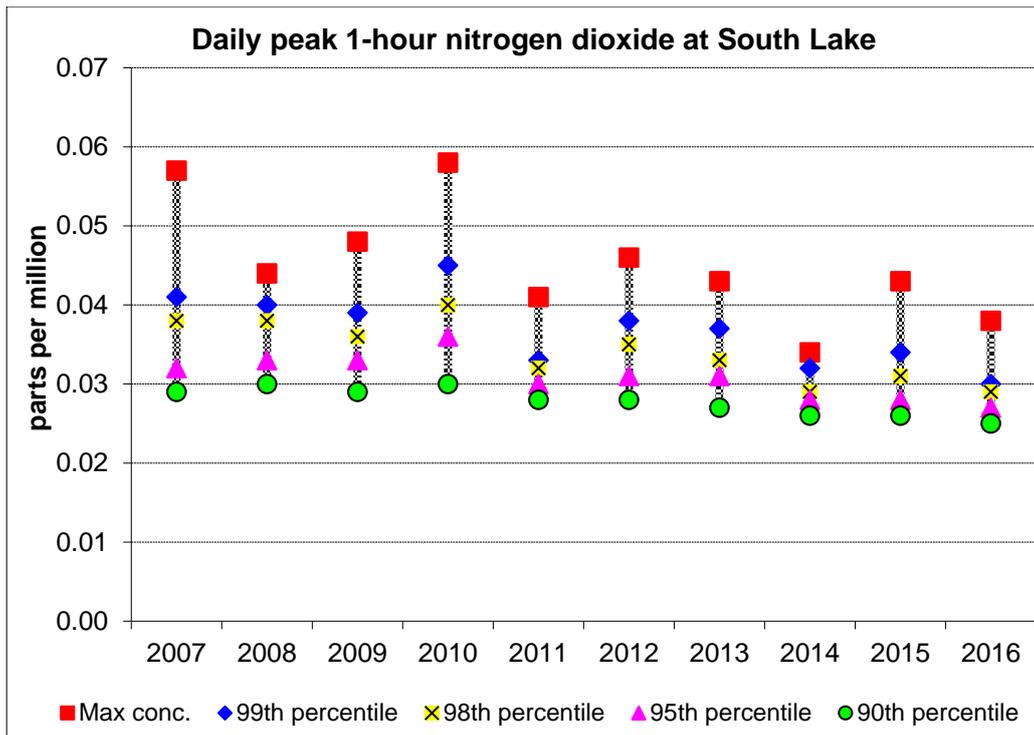


Figure A1-9 – one-hour nitrogen dioxide at South Lake

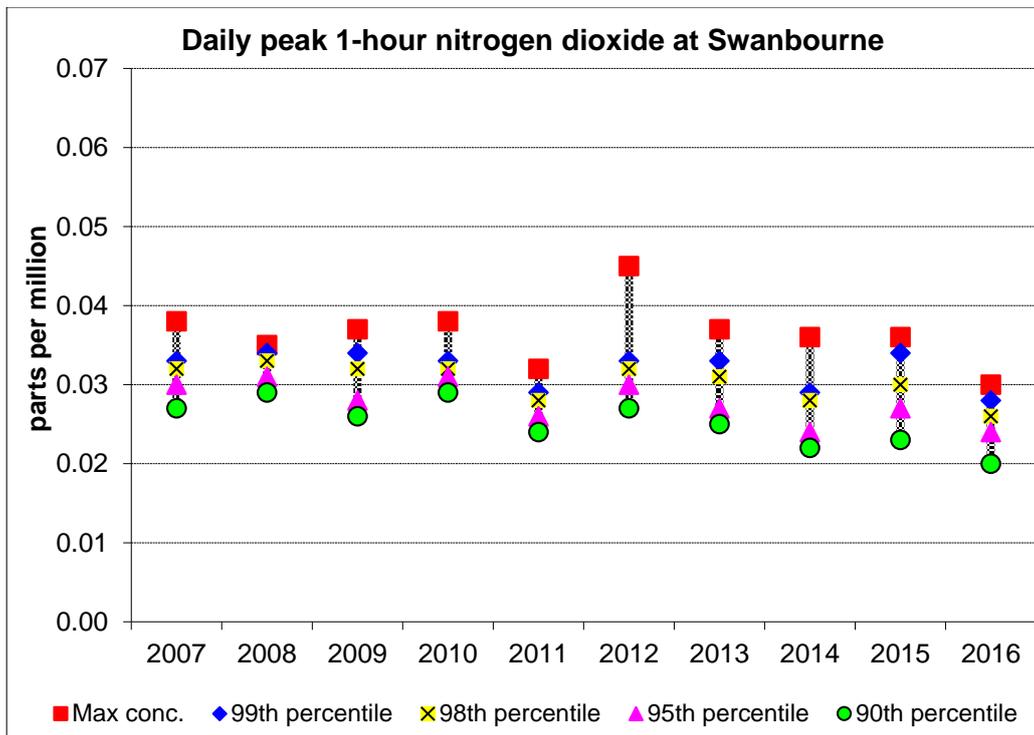


Figure A1-10 – one-hour nitrogen dioxide at Swanbourne

Ozone

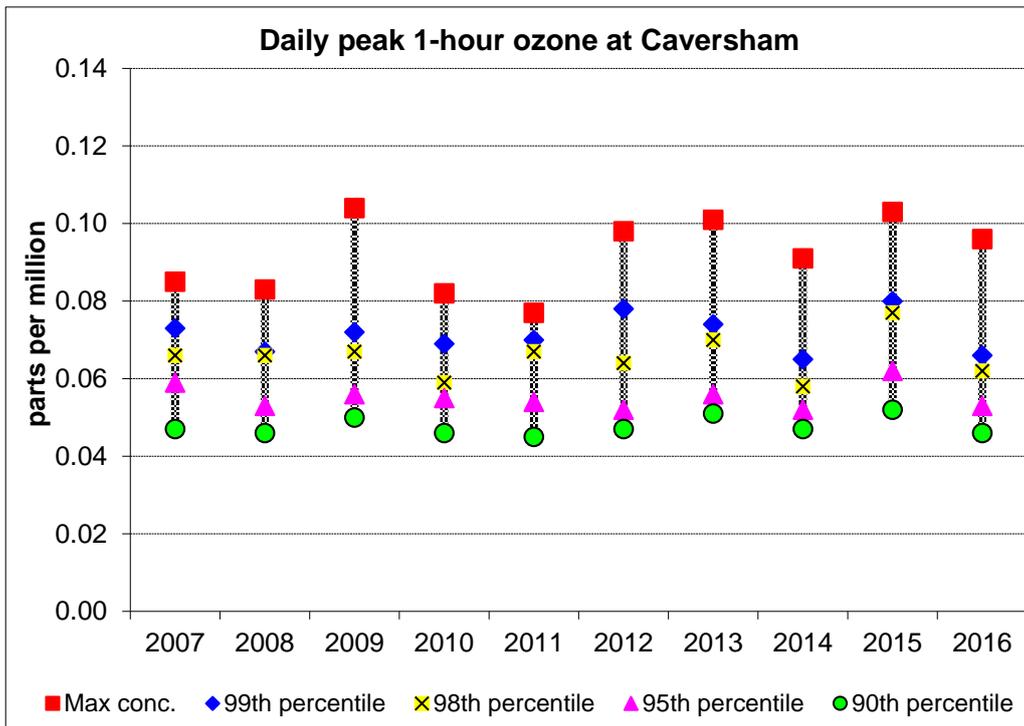


Figure A1-11 – one-hour ozone at Caversham

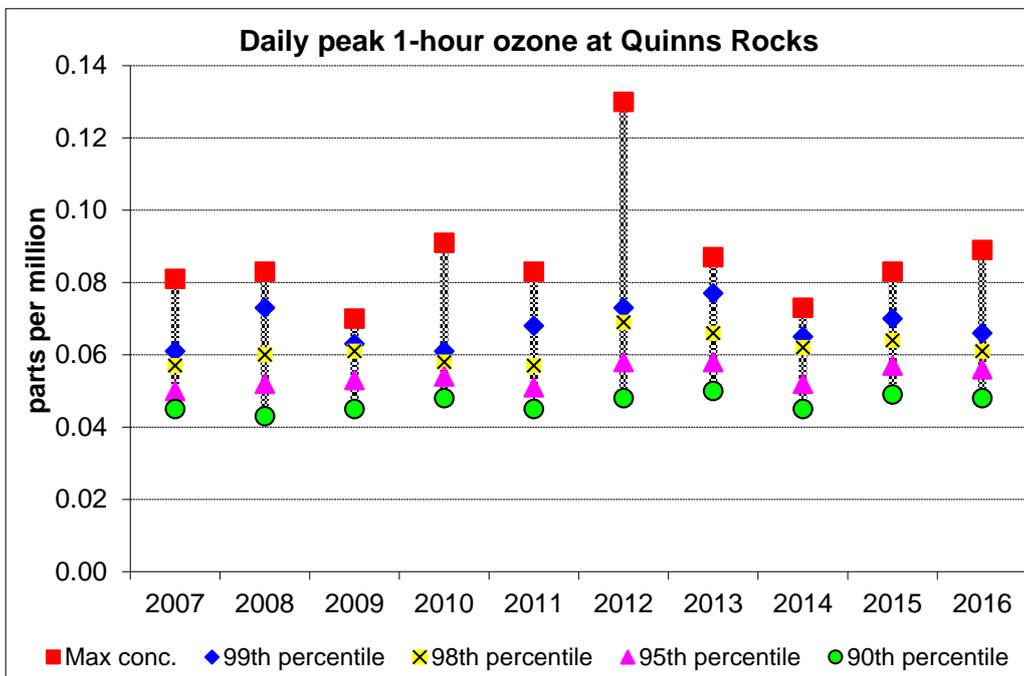


Figure A1-12 – one-hour ozone at Quinns Rocks

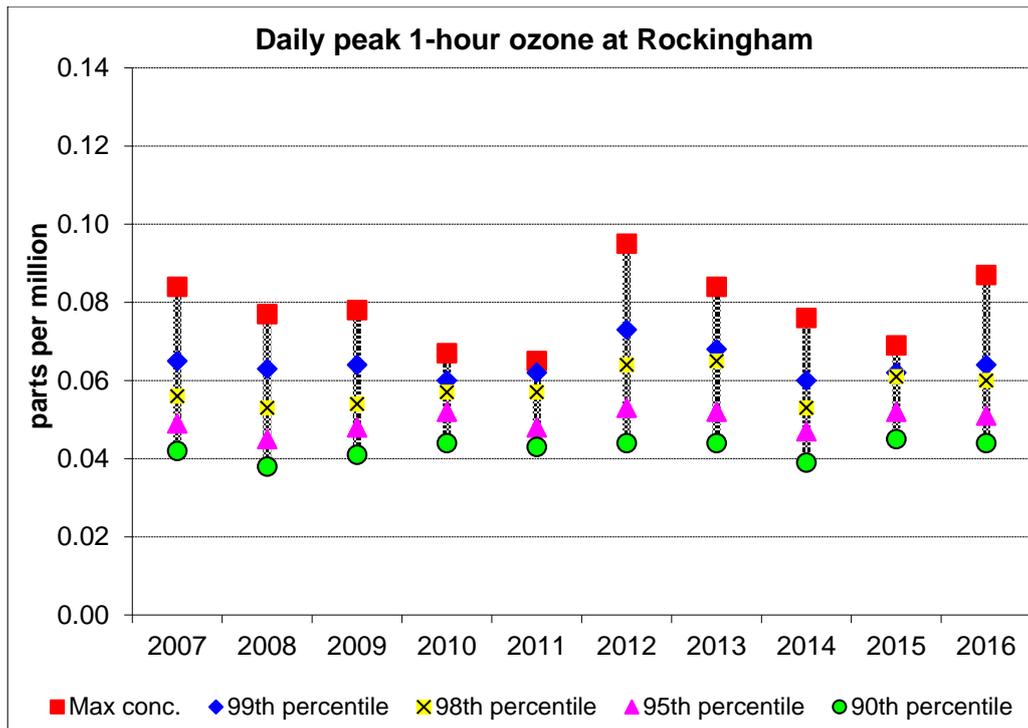


Figure A1-13 – one-hour ozone at Rockingham

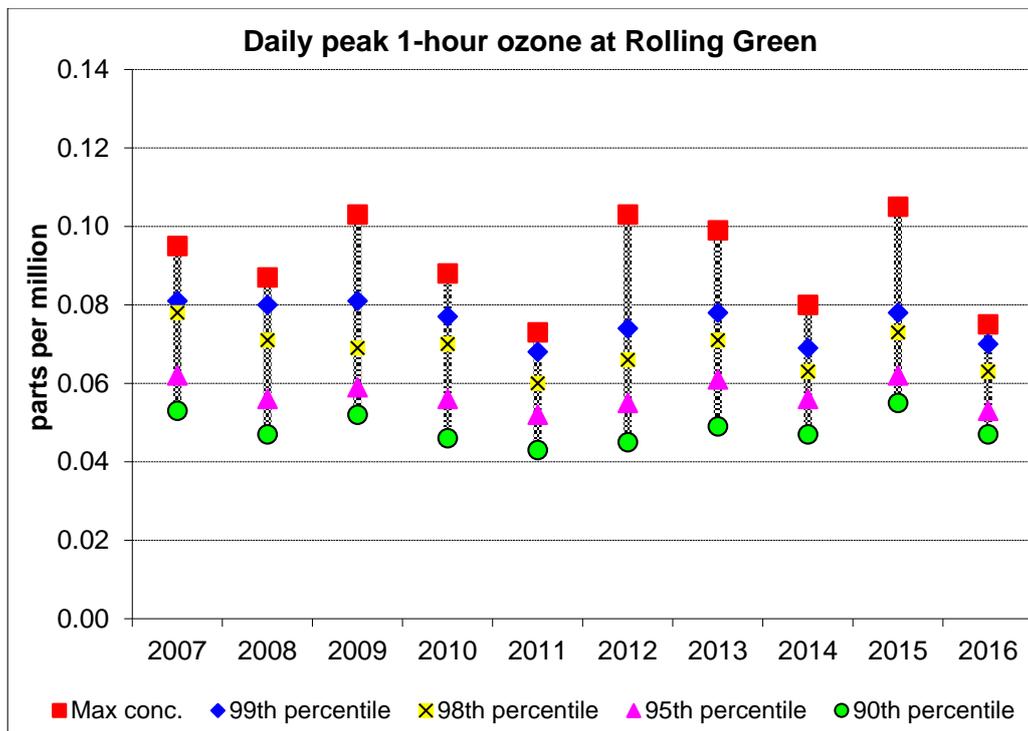


Figure A1-14 – one-hour ozone at Rolling Green

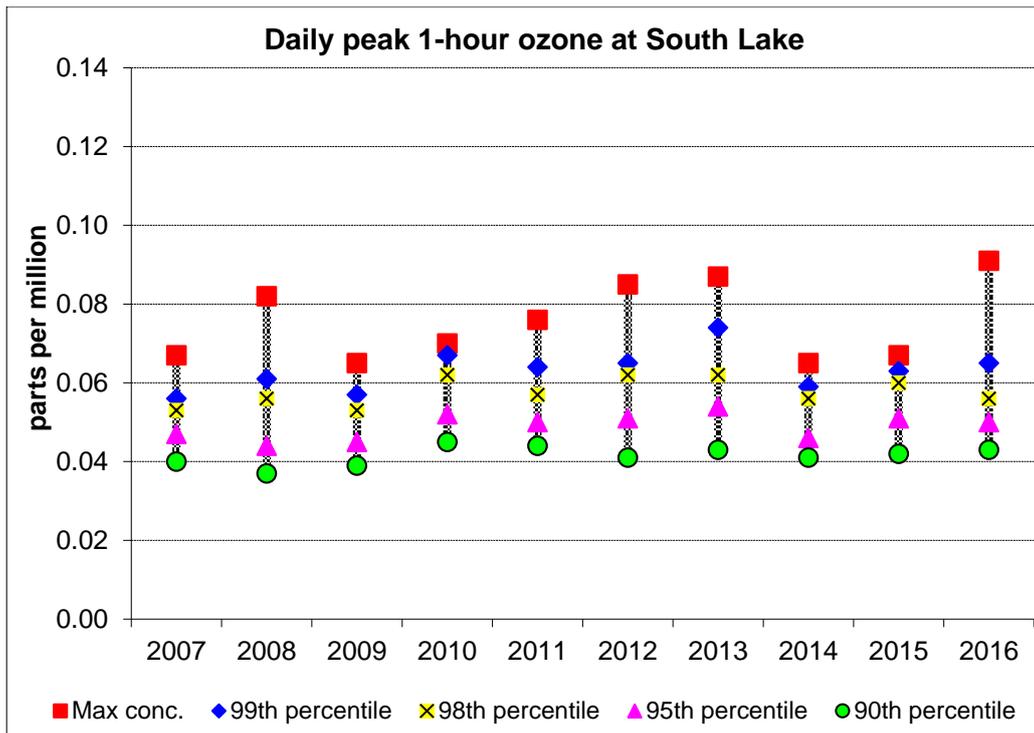


Figure A1-15 – one-hour ozone at South Lake

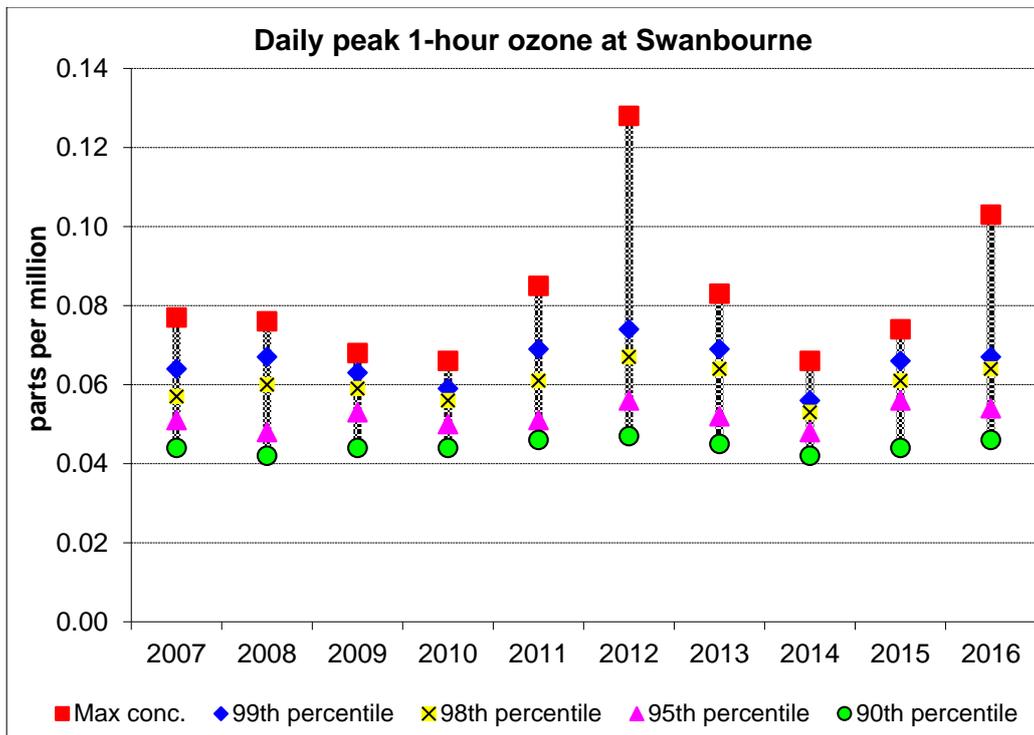


Figure A1-16 – one-hour ozone at Swanbourne

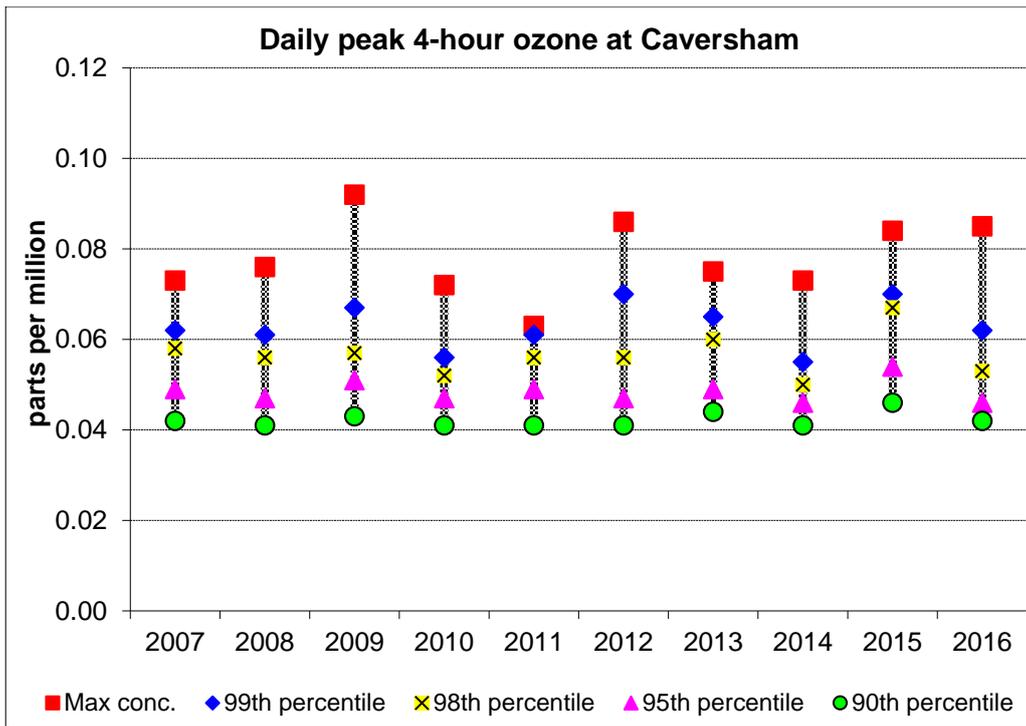


Figure A1-17 – four-hour ozone at Caversham

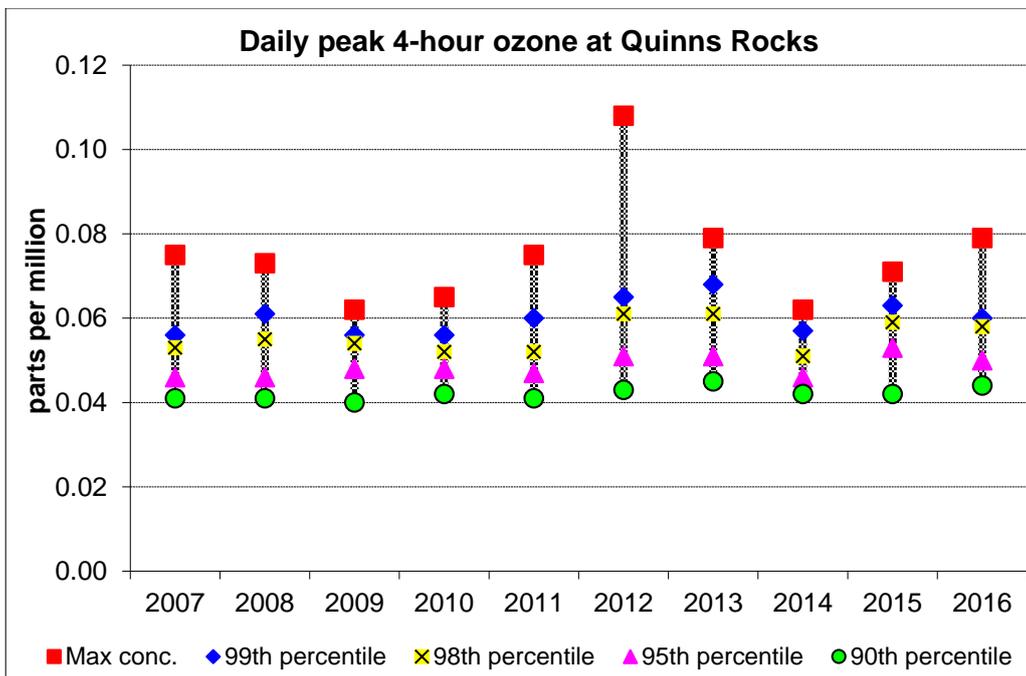


Figure A1-18 – four-hour ozone at Quinns Rocks

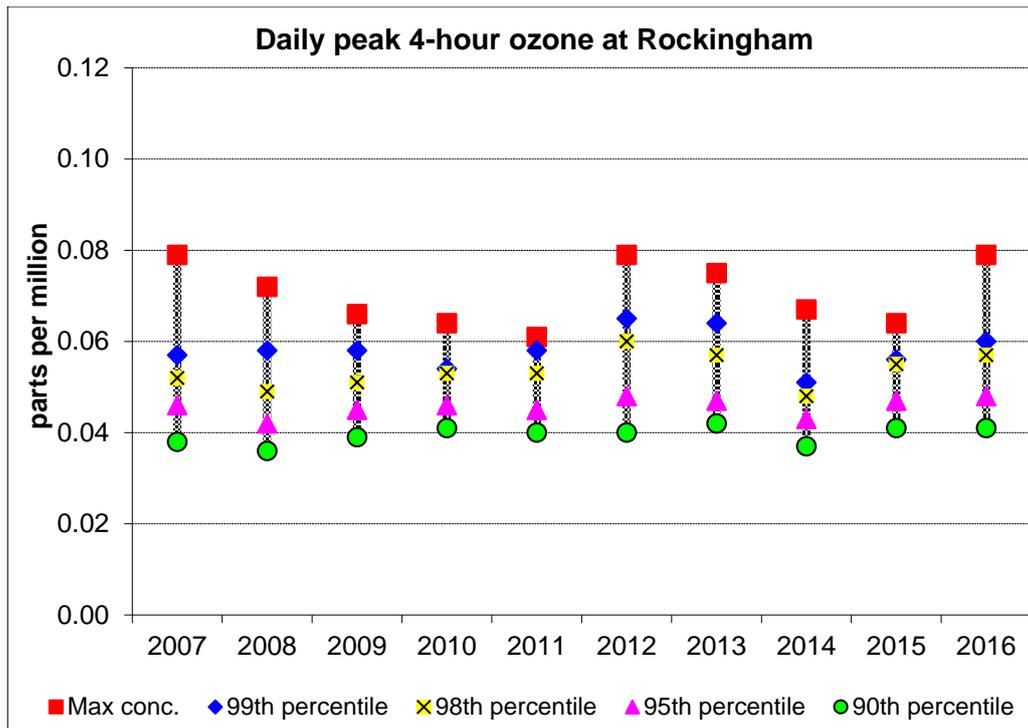


Figure A1-19 – four-hour ozone at Rockingham

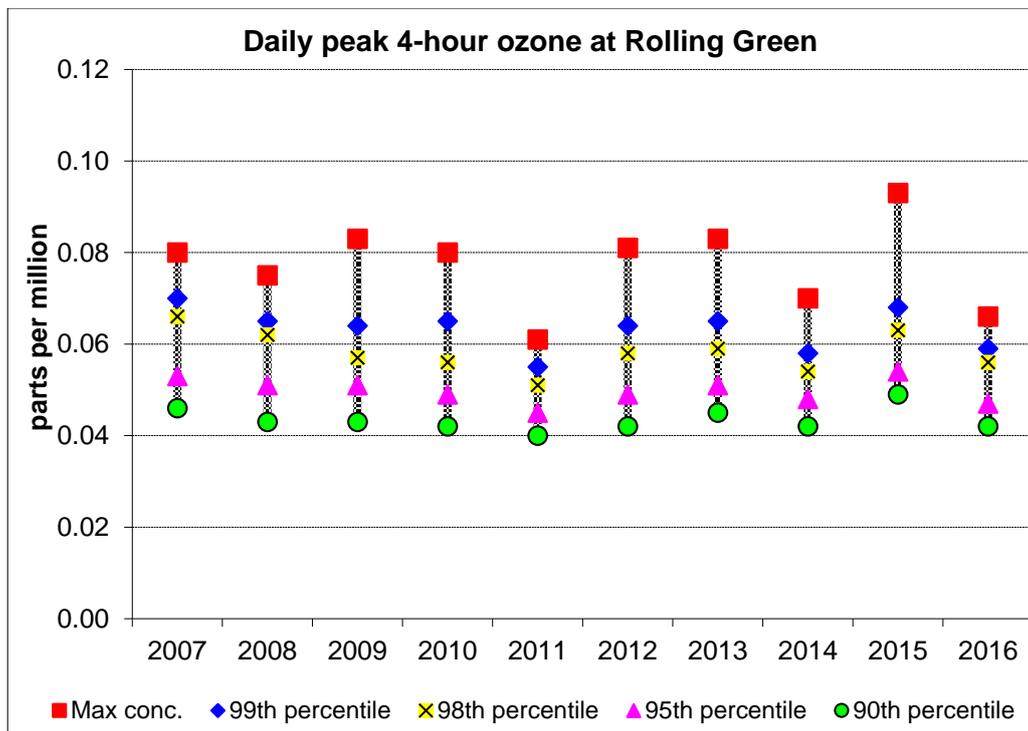


Figure A1-20 – four-hour ozone at Rolling Green

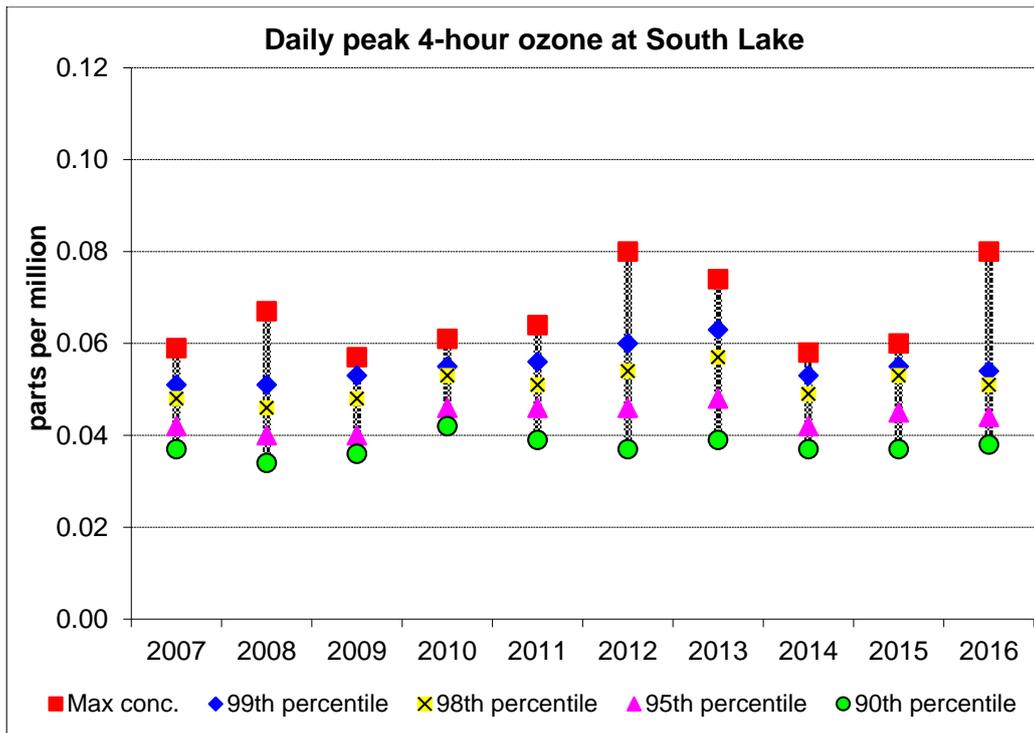


Figure A1-21 – four-hour ozone at South Lake

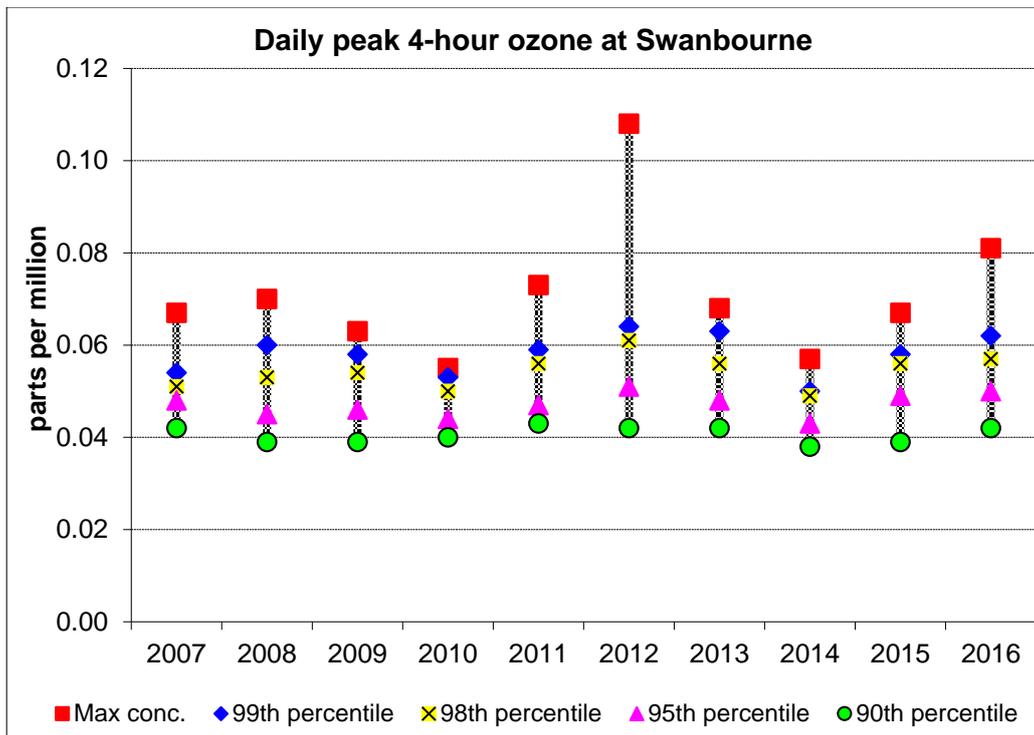


Figure A1-22 – four-hour ozone at Swanbourne

Sulfur dioxide

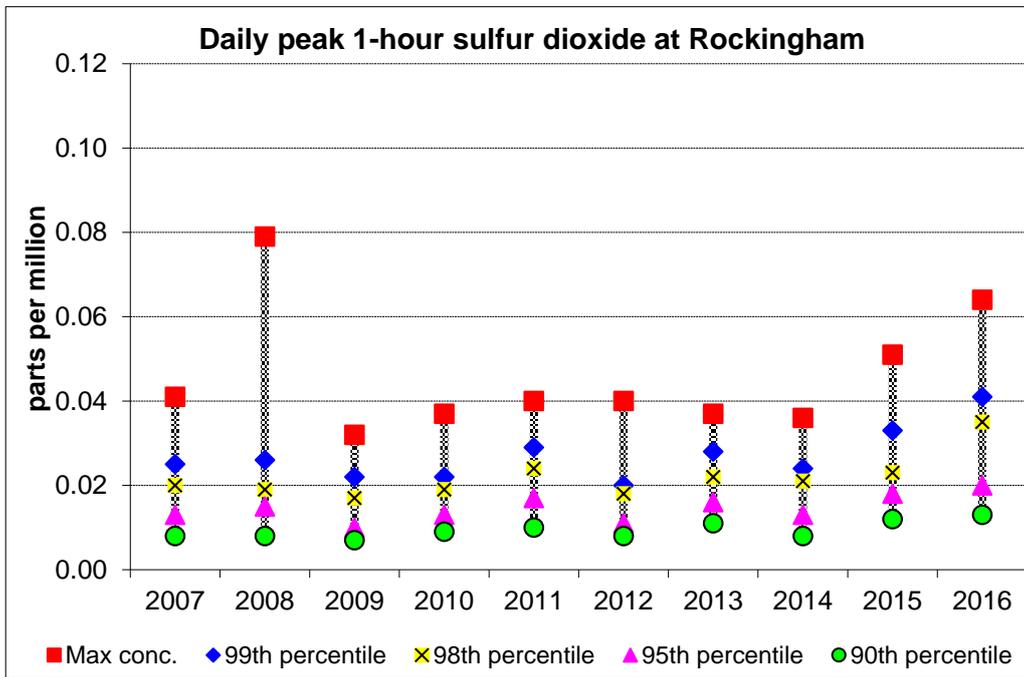


Figure A1-23 – one-hour sulfur dioxide at Rockingham

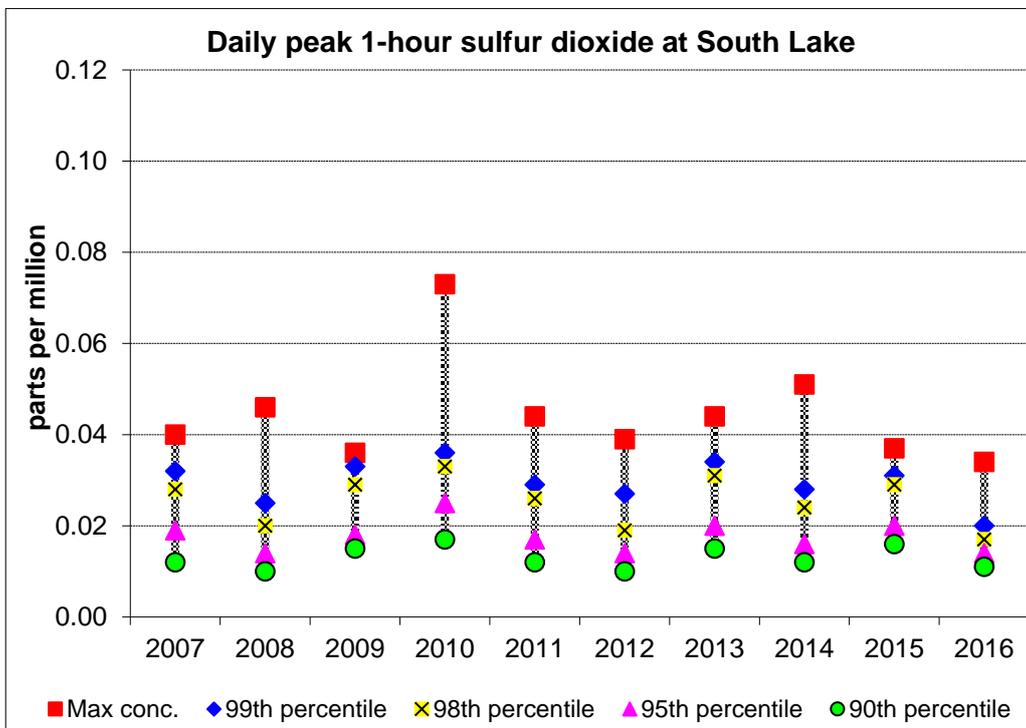


Figure A1-24 – one-hour sulfur dioxide at South Lake

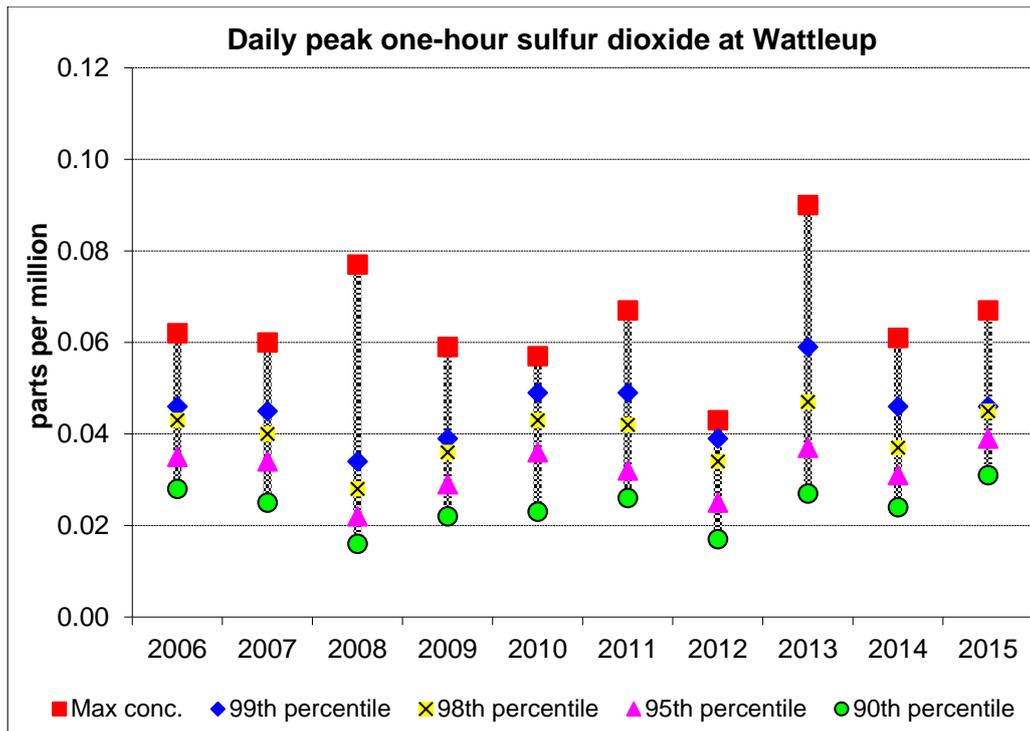


Figure A1-25 – one-hour sulfur dioxide at Wattleup

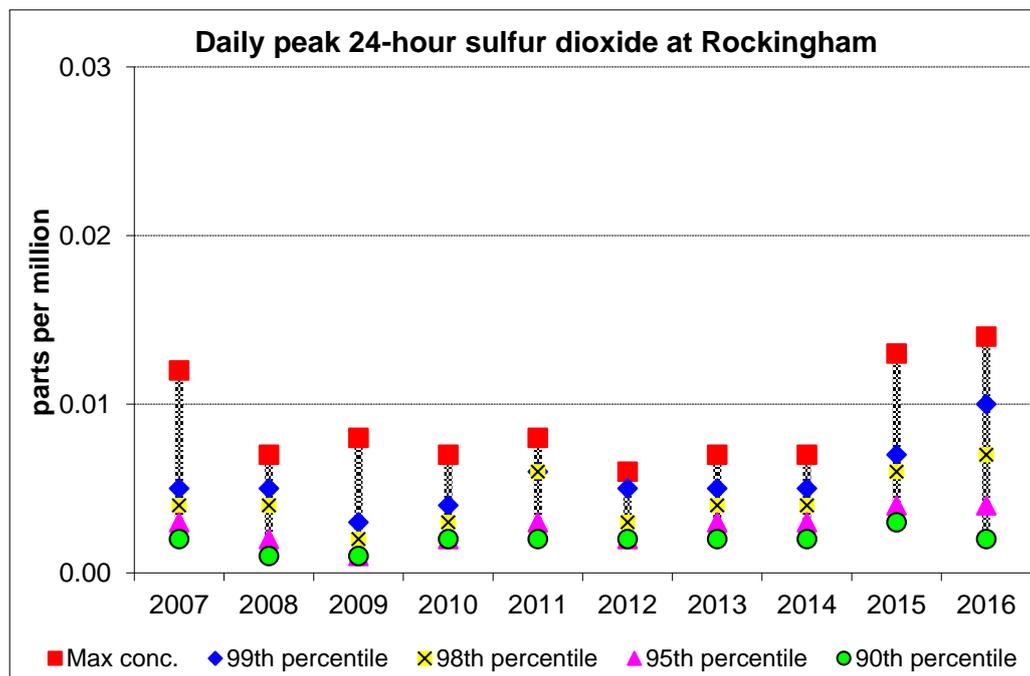


Figure A1-26 – 24-hour sulfur dioxide at Rockingham

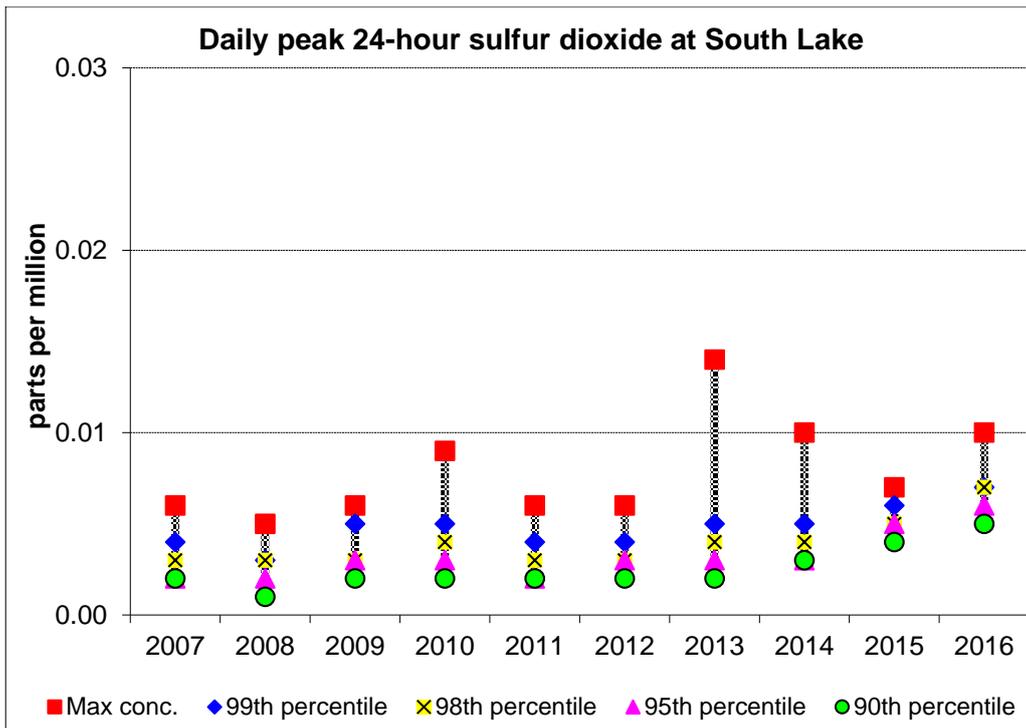


Figure A1-27 – 24-hour sulfur dioxide at South Lake

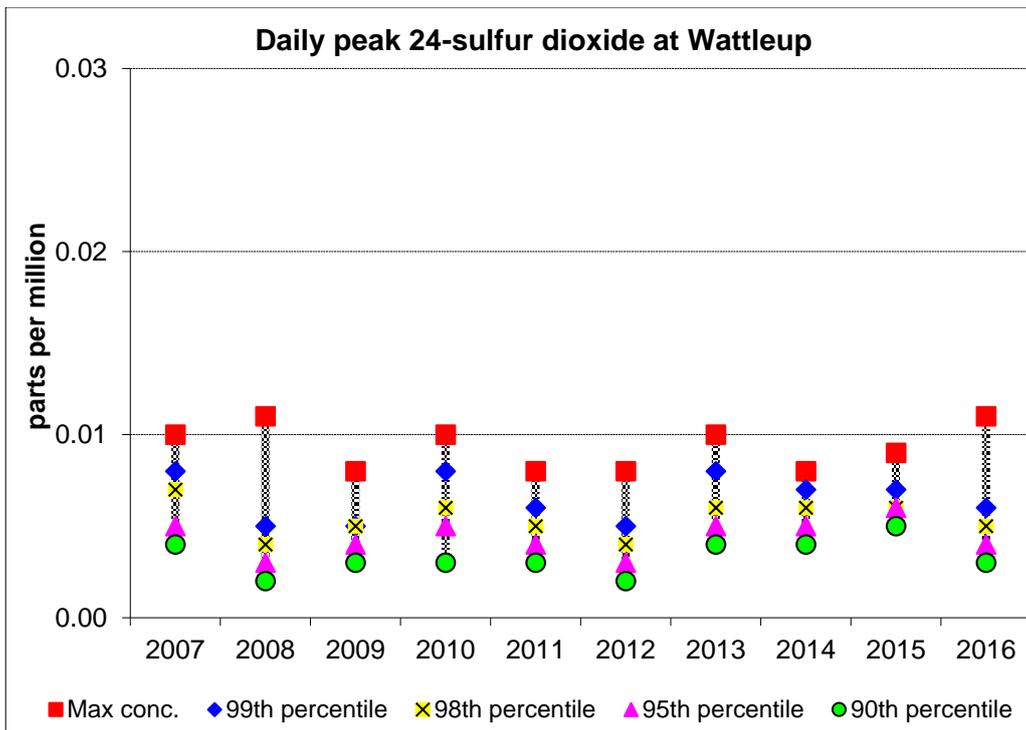


Figure A1-28 – 24-hour sulfur dioxide at Wattleup

Particles as PM₁₀

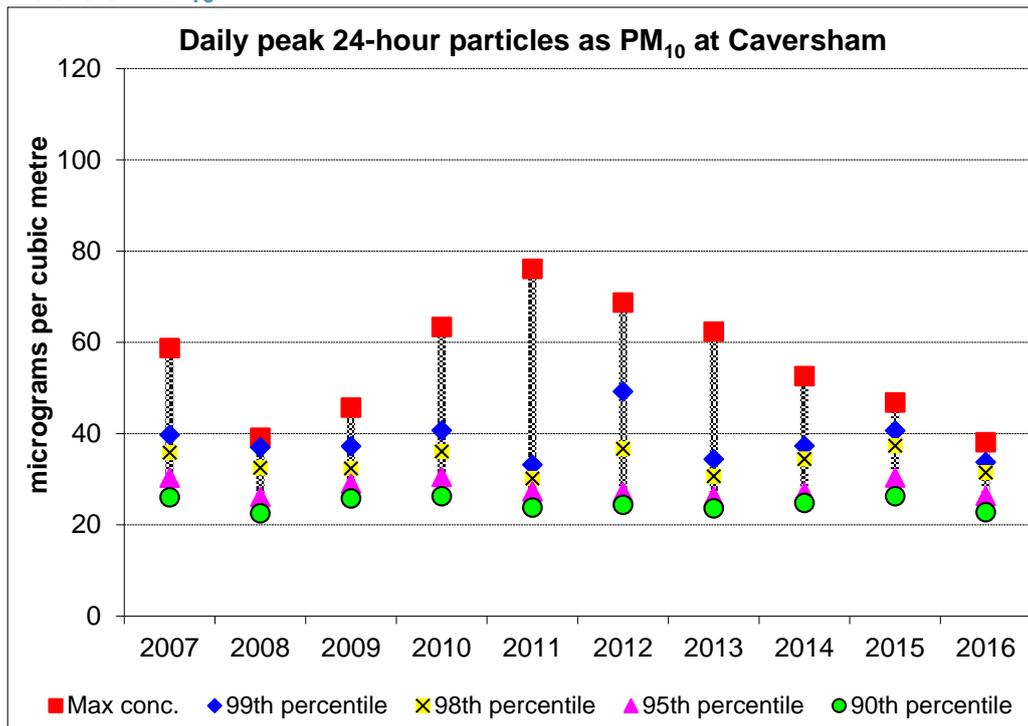


Figure A1-29 – 24-hour PM₁₀ at Caversham

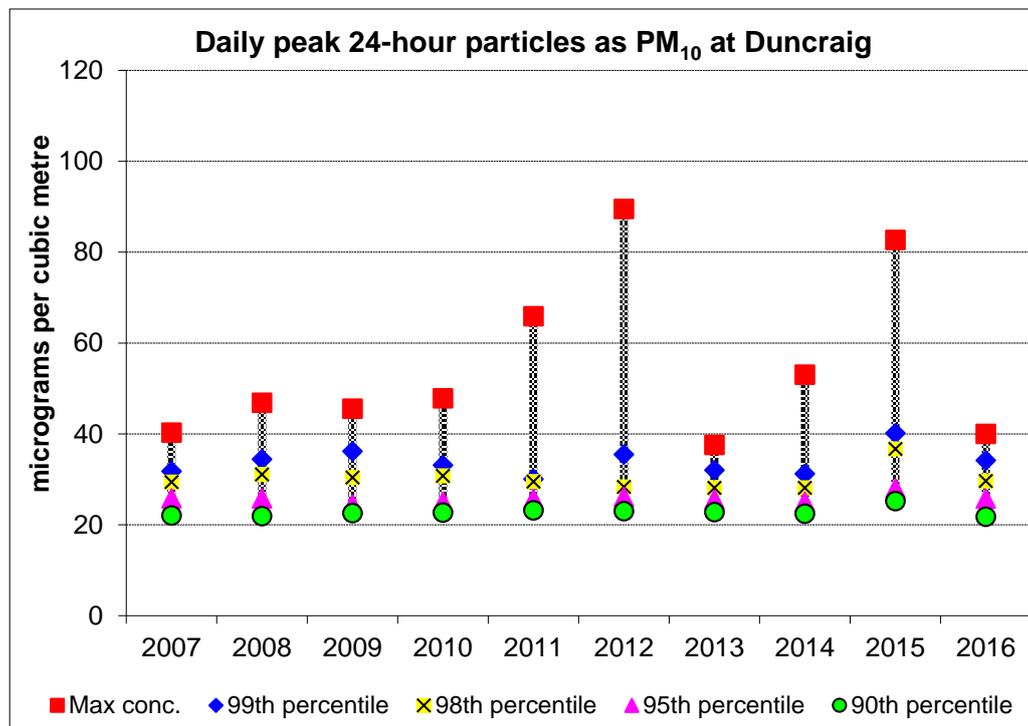


Figure A1-30 – 24-hour PM₁₀ at DunCraig

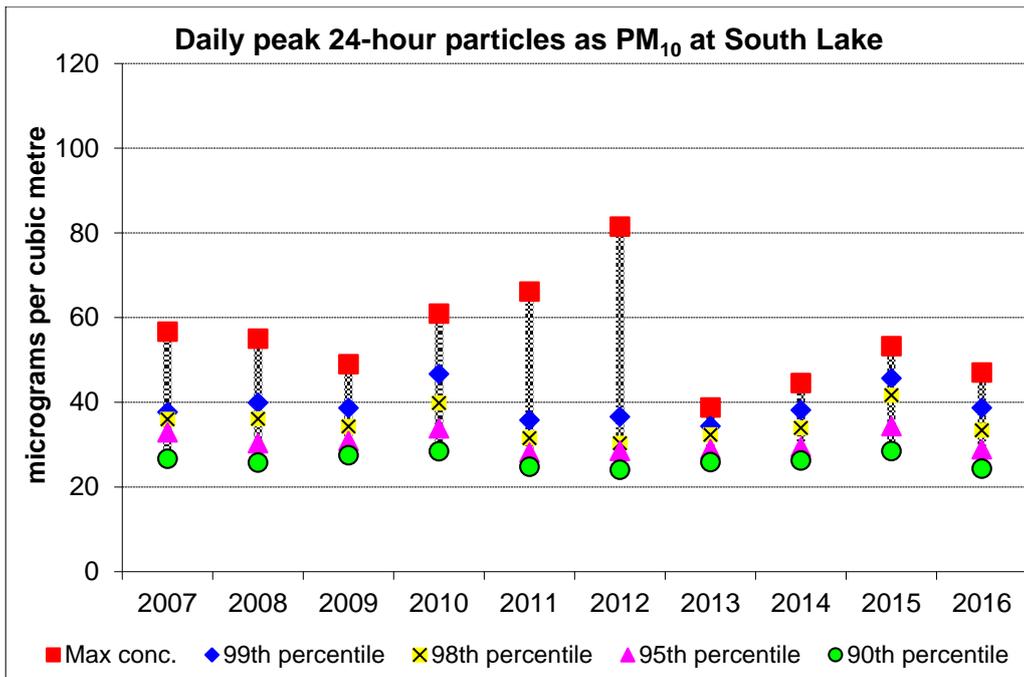


Figure A1-31 – 24-hour PM₁₀ at South Lake

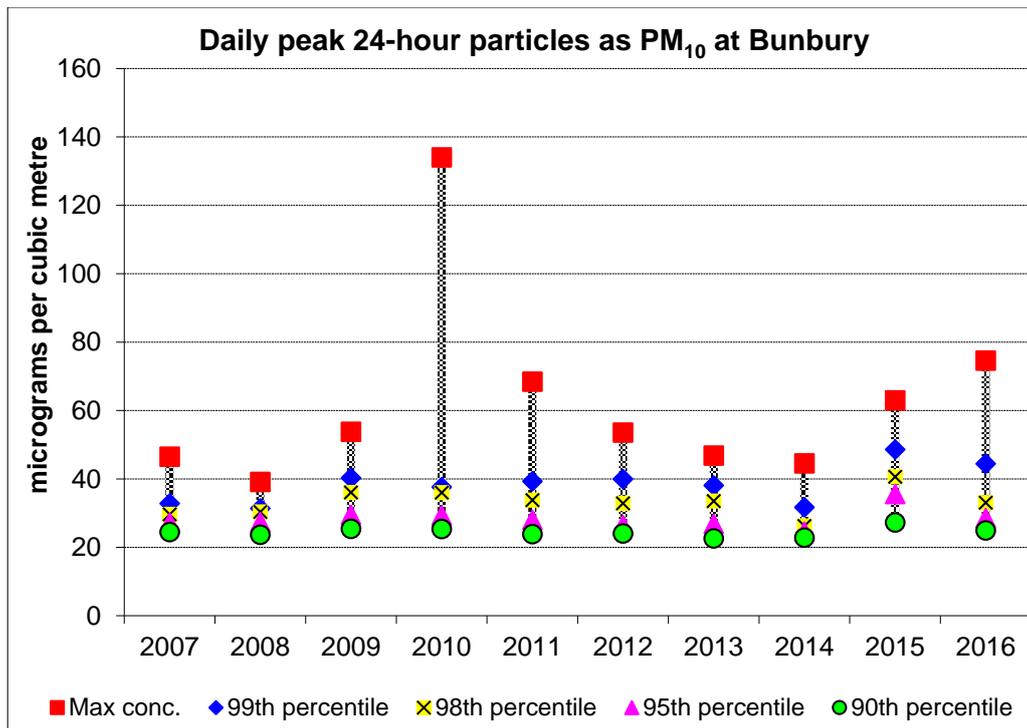


Figure A1-32 – 24-hour PM₁₀ at Bunbury

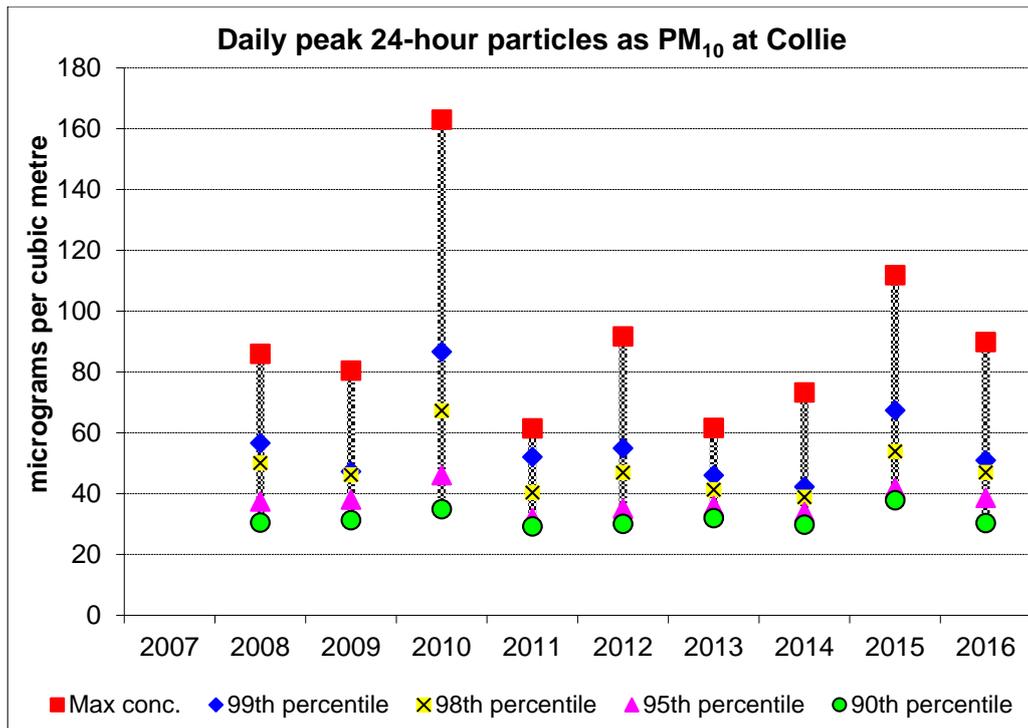


Figure A1-33 – 24-hour PM₁₀ at Collie

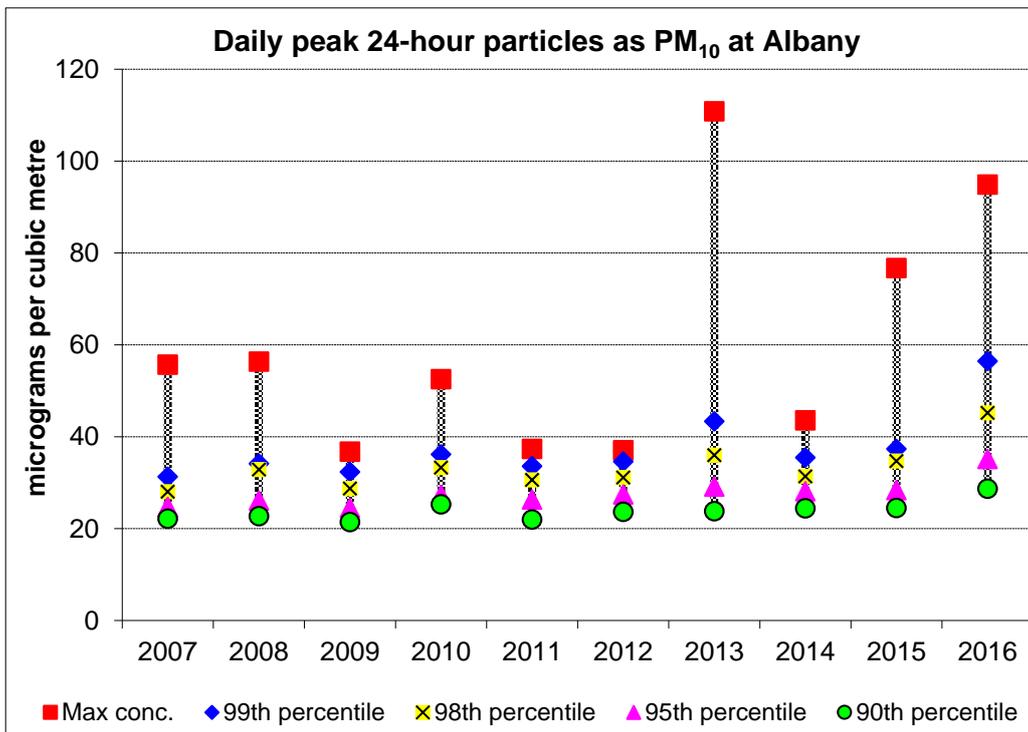


Figure A1-34 – 24-hour PM₁₀ at Albany

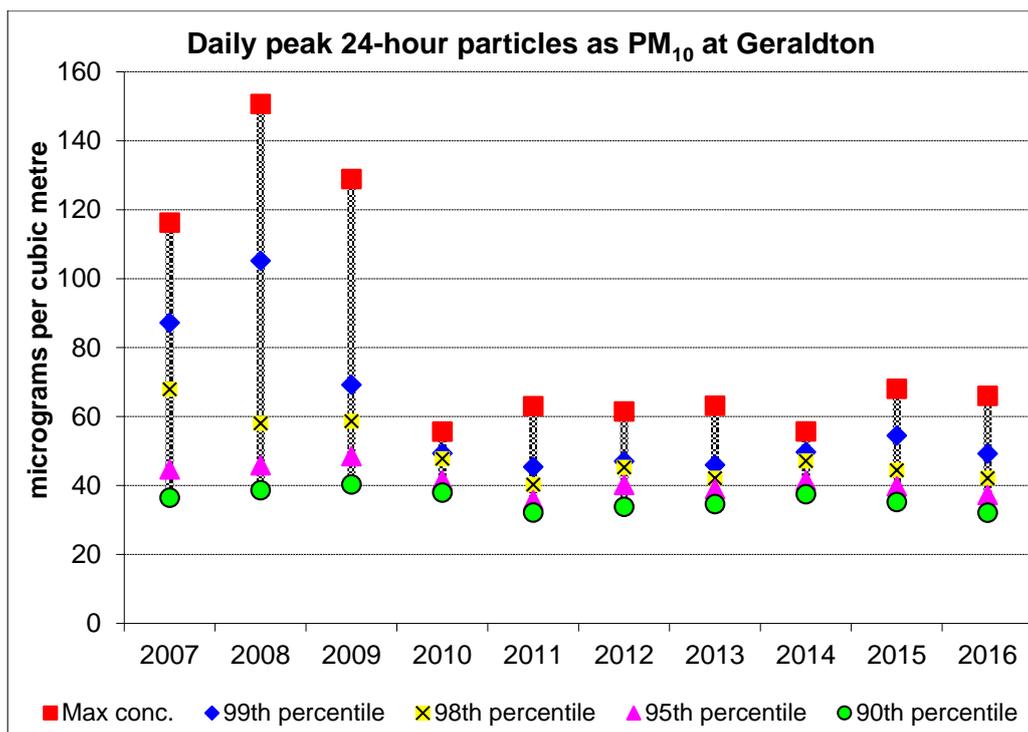


Figure A1-35 – 24-hour PM₁₀ at Geraldton

Particles as PM_{2.5}

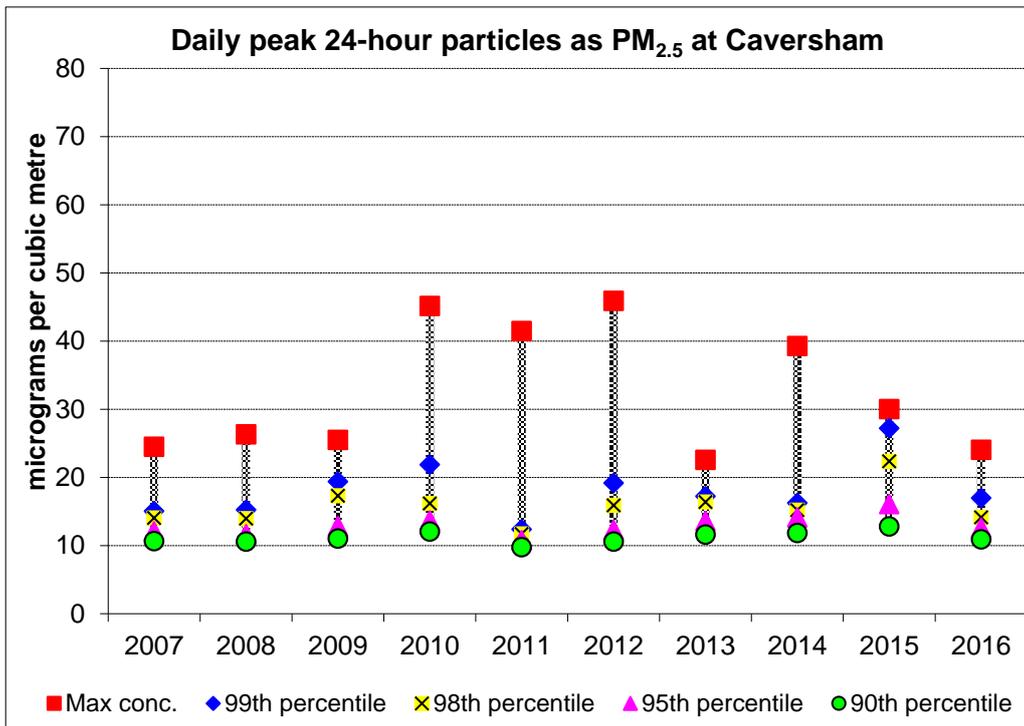


Figure A1-36 – 24-hour PM_{2.5} at Caversham

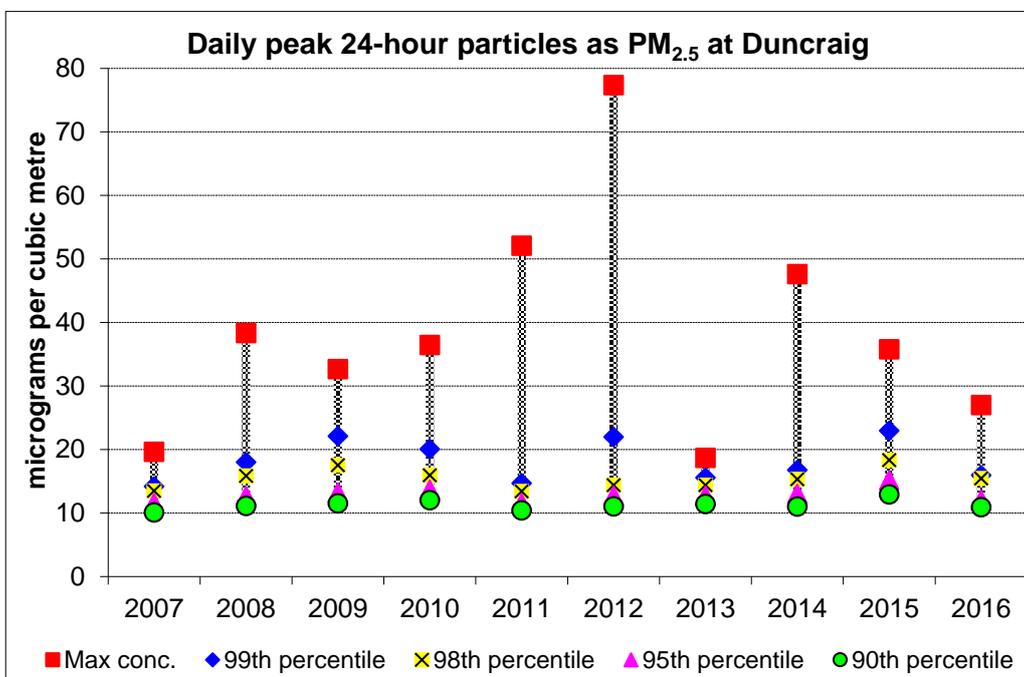


Figure A1-37 – 24-hour PM_{2.5} at Duncraig

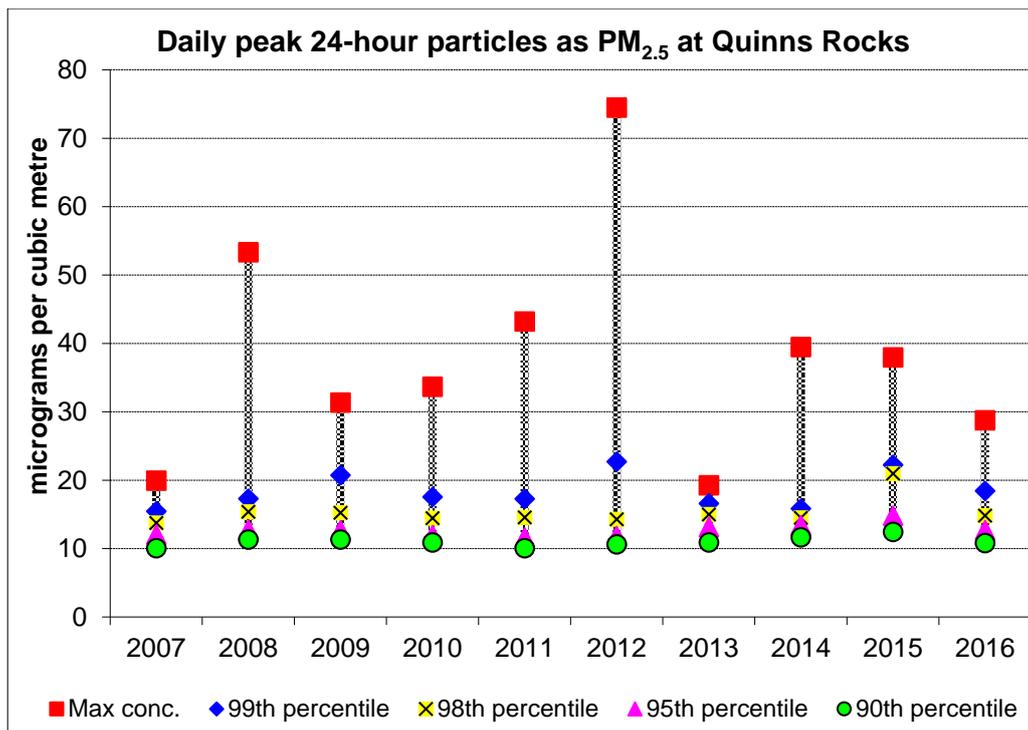


Figure A1-38 – 24-hour PM_{2.5} at Quinns Rocks

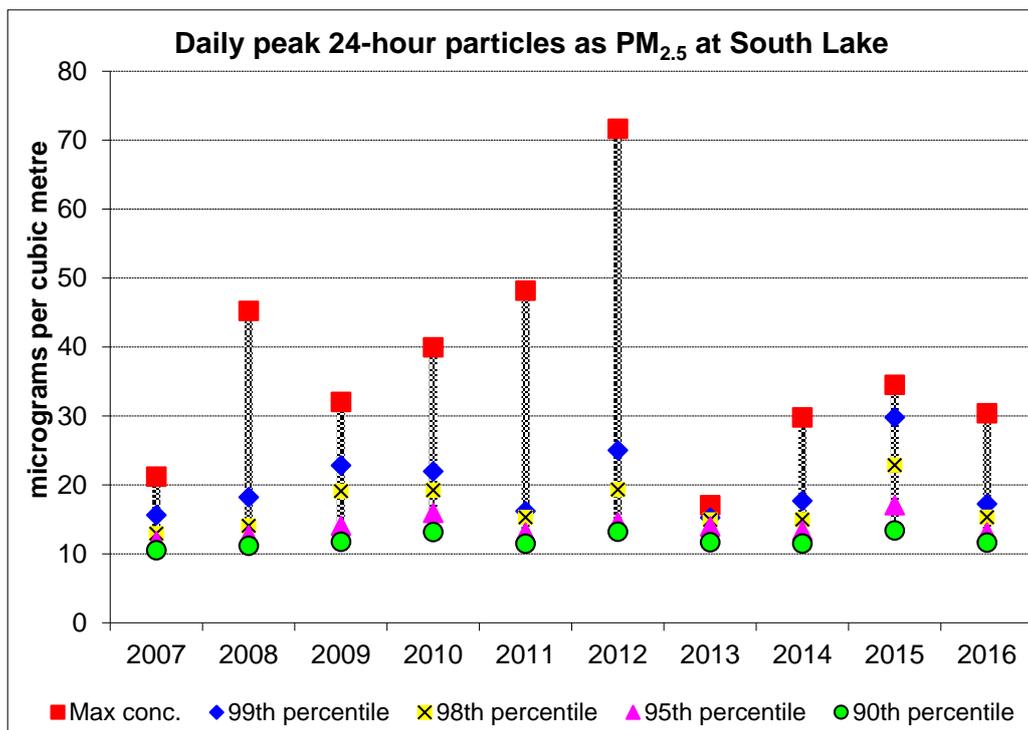


Figure A1-39 – 24-hour PM_{2.5} at South Lake

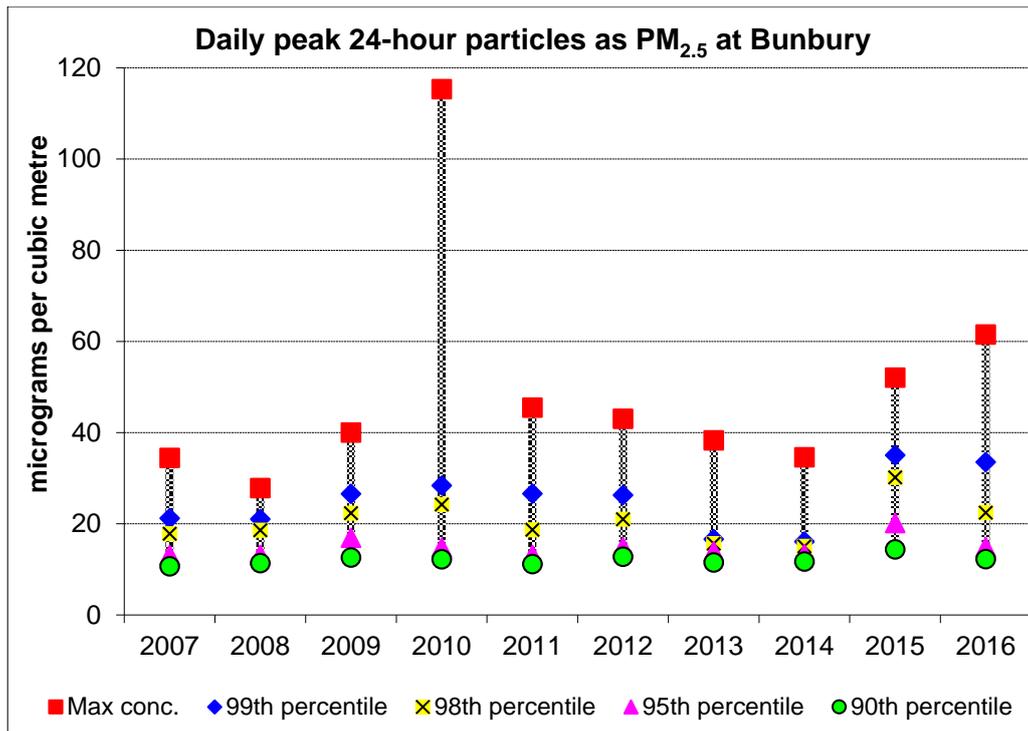


Figure A1-40 – 24-hour PM_{2.5} at Bunbury

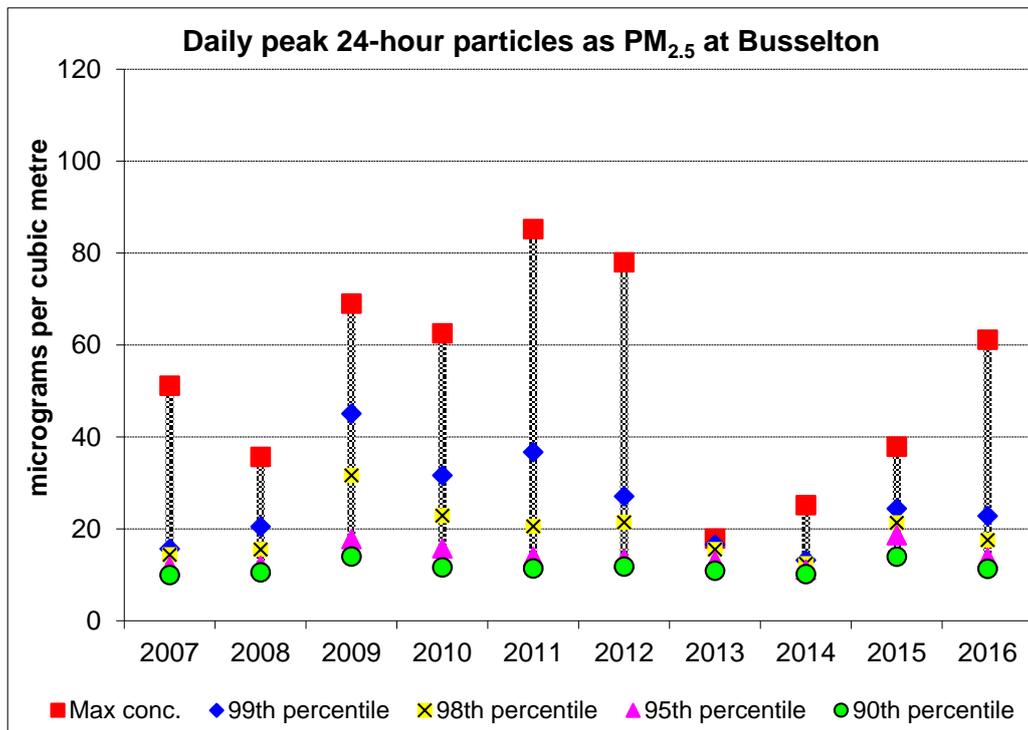


Figure A1-41 – 24-hour PM_{2.5} at Busselton

Attachment 2 – Exceedence summary

The following pages contain information specific to each parameter exceeding the relevant NEPM standard during 2016. Each analysis is provided in date order and may include one or more of 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 is specific to one event and shows a possible path that a parcel of air may have taken through space to have arrived at a particular location at a certain time. Where multiple trajectories are included on one map, the times and back trajectories displayed are those ending at the indicated location at 3am (red), 6am (orange), 9am (yellow), noon (green), 3pm (blue), 6pm (mauve), 9pm (purple) and midnight (black). A back trajectory does no more than use the wind speed and direction information recorded at various monitoring sites to track a simple path backwards to a possible origin site. Some major assumptions made in the calculation of these back trajectories, such as the meteorological conditions, can be interpolated between sites and no air dispersion throughout the path, create large uncertainties in the predicted path and must be acknowledged. Notwithstanding, the back trajectories as calculated provide a reasonable first approximation for the possible path taken by an air parcel in arriving at its destination.

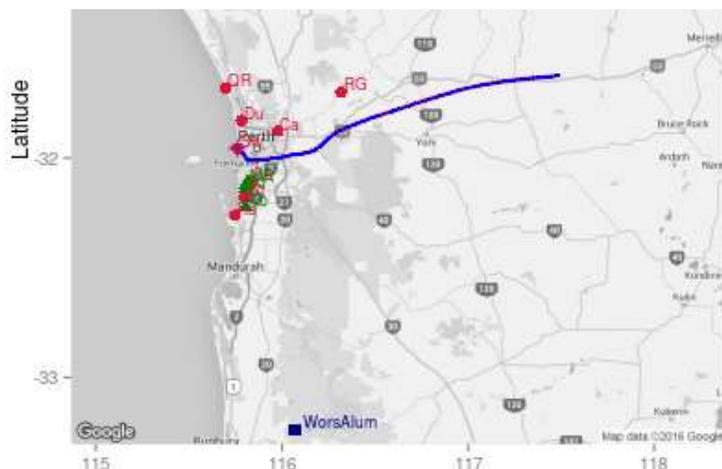
Satellite images are obtained from earthdata.nasa.gov/labs/worldview, where available and when cloud cover does not obscure the plume.

Abbreviations are occasionally used to represent air monitoring sites. The more common of these are:

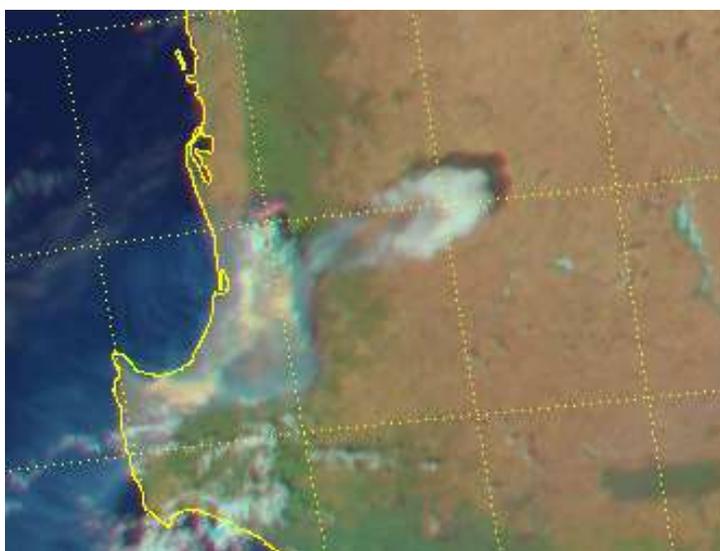
Metropolitan sites	
Ca	Caversham
Du	Duncraig
QR	Quinns Rocks
Ro	Rockingham
RG	Rolling Green
SL	South Lake
Sw	Swanbourne
Wt	Wattleup

Regional sites	
Al	Albany
Bu	Bunbury
Bn	Busselton
Co	Collie
Ge	Geraldton

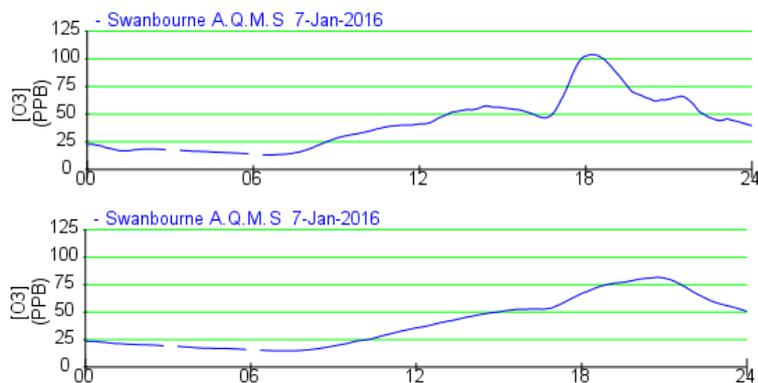
7 January 2016



Back trajectory over 12 hours ending at Swanbourne at 1800 on 07/01/2016.



Fire map from Himawari satellite: rammb.cira.colostate.edu dated 2016-01-07 05:00 UTC (13:00 AWST).



60 minute running averaged (top) and 4 hour averaged (bottom) time series plot of ozone at Swanbourne.

Pollutant

O₃

Monitoring Site

Swanbourne

NEPM standard

O₃ – 0.1 ppb (1 hour)

O₃ – 0.08 ppb (4 hour)

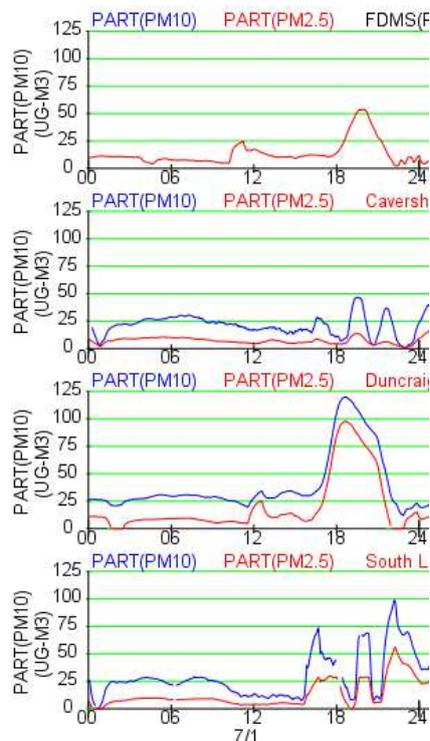
Concentration (ug/m³)

0.103 ppb (1 hour)

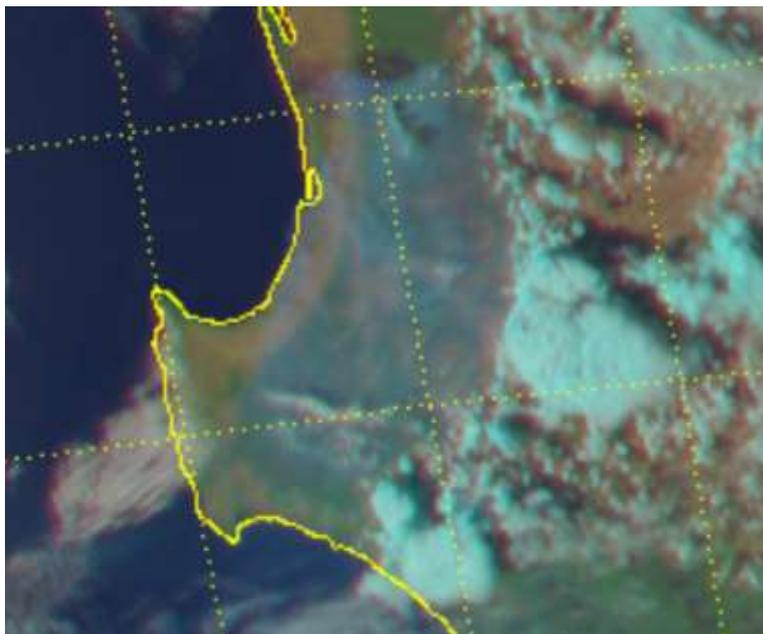
0.081 ppb (4 hour)

Description of event

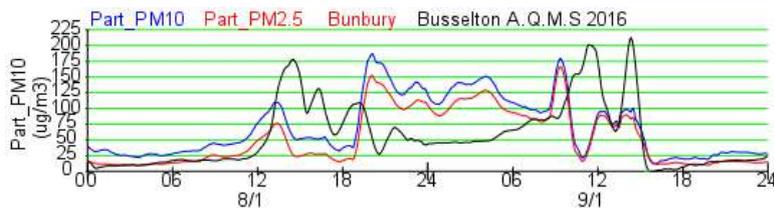
Possible long range transport and recirculation of smoke from lightning caused bushfires in Waroona Shire in the southwest, causing elevated ozone. Perth CBD temperature exceeded 40degC.



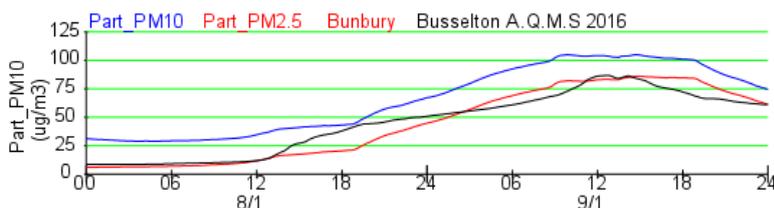
8 and 9 January 2016



Fire map from Himawari satellite: rammb.cira.colostate.edu dated 2016-01-09 08:00 UTC (16:00 AWST).



60 minute running averaged time series plot of PM₁₀ (blue) and PM_{2.5} (red) at Bunbury and PM_{2.5} (black) at Busselton.



24 hour running averaged time series plot of PM₁₀ (blue) and PM_{2.5} (red) at Bunbury and PM_{2.5} (black) at Busselton.

Pollutant

PM₁₀ and PM_{2.5}

Monitoring Site

Bunbury (PM₁₀ and PM_{2.5})

Busselton (PM_{2.5})

NEPM standard

PM₁₀ 50 µg/m³

PM_{2.5} 25 µg/m³

Averaging period

24 hours

Concentration (ug/m³)

Bunbury	PM ₁₀	PM _{2.5}
8/1/2016	67.1	44.9
9/1/2016	74.6	61.5

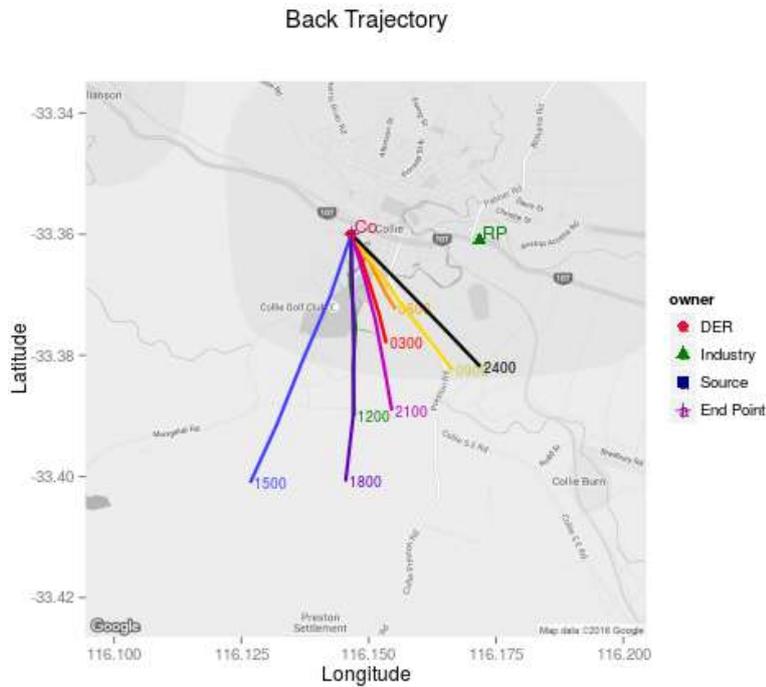
Busselton	PM ₁₀	PM _{2.5}
8/1/2016	NA	50.9
9/1/2016	NA	61.1

Description of event

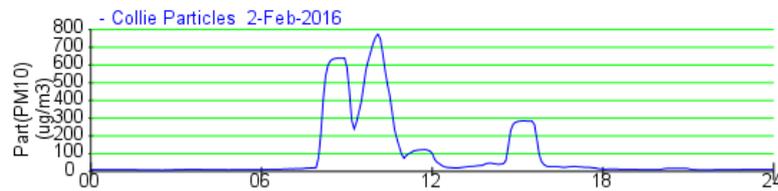
Long range transport and recirculation of smoke from lightning caused bushfires in Waroona Shire in the southwest of WA caused elevated particle levels in Bunbury and Busselton.

Collie recorded a PM₁₀ concentration of 47.9 µg/m³ 9 January 2016.

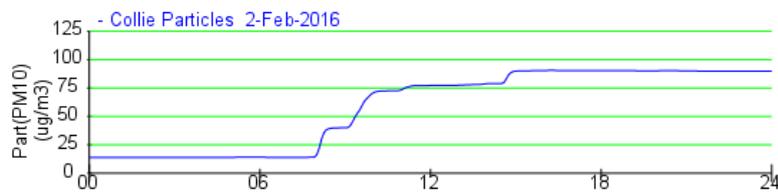
2 February 2016



Back trajectory over 20 minutes ending at Collie at indicated times on 02/02/2016.



60 minute running averaged time series plot of PM₁₀ at Collie.



24 hour running averaged time series plot of PM₁₀ at Collie.

Pollutant

PM₁₀

Monitoring site

Collie

NEPM standard

PM₁₀ 50 µg/m³

Averaging period

24 hours

Concentration (µg/m³)

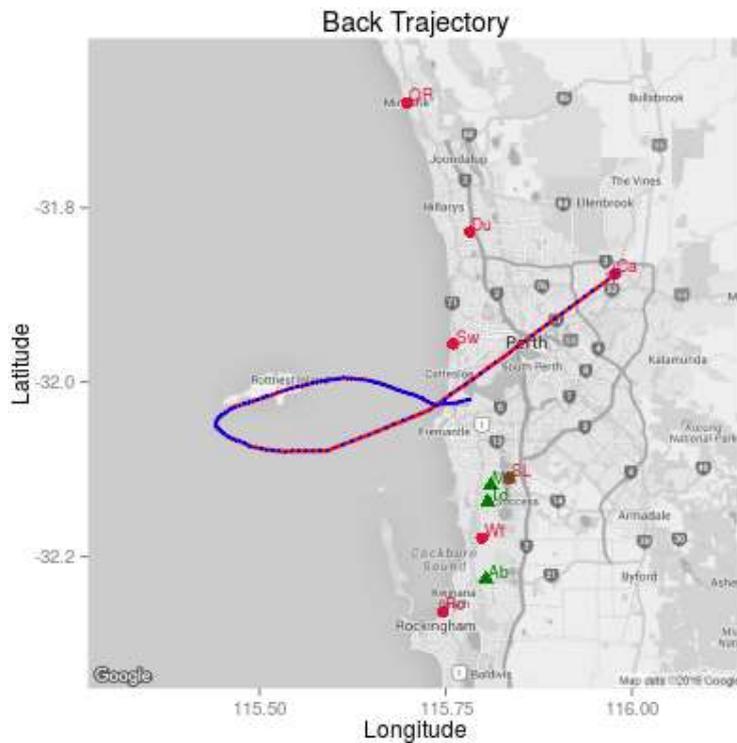
89.9 µg/m³

Description of event

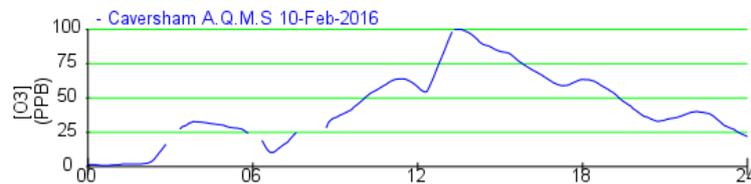
Repairs were performed to a bitumen driveway about 15 metres away from the monitor.

Sand, gravel and hotmix was spread and compacted causing elevated dust concentrations.

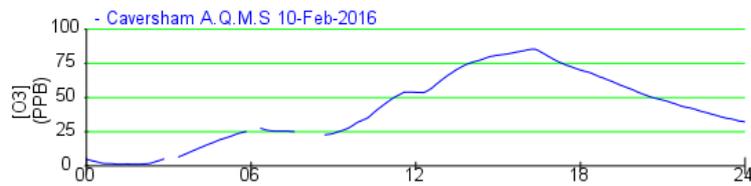
10 February 2016



Back trajectory over 720 minutes ending at Caversham at 1600 on 10/02/2016.



60 minute running averaged time series plot of ozone at Caversham.



4 hour running averaged time series plot of ozone at Caversham (bottom).

Pollutant

O₃

Monitoring site

Caversham

NEPM standard

O₃ 0.08 ppm

Averaging period

4 hours

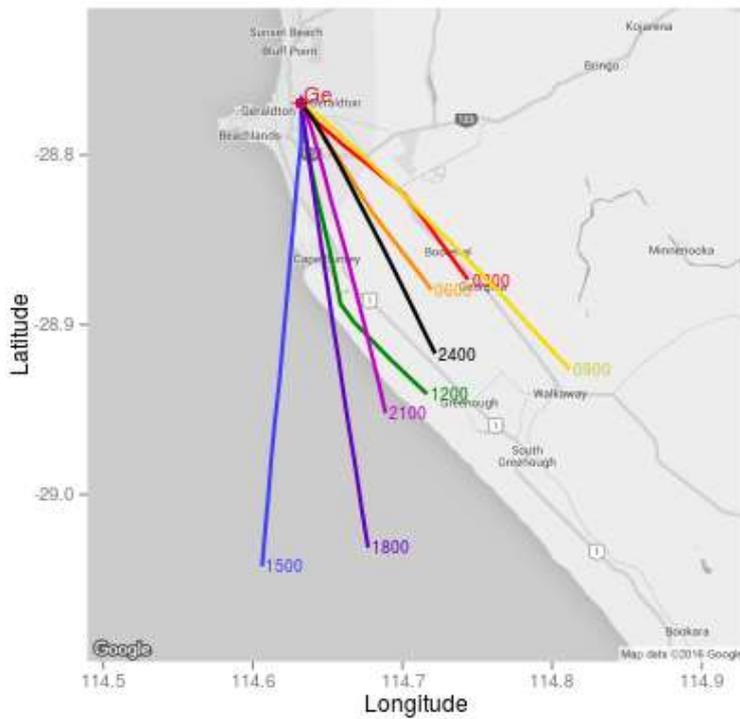
Concentration (ppm)

0.085 ppm

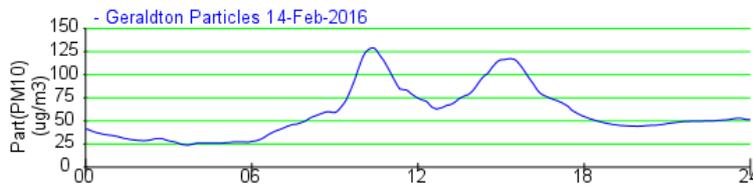
Description of event

Inland ozone event caused by recirculation of city emissions and slightly elevated particle concentrations throughout the metropolitan region.

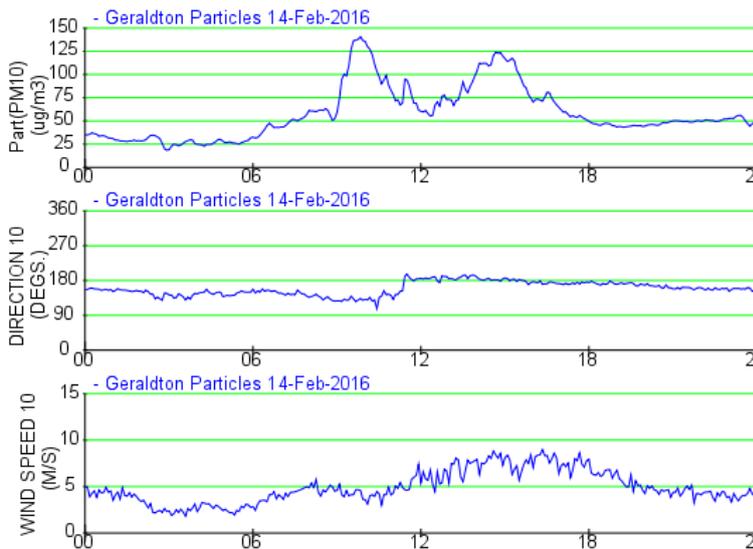
14 February 2016



Back trajectory over 60 minutes ending at Geraldton at indicated times on 14/02/2016.



60 minute running averaged time series plot of PM₁₀ at Geraldton.



5 minute running averaged time series plot of PM₁₀, wind speed and direction at Geraldton.

Pollutant

PM₁₀

Monitoring site

Geraldton

NEPM standard

PM₁₀ 50 µg/m³

Averaging period

24 hours

Concentration (µg/m³)

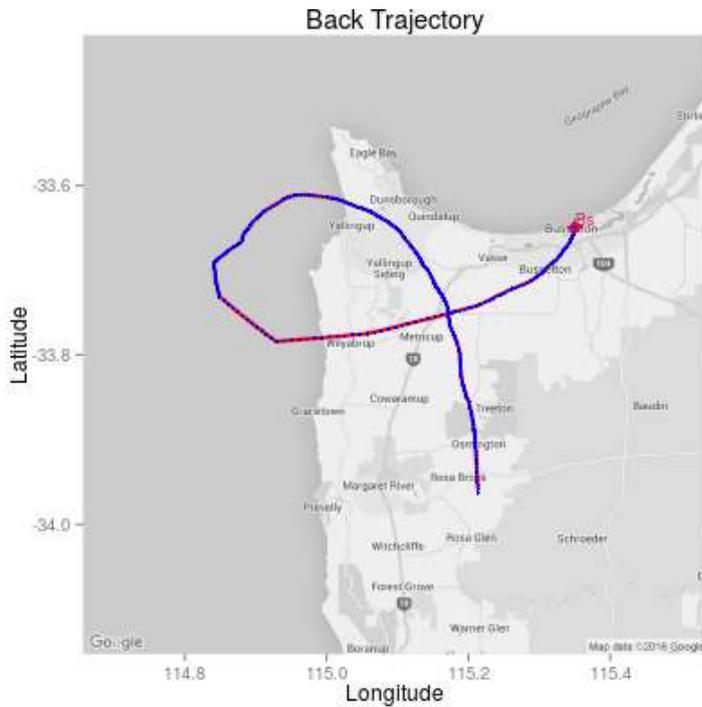
58.2 µg/m³

Description of event

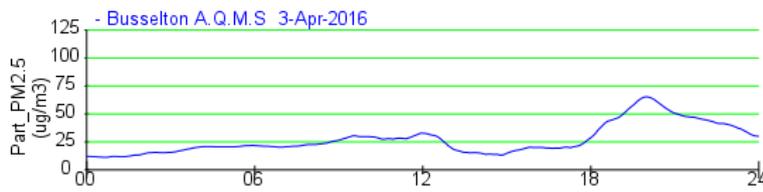
Geraldton-based DWER staff advised there was no particle event visible during the day.

The bimodal nature of the event suggested it was most likely a localised earth moving event with work occurring in the morning and afternoon.

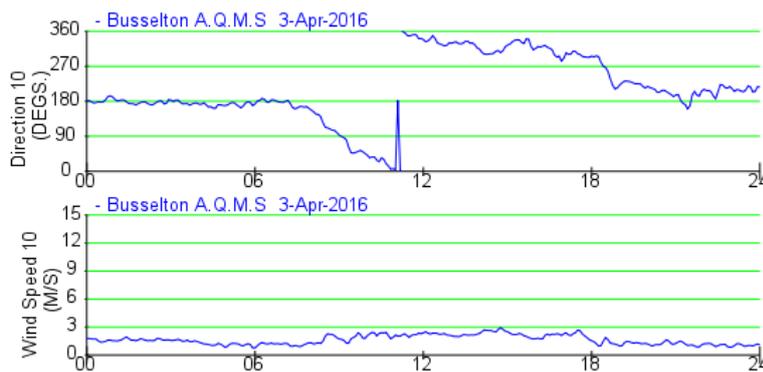
03 April 2016



Back trajectory over 1,440 minutes ending at Busselton at 2000 on 03/04/2016.



60 minute running averaged time series plot of PM_{2.5} at Busselton.



5 minute averaged time series plot of wind speed and direction at Busselton.

Pollutant

PM_{2.5}

Monitoring site

Busselton

NEPM standard

PM_{2.5} 25 µg/m³

Averaging period

24 hours

Concentration (µg/m³)

27.5 µg/m³

Description of event

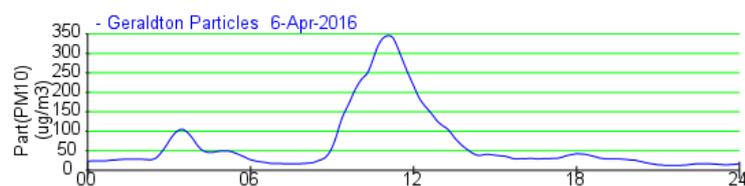
A number of prescribed burns were in progress in the region south of Busselton.

- DON_046 Yarramin 19km E of Manjimup
 Burn date/time: Sunday, 03 April 2016 10:17
 Burn ID: DON_046
- DON_040 Alco 5 km N of Manjimup
 Burn date/time: Sunday, 03 April 2016 10:15
 Burn ID: DON_040
- DON_004 Glenlynn 5 km SE of Bridgetown
 Burn date/time: Saturday, 02 April 2016 00:57
 Burn ID: DON_004
- BWD_058 Red Gully_ 124.9 km SW of Nannup
 Burn date/time: Saturday, 02 April 2016 00:54
 Burn ID: BWD_058
- BWD_073 Rapids_ 539
 Burn date/time: Friday, 11 April 2016 10:13
 Burn ID: BWD_073

06 April 2016



Back trajectory over 1,440 minutes ending at Geraldton at 1100 on 06/04/2016.



60 minute running averaged time series plot of PM₁₀ at Geraldton.

Pollutant

PM₁₀

Monitoring site

Geraldton

NEPM standard

PM₁₀ 50 µg/m³

Averaging period

24 hours

Concentration (µg/m³)

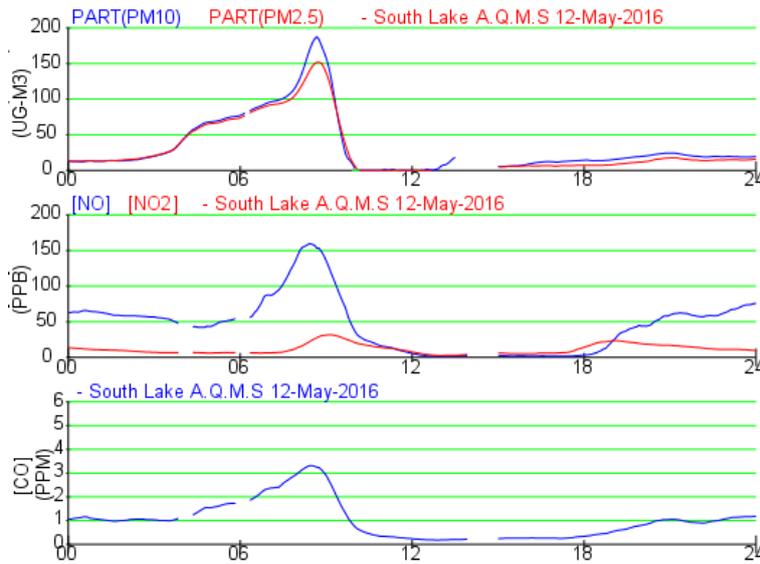
66.0 µg/m³

Description of event

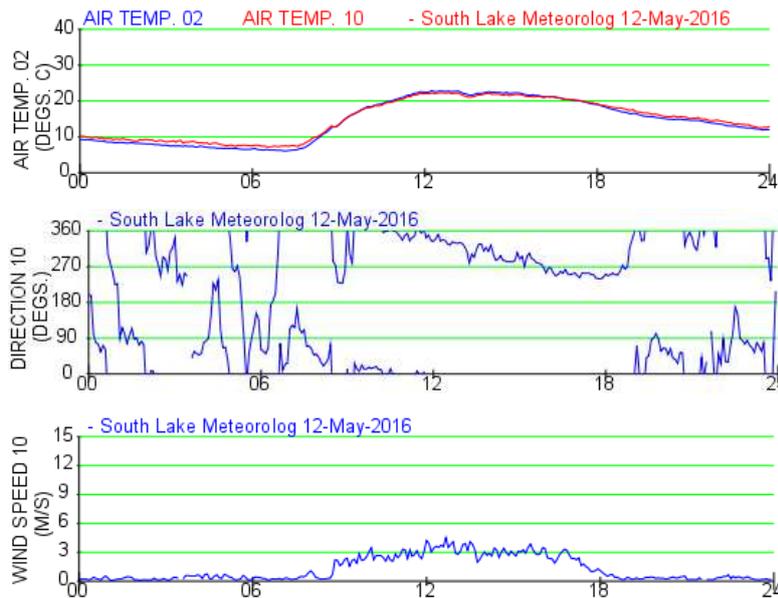
Geraldton-based staff advised smoke in Geraldton was caused by farmers burning off, plus dust lift off from paddocks. Winds were strong on 5 and 6 April. Steady 60km southerlies Tuesday afternoon and then about 50+km e/se on the Wednesday recorded at the airport, which is about 10km from the monitoring station.

No prescribed burns were noted in the region.

12 May 2016



60 minute running averaged time series plot of PM₁₀ and PM_{2.5} (top), NO and NO₂ (centre) and CO (bottom) at South Lake



Five minute averaged time series plot of air temperature (top), wind direction (centre) and wind speed (bottom) at South Lake.

Smoke alert for southern part of Perth metro area – 12 May 2016

Published: Thursday, 12 May 2016 07:19

The Department of Parks and Wildlife has issued a smoke alert for the southern part of the Perth metropolitan area. The smoke is from a number of Parks and Wildlife and private property prescribed burns being carried out across the Perth Hills and South West.

www.dpaw.wa.gov.au/news/alerts/smoke-alerts/item/2554-smoke-alert-for-southern-part-of-perth-metro-area-12-may-2016 (Please note: At the time of publication this link was no longer active.)

Pollutant

PM_{2.5}

Monitoring site

South Lake

NEPM standard

PM₁₀ 50 µg/m³

PM_{2.5} 25 µg/m³

Averaging period

24 hours

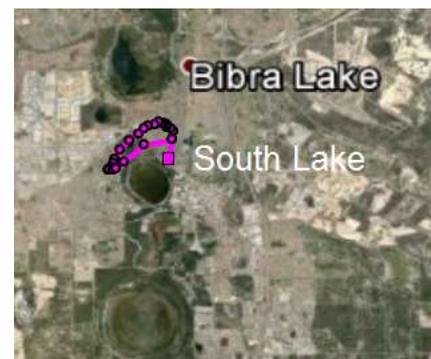
Concentration (µg/m³)

PM_{2.5} 30.4 µg/m³

Description of event

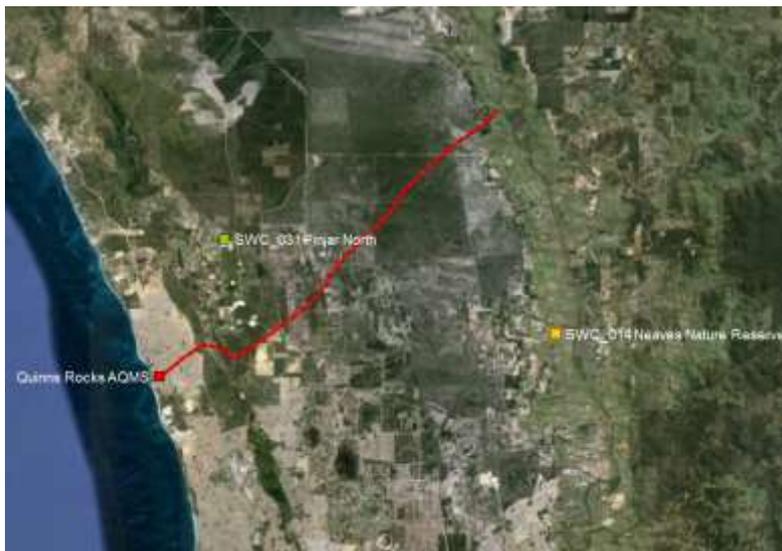
Low wind speed coupled with low morning temperatures and low level temperature inversion.

Elevated levels most likely caused by early morning smoke from prescribed burns conducted in the Perth Hills and the South West.

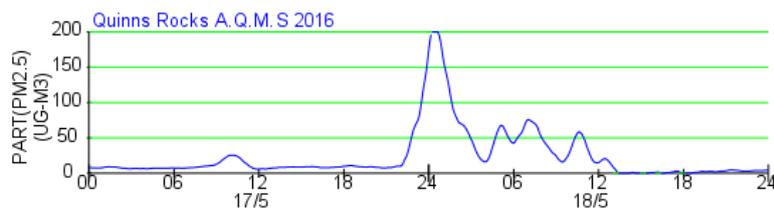


Back trajectory to South Lake over a period of 120 minutes ending 0900 on 12/05/2016.

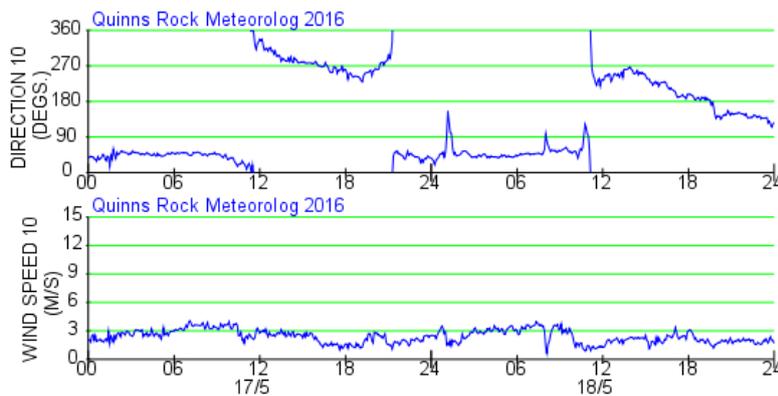
18 May 2016



Back trajectory over 240 minutes ending at Quinns Rocks at 0200 on 18/05/2016.



60 minute running averaged time series plot of PM_{2.5} at Quinns Rocks.



Five minute averaged time series plot of wind speed and direction at Quinns Rocks.

Pollutant

PM_{2.5}

Monitoring site

Quinns Rocks

NEPM standard

PM_{2.5} 25 µg/m³

Averaging period

24 hours

Concentration (µg/m³)

PM_{2.5} 28.8 µg/m³

Description of event

Elevated levels most likely caused by early morning smoke from prescribed burns conducted in the region at:

SWC_031 Pinjar North CF 15km N of Wanneroo.

SWC_014 Neaves Nature Reserve 7km WNW of Bullsbrook

(www.dpaw.wa.gov.au/management/fire/prescribed-burning/burns).

23 October 2016



worldview.earthdata.nasa.gov for this event.

Pollutant

PM_{2.5}

Monitoring site

Bunbury

NEPM standard

25µg/m³

Averaging period

24 hours

Concentration (µg/m³)

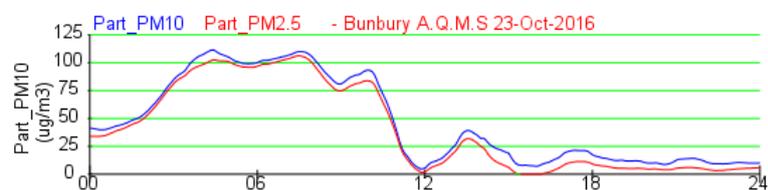
39.9µg/m³

Description of event

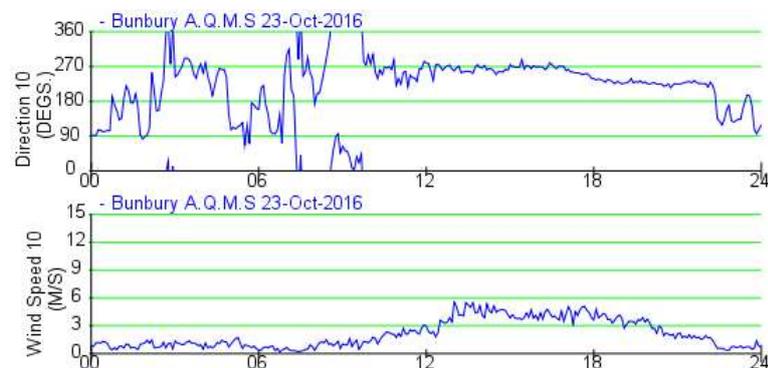
A number of controlled burns in the South West at:

WTN_046 Kemerton 211 3km NE of Australind

BWD_048 Argyle 032 7km SW of Donnybrook townsite



60 minute running averaged time series plot.



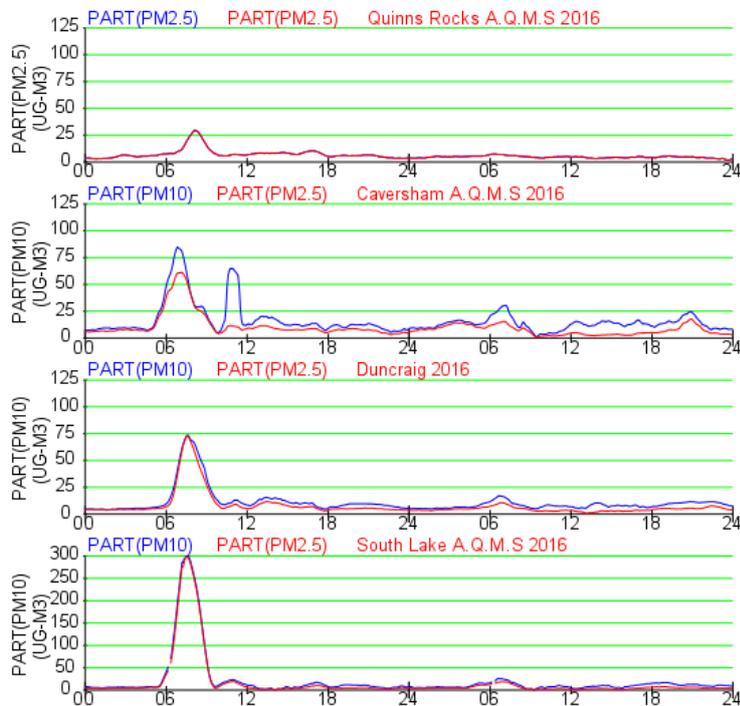
Five minute averaged time series plot of wind speed and direction at Bunbury.



26 October 2016



worldview.earthdata.nasa.gov for this event (Aqua/MODIS).



60 minute running averaged time series plot of PM₁₀ (blue) and PM_{2.5} (red) from South Lake on 26/10/2016 and three other metropolitan sites.

Pollutant

PM_{2.5}

Monitoring site

South Lake

NEPM standard

25µg/m³

Averaging period

24 hours

Concentration (µg/m³)

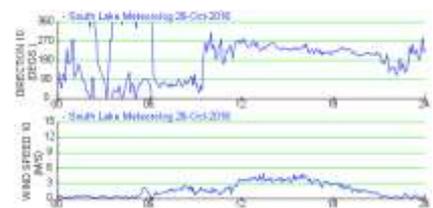
28.9µg/m³

Description of event

Easterly winds in the morning caused smoke from various controlled burns in the southwest to influence all particle readings at DWER metropolitan sites.



MODIS Satellite Hotspot

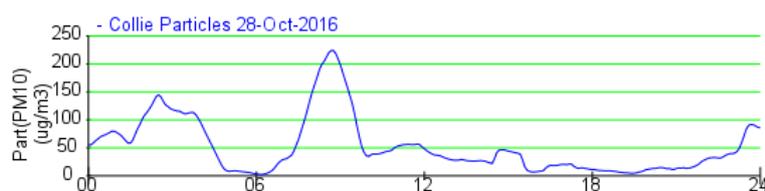


Five minute averaged time series plot of wind speed and direction at South Lake.

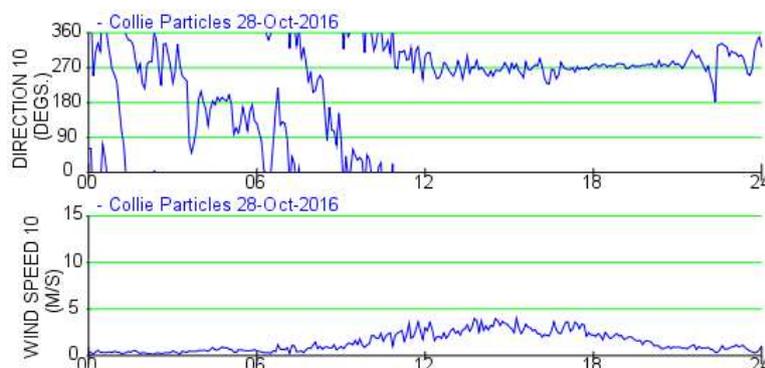
28 October 2016



worldview.earthdata.nasa.gov for this event (Aqua/MODIS) 28/10/2016.



60 minute running averaged time series plot at Collie.



Five minute averaged time series plot of wind speed and direction at Collie.

Pollutant

PM₁₀

Monitoring site

Collie

NEPM standard

50µg/m³

Averaging period

24 hours

Concentration (µg/m³)

51.9µg/m³

Description of event

A number of controlled burns in the South West coupled with low wind speeds.

06 November 2016



worldview.earthdata.nasa.gov for this event (Aqua/MODIS) 05/11/2016. No satellite image on 6/11/2016 due to extensive cloud cover.

Pollutant

PM₁₀

Monitoring site

Collie

NEPM standard

50µg/m³

Averaging period

24 hours

Concentration (µg/m³)

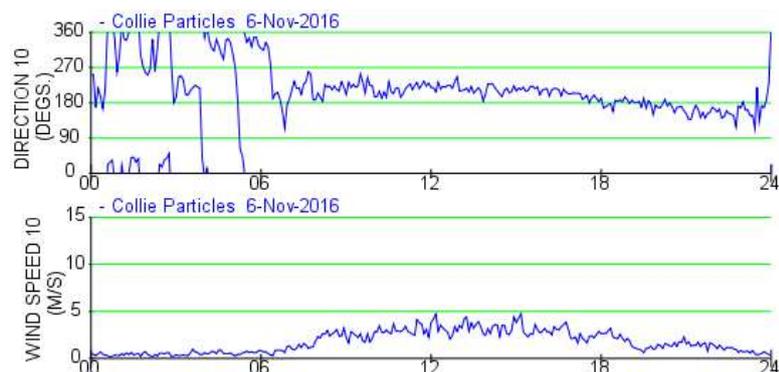
50.5µg/m³

Description of event

A number of controlled burns in the South West coupled with low wind speeds.



60 minute running averaged time series plot at Collie.

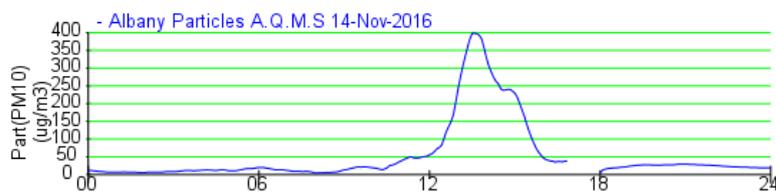


Five minute averaged time series plot of wind speed and direction at Collie.

14 November 2016



firms.modaps.eosdis.nasa.gov/active_fire/kml/Australia_and_New_Zealand_24h.kml for this event (MODIS) 14/11/2016.



60 minute running averaged time series plot.



Five minute averaged time series plot of wind speed and direction at Albany.

Pollutant

PM₁₀

Monitoring site

Albany

NEPM standard

50µg/m³

Averaging period

24 hours

Concentration (µg/m³)

53.7µg/m³

Description of event

No prescribed burns were reported in the vicinity of Albany:

(www.dpaw.wa.gov.au/management/fire/prescribed-burning/burns).

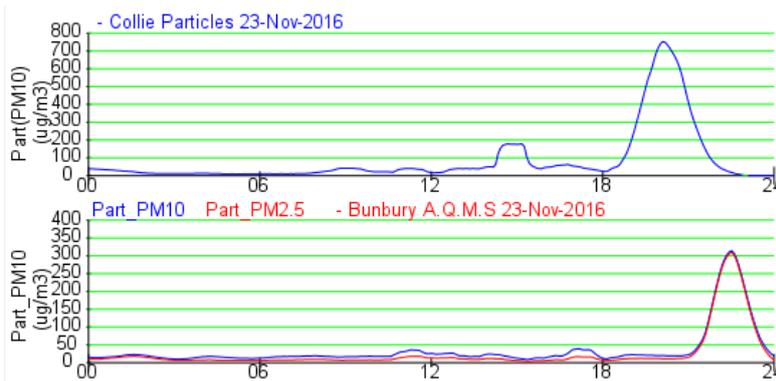
Several fire events detected by MODIS hotspot northeast of Albany could be possible source of the smoke.

Early morning northerly winds followed by easterlies may have directed smoke over Albany.

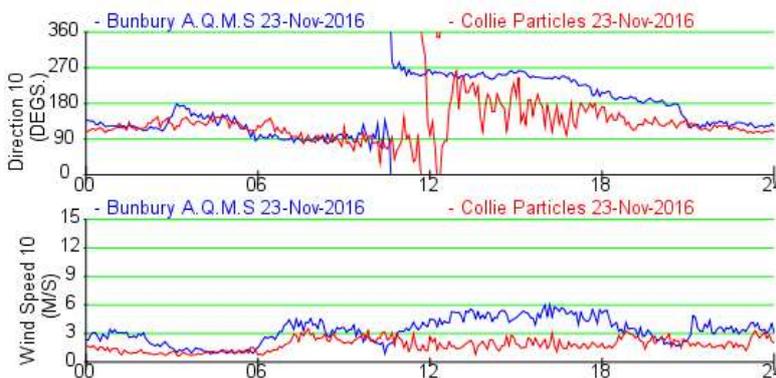
23 November 2016



worldview.earthdata.nasa.gov (Aqua/MODIS) 23/11/2016.



60 minute running averaged time series plot.



Five minute averaged time series plot of wind speed and direction at Bunbury and Collie.

Pollutant

PM₁₀ and PM_{2.5}

Monitoring site

Collie and Bunbury

NEPM standard

PM₁₀ 50µg/m³

PM_{2.5} 25µg/m³

Averaging period

24 hours

Concentration (µg/m³)

Location	PM ₁₀	PM _{2.5}
Collie	84.3	NA
Bunbury	35.1	26.3

Description of event

During the event, winds were from the east southeast.

A number of controlled burns active in the South West likely caused the exceedences.



Active burns from previous lightings obtained on 24/11/2016:

(www.dpaw.wa.gov.au/management/fire/prescribed-burning/burns/active-burns-from-previous-lighting-no-planned-ignitions-today).

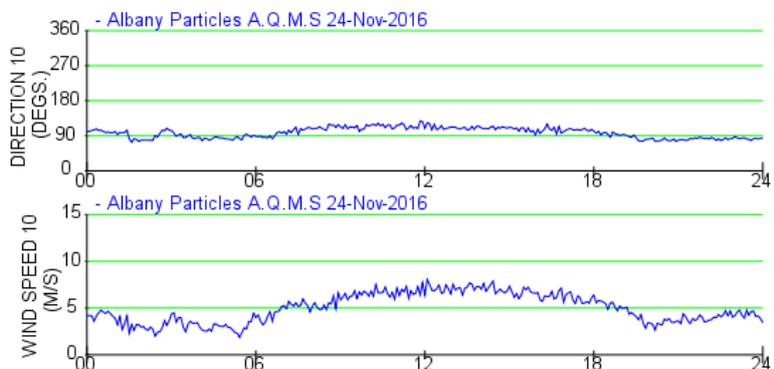
24 November 2016



worldview.earthdata.nasa.gov (Aqua/MODIS) 24/11/2016.



60 minute running averaged time series plot.



Five minute averaged time series plot of wind speed and direction.

Pollutant

PM₁₀

Monitoring site

Albany

NEPM standard

50µg/m³

Averaging period

24 hours

Concentration (µg/m³)

59.1µg/m³

Description of event

No prescribed burns were reported in the vicinity of Albany:

(www.dpaw.wa.gov.au/management/fire/prescribed-burning/burns).

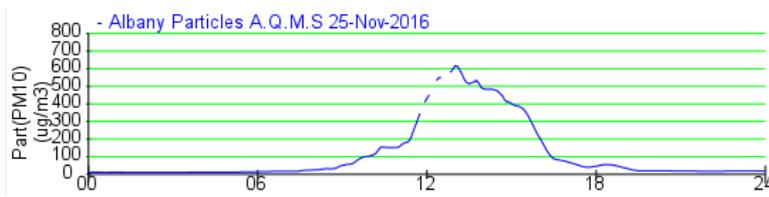
No fire events were detected by MODIS hotspot east of Albany.

Local advice is that nearby construction activity to the east of the monitor is the most likely cause of the particle exceedence.

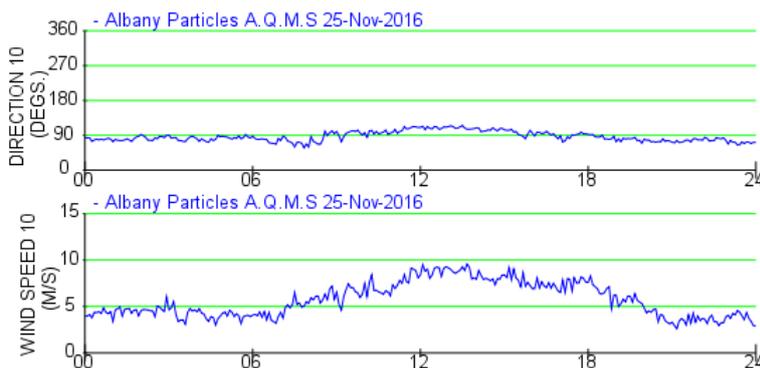
25 November 2016



www.emergency.wa.gov.au/ 27/11/2016.



60 minute running averaged time series plot.



Five minute averaged time series plot of wind speed and direction.

Pollutant

PM₁₀

Monitoring site

Albany

NEPM standard

50µg/m³

Averaging period

24 hours

Concentration (µg/m³)

94.9µg/m³

Description of event

No prescribed burns were reported in the vicinity of Albany:

(www.dpaw.wa.gov.au/management/fire/prescribed-burning/burns).

No fire events were detected by MODIS hotspot east of Albany.

Local advice is that nearby construction activity to the east of the monitor is the most likely cause of the particle exceedence.

27 November 2016



worldview.earthdata.nasa.gov (Terra/MODIS) 27/11/2016.

Pollutant

PM₁₀ and PM_{2.5}

Monitoring site

Various

NEPM standard

PM₁₀ 50µg/m³

PM_{2.5} 25µg/m³

Averaging period

24 hours

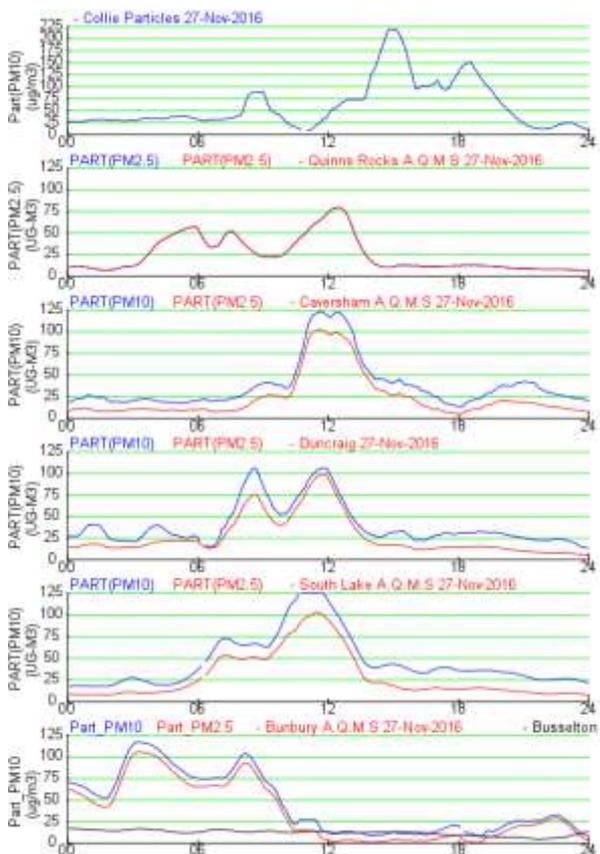
Concentration (µg/m³)

Location	PM ₁₀	PM _{2.5}
Bunbury	43.1	34.5
Collie	60.5	-
Caversham	38.1	24.1
Duncraig	40.0	27.0
Quinns Rocks	-	25.3
South Lake	47.0	29.0

Description of event

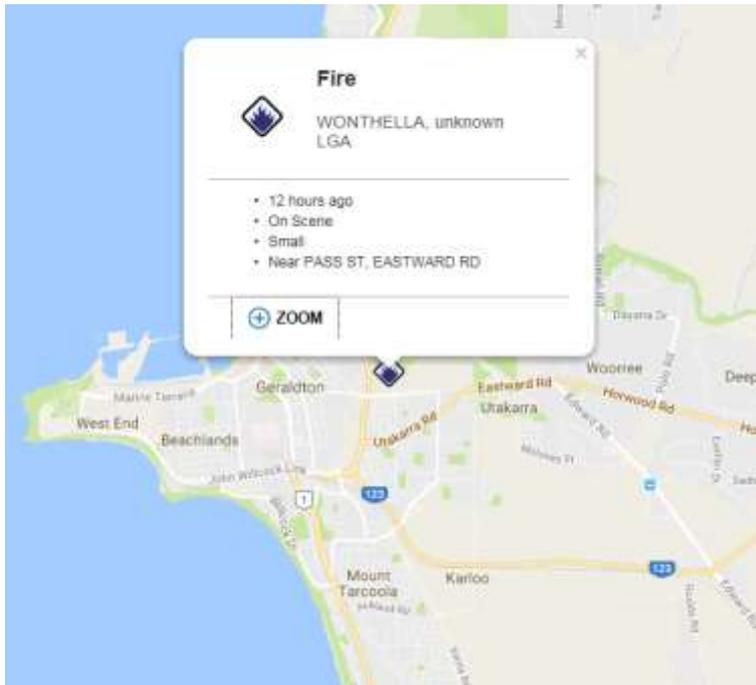
Smoke from bushfire in the South West.

www.canberratimes.com.au/wa-news/bunbury-air-quality-worse-than-beijing-due-to-bushfire-smoke-20161127-gsynir.html.

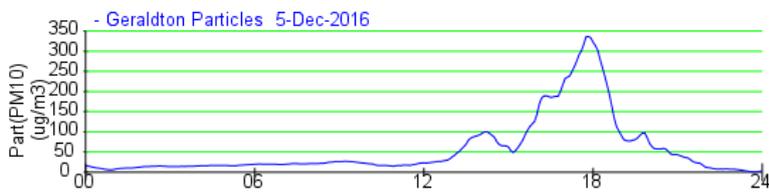


60 minute running averaged time series plot.

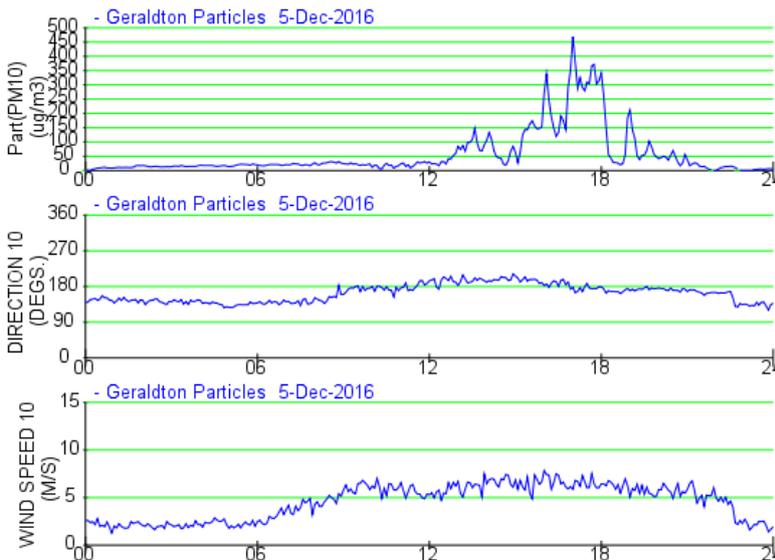
05 December 2016



www.emergency.wa.gov.au/# accessed 06/12/2016.



60 minute running averaged time series plot



Five minute averaged time series plot of wind speed and direction at Geraldton.

Pollutant

PM₁₀

Monitoring site

Geraldton

NEPM standard

50µg/m³

Averaging period

24 hours

Concentration (µg/m³)

55.4µg/m³

Description of event

There were no controlled burns in the vicinity of Geraldton.

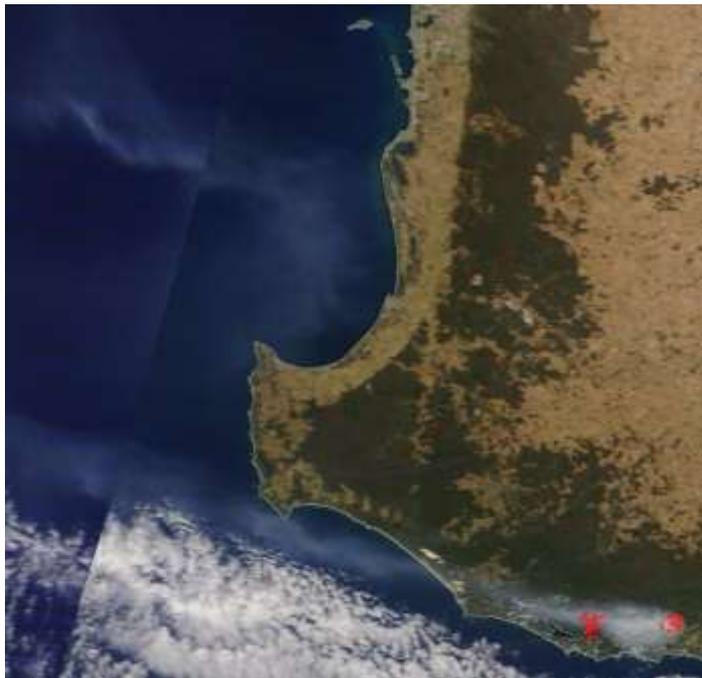
Modis satellite showed no hotspots on the day:

firms.modaps.eosdis.nasa.gov/active_fire/kml/Australia_and_New_Zealand_24h.kml

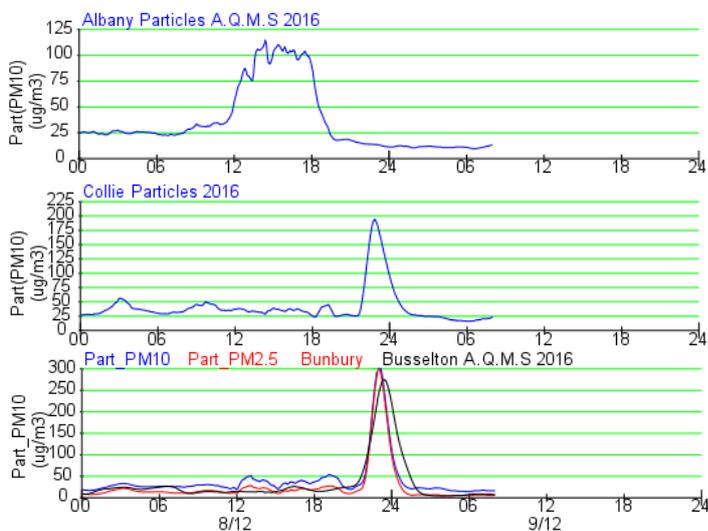
Wind was steady from the south before, during and after the event.

Advice from Geraldton-based staff indicates this was possibly a small localised event.

08 December 2016



worldview.earthdata.nasa.gov (Terra/MODIS) 08/12/2016.



60 minute running averaged time series plot.

Pollutant

PM_{2.5}

Monitoring site

Bunbury and Busselton

NEPM standard

25µg/m³

Averaging period

24 hours

Concentration (µg/m³)

Location	PM ₁₀	PM _{2.5}
Bunbury	47.4	33.0
Busselton	-	39.0
Collie	46.1	-
Albany	43.3	-

Description of event

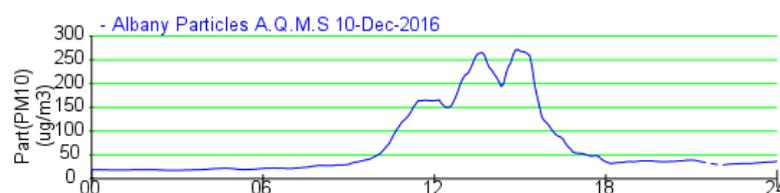
Smoke Alert Advice was issued at 6:09 PM on 8 December 2016 by Department of Parks and Wildlife for the South West and lower South West from Bunbury to Walpole including the towns of Busselton, Margaret River, Manjimup, Quinninup, Northcliffe, Pemberton and Denmark, and others in these areas.

“The smoke is due to prescribed burns carried out to manage bushfire risk and is expected to clear by tomorrow. Smoke is impacting Muir Highway, South West Highway south of Manjimup, and the South Coast Highway between Walpole and Denmark.”

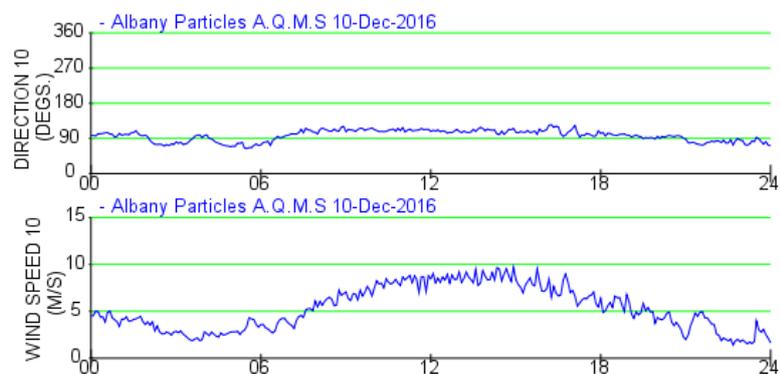
10 December 2016



worldview.earthdata.nasa.gov (Terra/MODIS) 09/12/2016.



60 minute running averaged time series plot.



Five minute averaged time series plot of wind speed and direction.

Pollutant

PM₁₀

Monitoring site

Albany

NEPM standard

50µg/m³

Averaging period

24 hours

Concentration (µg/m³)

68.9 µg/m³

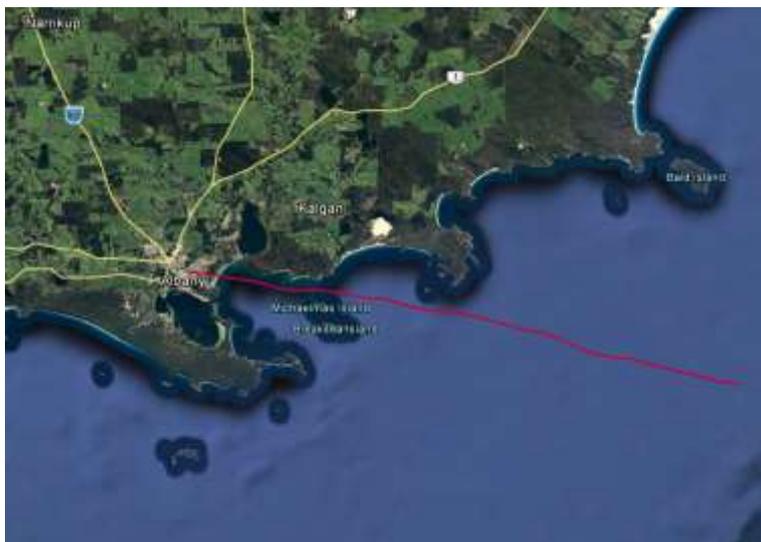
Description of event

Although there was a prescribed burn active the previous day in vicinity of Walpole generating large quantities of smoke, it was unlikely this caused the exceedance as winds were easterly for the whole day.

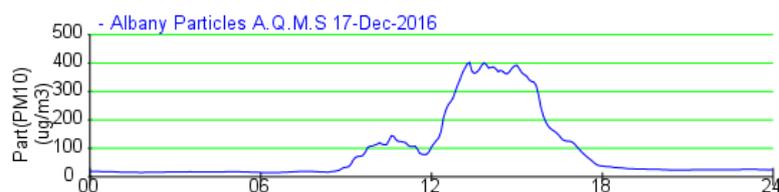
No fire events were detected by MODIS hotspot east of Albany.

Local advice is that nearby construction activity to the east of the monitor is the most likely cause of the particle exceedence.

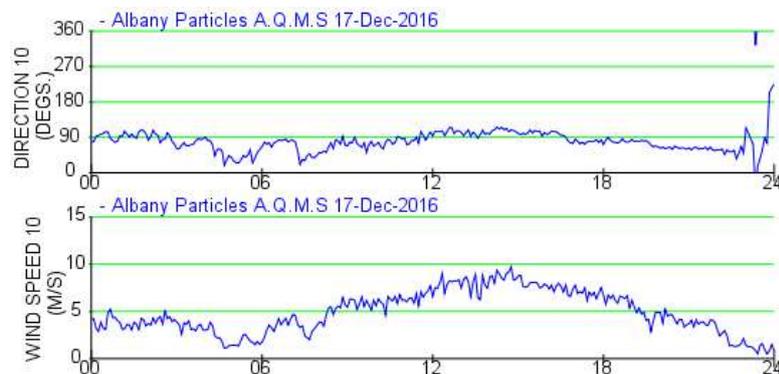
17 December 2016



Back trajectory over 60 minutes to Albany.



60 minute running averaged time series plot.



Five minute averaged time series plot of wind speed and direction.

Pollutant

PM₁₀

Monitoring site

Albany

NEPM standard

50µg/m³

Averaging period

24 hours

Concentration (µg/m³)

88.4 µg/m³

Description of event

There were no fire activities detectable in or near Albany. Winds were east for the period of elevated particles.

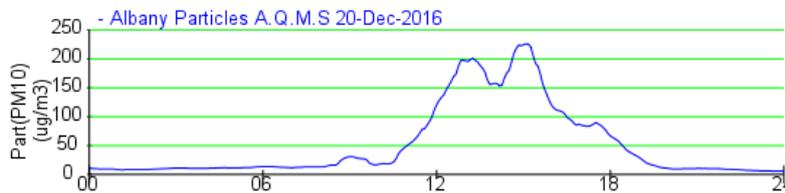
No fire events were detected by MODIS hotspot east of Albany.

Local advice is that nearby construction activity to the east of the monitor is the most likely cause of the particle exceedence.

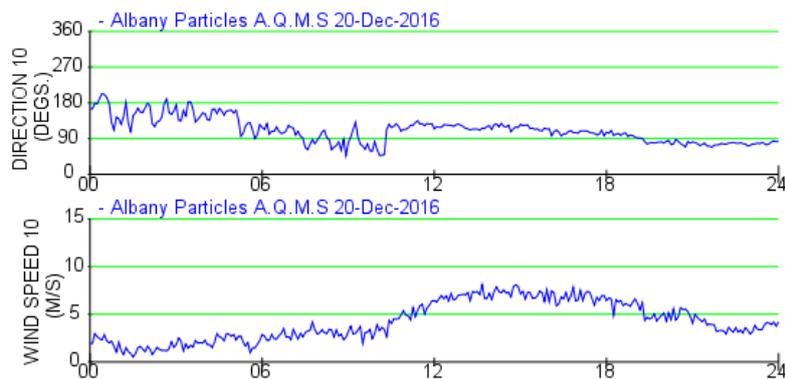
20 December 2016



Warnings and incidents for 21/12/2016 (www.emergency.wa.gov.au).



60 minute running averaged time series plot.



Five minute averaged time series plot of wind speed and direction.

Pollutant

PM₁₀

Monitoring site

Albany

NEPM standard

50µg/m³

Averaging period

24 hours

Concentration (µg/m³)

51.2 µg/m³

Description of event

Although there was some fire activity north of Albany, it was unlikely this caused the exceedance as winds were south and east for the whole day.

No fire events were detected by MODIS hotspot east of Albany.

Local advice is that nearby construction activity to the east of the monitor is the most likely cause of the particle exceedence.