



2017 Western Australia air monitoring report

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

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Summary

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

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 are within the Perth metropolitan region:

- Caversham
- Duncraig
- Quinns Rocks
- Rolling Green
- Rockingham
- South Lake
- Swanbourne
- Wattleup.

And there are five regional sites located in:

- Albany
- Bunbury
- Busselton
- Collie
- Geraldton.

The Quinns Rocks site was decommissioned in early 2017 due to redevelopment of the site. DWER is negotiating with the relevant council to reinstate the site at another suitable location.

One additional site was commissioned in Kalgoorlie in December 2017. The site contains instruments to monitor PM₁₀ and PM_{2.5} particles, carbon monoxide and sulfur dioxide. Data from this site have not been included in this 2017 report.

During 2017 the AAQ NEPM goal was not met for PM₁₀ particles at Albany, Caversham, Collie and Geraldton. PM_{2.5} particles did not meet the AAQ NEPM goal at Bunbury, Caversham, Duncraig and South Lake.

Across all monitoring sites there were 38 exceedences in 2017, comprising 20 exceedences of PM₁₀ particles (including 13 exceptional events) and 18 of PM_{2.5} particles (including 12 exceptional events).

Of the 25 particle exceedences that were classed as exceptional events 24 were due to prescribed burning activities and one due to a combination of bushfires and

prescribed burning activities. These exceptional event exceedences are not included in the NEPM goal assessment.

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

A. Monitoring summary

A.1 Current monitoring stations

The DWER monitoring network (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 Atmospheric Research (CSIRO) provided advice on monitoring site locations for the Perth Photochemical Smog Study and Perth Haze Study.

The Bunbury station (Figure A2) was established in the southwest of the state to monitor fuel reduction burns, with stations in Busselton and Collie also in operation for that purpose.

The Geraldton station (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.

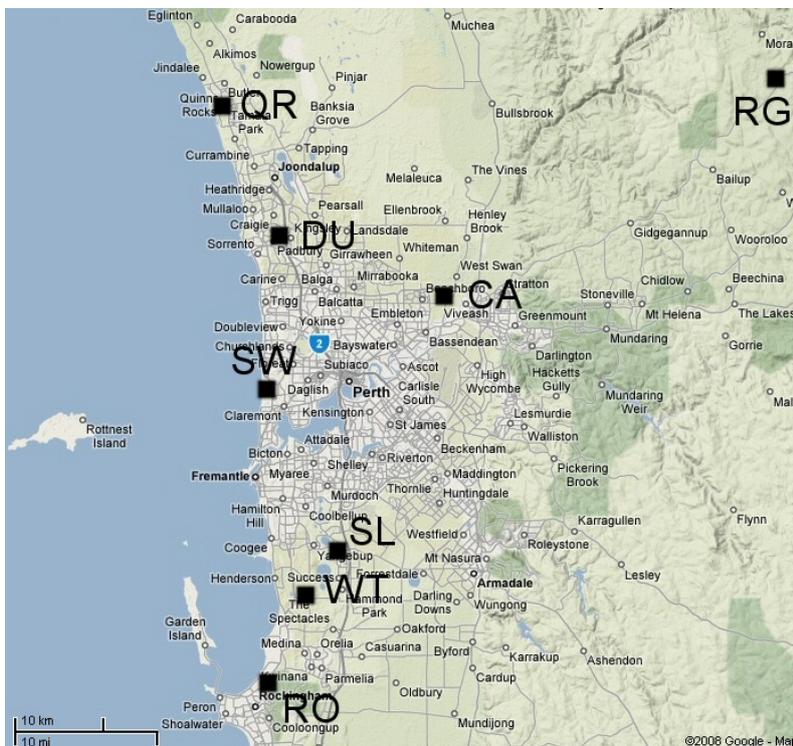


Figure A1: DWER air quality monitoring stations operating in the Perth Metropolitan Region



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



Figure A3: DWER air quality monitoring station operating in Geraldton

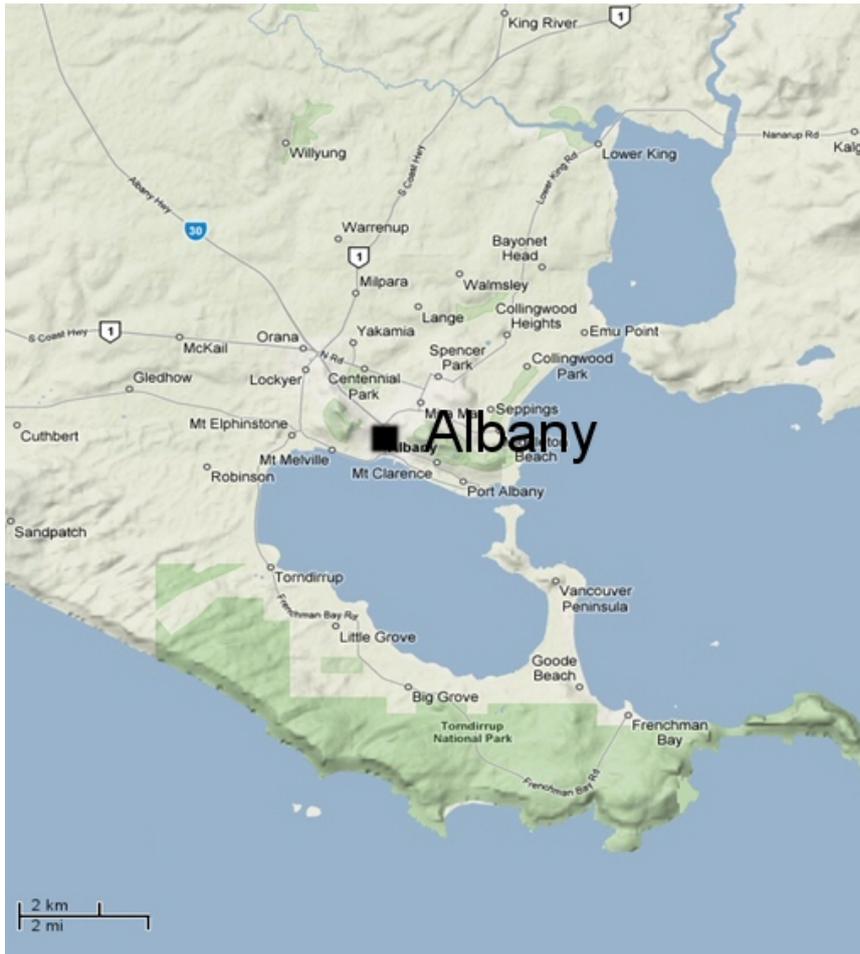


Figure A4: DWER air quality monitoring station operating in Albany

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
Albany					07/06 to present	
Bunbury					06/99 to present	04/97 to present
Busselton						11/06 to present
Caversham	08/93 to Present	11/89 to present	09/90 to present		01/04 to present	03/94 to present
Collie					02/08 to present	
Duncraig	08/95 to Present		08/95 to present		06/96 to present	01/95 to present
Geraldton					09/05 to present	
Kalgoorlie‡	12/17 to present			12/17 to present	12/17 to present	12/17 to present
Quinns Rocks *		11/92 to 03/17	11/92 to 03/17			07/06 to 03/17
Rockingham		12/95 to present	12/95 to present	07/88 to present		
Rolling Green		01/93 to present	01/93 to present			
South Lake	03/00 to present	04/06 to present				
Swanbourne		01/93 to present	03/93 to present			
Wattleup				01/88 to present		

‡ Kalgoorlie has been commissioned but has collected insufficient data to include within this report

* Quinns Rocks was decommissioned in March 2017 but will be re-established at a new location

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 by:

- visiting www.dwer.wa.gov.au
- emailing airquality@dwer.wa.gov.au
- telephoning (08) 6364 7000.

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	TEOM *
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	TEOM *

*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}
Albany					P/T	
Bunbury					P/T	P/T
Busselton						DWER
Caversham	DWER	P/T	P/T		P/T	P/T
Collie					DWER	
Duncraig	P/T		DWER		P/T	P/T
Geraldton					P/T	
Quinns Rocks		DWER	DWER			DWER
Rolling Green		DWER	DWER			
Rockingham		DWER	DWER	DWER		
South Lake	P/T	P/T	P/T	P	P/T	P/T
Swanbourne		P/T	P/T			
Wattleup				DWER		

Symbols key:

- *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
Albany	Large rural town located 380 kilometres south-southwest of Perth with moderate density housing and typical local traffic flows.
Bunbury	Large rural town located 145 kilometres south of Perth with moderate density housing and typical local traffic flows.
Busselton	Small rural town located 185 kilometres south of Perth with moderate density housing and typical local traffic flows.
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.
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.
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.
Geraldton	Large rural town located 377 kilometres north of Perth in the midwest with moderate density housing and typical traffic flows.
Kalgoorlie	Large rural town located 500 kilometres east-northeast of Perth in the goldfields with dry climate, moderate density housing and typical traffic flows.
Quinns Rocks	Outer north coastal suburb located 35 kilometres north of Perth with moderate density housing and typical local traffic flows
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.
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.
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.
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.
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.
C. 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	1,944,000				B&C	A	
Mandurah ^b	80,800	P	P	P	F	F	P
Albany	29,400	F	F	F	F	F	
Bunbury	71,000	A&F	E&F	E&F	D&F	F	
Kalgoorlie-Boulder ^c	29,900	M	E&F	E&F	T	F	P
Geraldton	32,000	F	E&F	E&F	D&F	F	

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

a. 2016 data (<http://www.censusdata.abs.gov.au>)

b. Mandurah station has yet to be established

c. Kalgoorlie station was commissioned in December 2017

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

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	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Duncraig	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	6 metres to medium-sized trees and presence of power pole.
Quinns Rocks	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	15 metres to small to medium-sized trees. Surrounding area dominated by low scrub.
Rockingham	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	12 metres to trees. Northern vector dominated by grain storage facility.
Rolling Green	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
South Lake	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Swanbourne	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Wattleup	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Southwest region										
Albany	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Bunbury	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	15 metres to small to medium-sized eucalyptus trees.
Busselton	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	5 metres to small to medium-sized eucalyptus trees.
Collie	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Some trees and shipping containers nearby
Midwest region										
Geraldton	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	

A.2 Carbon monoxide

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 depression through which the freeway passes. 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 carbon monoxide (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, Western Australia maintained performance monitoring of carbon monoxide 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. Distinct seasonal influences can be seen in Figure A5 with CO concentrations peaking during winter months and falling during summer.

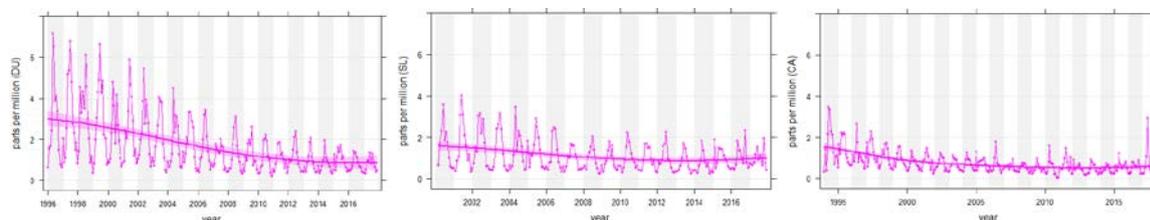


Figure A5: Smoothed trend (dark lines) for CO at Duncraig (left), South Lake (centre) and Caversham (right).

During the 2015/16 National Pollutant Inventory reporting year, CO emissions in urban areas were evenly distributed between motor vehicles (2 million tonnes (MT)) and combustion products from fuel reduction burns and wildfires (2.1MT)¹. These two sources account for over 90 per cent of the CO emissions in urban areas with the next highest emission from domestic solid fuel burning at 0.2MT per annum.

¹ <http://www.npi.gov.au/npidata/action/load/emission-by-source-result/criteria/substance/20/destination/ALL/source-type/ALL/substance-name/Carbon%2Bmonoxide/subthreshold-data/Yes/year/2016>



Figure A6: The PM10 maximum (blue), 99th (red) and 95th (black) percentiles for each hour of the day at Duncraig over two year periods 1996-1997 (left), 2006-2007 (centre) and 2016-2017 (right)

Percentile concentrations for CO for each hour of the day during three two-year periods at Duncraig are shown in Figure A6. The CO profile shows a marked decrease in overnight concentrations over a 20 year timespan. One possible reason for this is the introduction of the *Environmental Protection (Domestic Solid Fuel Burning Appliances and Firewood Supply) Regulations 1998* which require heating appliances (wood heaters) sold to meet emission standards set out in the relevant Australian and New Zealand Standard (AS/NZS4013:1999) and regulate the moisture content of wood sold as firewood.

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

A.3 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 which has the following desirable attributes:

- provides spatial spread of stations (it will measure ozone returning on shore in the southern part of the metropolitan area)
- is a moderate distance inland in a growing urban area, hence it is well classed as a population average station
- may occasionally detect the interactions of ozone (O₃) rich air with the nitrogen oxide (NO_x) rich plumes from Kwinana industry (potentially giving elevated nitrogen dioxide (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 A7. 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. For the two year period 2016-2017 the ratio at Swanbourne increased to 0.63.

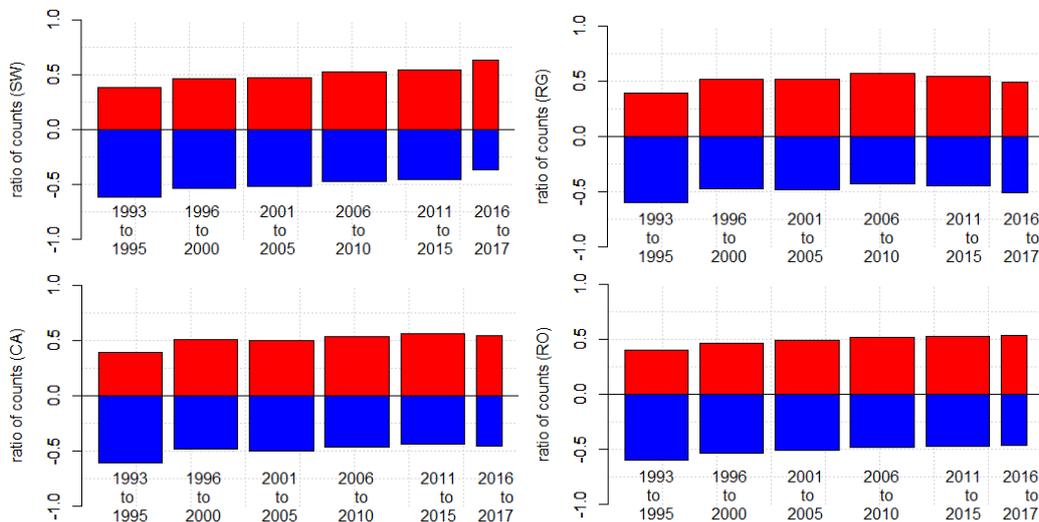


Figure A7: Ratio of the number of hourly averaged ozone concentrations at Swanbourne and Rolling Green (top panel) and, Caversham and Rockingham (lower panel) that was higher (red) or equal to or lower (blue) than the 25-year average concentration for that site

A similar increasing pattern is evident at the other coastal site of Rockingham. The inland sites of Caversham and Rolling Green have a less distinct pattern.

A.4 Nitrogen dioxide

Owing to the close chemical reactivity relationship, nitrogen dioxide (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 A8 demonstrates how nitrogen oxides (NO_x) (NO + NO₂) monthly means have decreased at all sites. The median of the daily one hour nitrogen monoxide (NO) maximum has also seen a general decrease over time, with Duncraig experiencing an average of 0.5 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 +

$O_3 \rightarrow NO_2 + O_2$). The general build-up in O_3 therefore commences earlier (and consequently closer to populated areas) than it otherwise would².

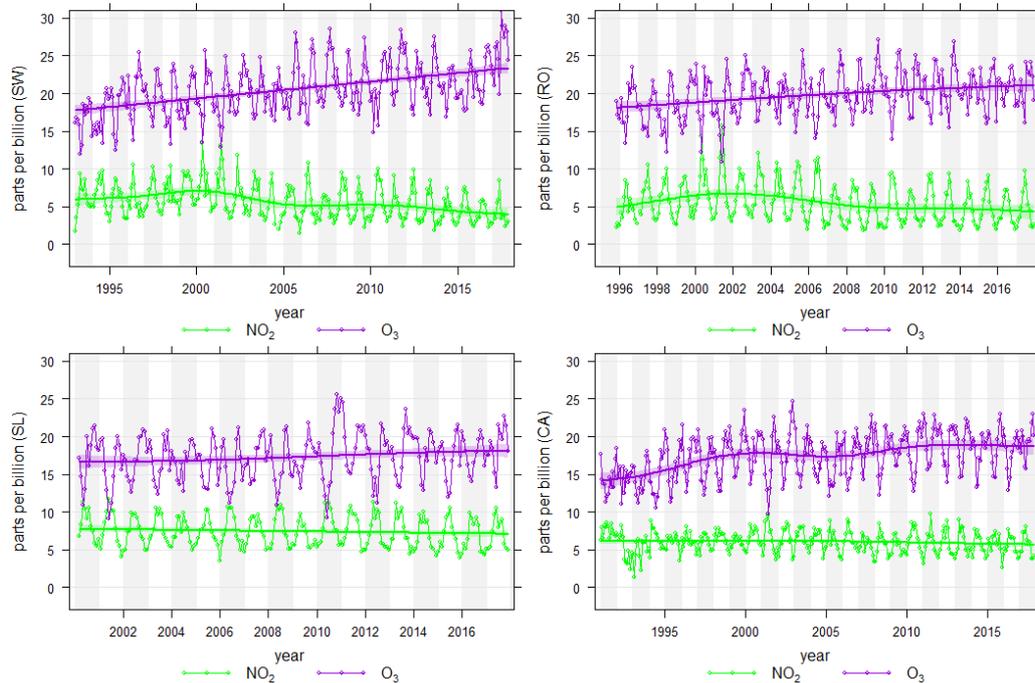


Figure A8: Smoothed trend (dark lines) at Swanbourne and Rockingham (top panel) and South Lake and Caversham (lower panel) using the monthly mean concentration of NO_x (green) and O₃ (violet).

A.5 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 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

² D.H.Stedman, *Environ. Chem.* 2004, 1, 65-66

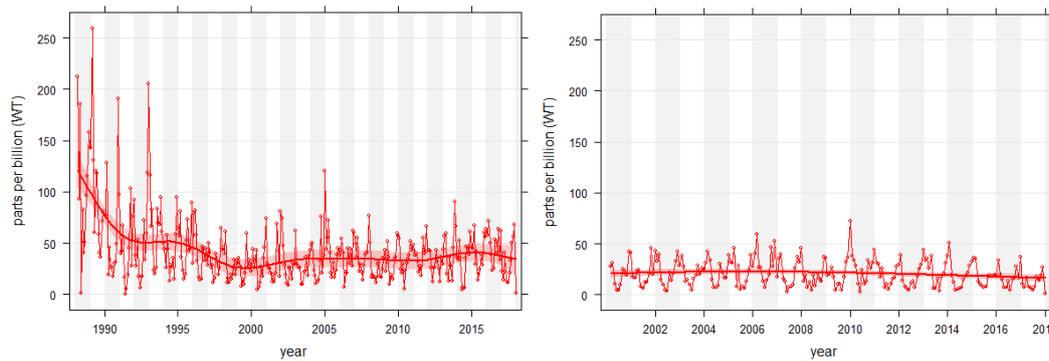


Figure A9: Trend line for maximum hourly averaged sulfur dioxide concentration at Wattleup, located within the Kwinana Industrial Buffer (left) and South Lake (right).

A.6 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 AAQ NEPM Technical Paper No. 4, Screening Procedures, and the WA Monitoring Plan, a performance monitoring station for lead has not been maintained since 2001.

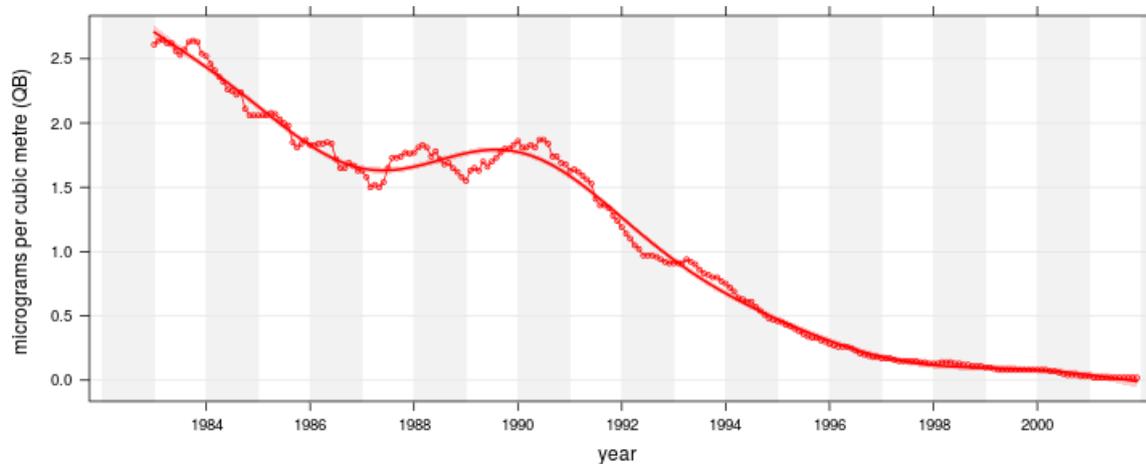


Figure A10: Trend line for annual moving averaged lead concentration within the Perth CBD

A.7 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 and some industrial emissions.

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

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 A11 for three metropolitan sites, can indicate differences in the ratio of $PM_{2.5}:PM_{10}$, 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 A11 represent periods where the one hour averaged PM_{10} exceeded an arbitrary concentration of $50\mu g/m^3$. This cut-off was chosen to limit the analysis to those at the higher end of the spectrum. Whereas Duncraig exhibits a larger number of high-ratio events, both Caversham and South Lake display a larger number of low-ratio events. These differences can be explained based on the site locations

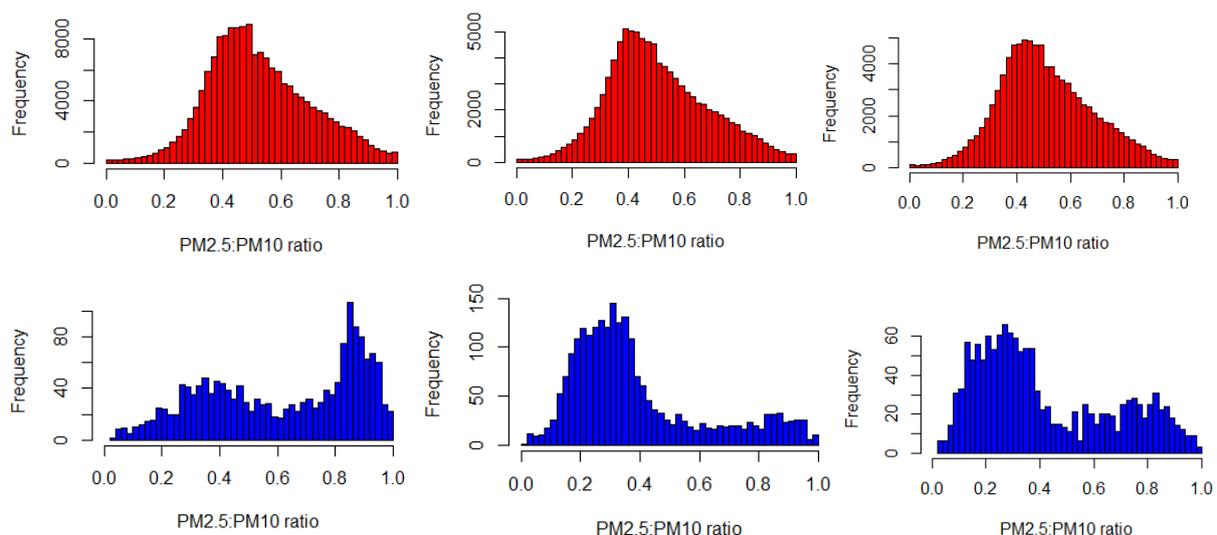


Figure A11: Frequency distribution of $PM_{2.5}:PM_{10}$ ratios of hourly averages at Duncraig (left), South Lake (centre) and Caversham (right) since installation using all data (top) and data where hourly averaged PM_{10} was greater than, or equal to $50\mu g/m^3$ (bottom)

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 or prescribed burn. One therefore expects to see a larger proportion of high $PM_{2.5}:PM_{10}$ ratio which is 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}:PM₁₀ ratios.

A.8 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 Area 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 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.

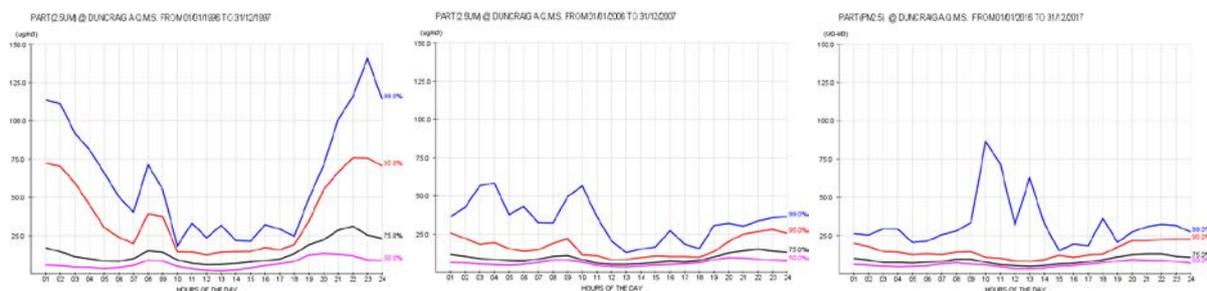


Figure A12: The PM_{2.5} 99th (blue), 95th (red), 75th (black) and 50th (mauve) percentiles for each hour of the day at Duncraig over winter months spanning two year periods 1996-1997 (left), 2006-2007 (centre) and 2016-2017 (right)

Percentile concentrations for PM_{2.5} for each hour of the day over winter months during three two-year periods at Duncraig are shown in Figure A12. The PM_{2.5} profile shows a marked decrease in overnight concentrations over the initial ten year timespan with a much smaller improvement over the second decade. As indicated in section A2 on carbon monoxide, one possible reason for this initial and dramatic decrease in fine particle concentrations during winter is the introduction of the *Environmental Protection (Domestic Solid Fuel Burning Appliances and Firewood Supply) Regulations 1998* which require heating appliances (wood heaters) sold to meet emission standards set out in the relevant Australian and New Zealand Standard (AS/NZS4013:1999) and regulate the moisture content of wood sold as firewood.

In addition, in 2006 and 2007 Wood Heater Replacement Programs were conducted by the then Department of Environment and Conservation, which offered up to \$600 as an economic incentive to encourage people using wood heaters or fireplaces as the main source of heating in their homes to convert to an alternative heating source.

A.9 Variation to the NEPM

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

- provide for a PM₁₀ annual standard of 25µg/m³

- create two standards for PM_{2.5} of 25µg/m³ averaged over 24 hours, and 8µg/m³ averaged over one year
- remove the five allowable exceedences for PM₁₀ one-day average standards when determining compliance with the NEPM goal
- 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
 - 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.

A.10 Exceedence summary

There were a number of exceedences of PM_{2.5} and PM₁₀ in 2017. The NEPM goal for particles was not met at:

- Albany
- Bunbury
- Caversham
- Collie
- Duncraig
- Geraldton
- South Lake.

Detailed summaries of all exceedences are provided in Attachment 2.

Table A9: Air NEPM standard exceedences recorded during 2017

Site	Pollutant	Concentration	Date	Event cause
Albany	PM ₁₀	61.8 µg/m ³	04/01/2017	AS
Albany	PM ₁₀	52.3 µg/m ³	10/11/2017	AS
Bunbury	PM _{2.5}	28.1 µg/m ³	05/04/2017	AS
Bunbury	PM _{2.5}	26.6 µg/m ³	13/05/2017	PB
Bunbury	PM _{2.5}	33.9 µg/m ³	10/06/2017	PB
Bunbury	PM _{2.5}	31.4 µg/m ³	15/09/2017	PB
Bunbury	PM _{2.5}	30.5 µg/m ³	04/11/2017	PB
Bunbury	PM _{2.5}	25.6 µg/m ³	05/11/2017	PB
Busselton	PM _{2.5}	28.8 µg/m ³	13/05/2017	PB
Caversham	PM _{2.5}	26.6 µg/m ³	05/04/2017	AS
Caversham	PM _{2.5}	44.2 µg/m ³	13/05/2017	PB
Caversham	PM ₁₀	53.4 µg/m ³	13/05/2017	PB
Caversham	PM ₁₀	79.2 µg/m ³	01/06/2017	AS
Caversham	PM _{2.5}	65.9 µg/m ³	01/06/2017	AS
Caversham	PM _{2.5}	37.9 µg/m ³	02/06/2017	AS
Caversham	PM _{2.5}	65.2 µg/m ³	07/06/2017	PB/BF
Caversham	PM ₁₀	79.1 µg/m ³	07/06/2017	PB/BF
Collie	PM ₁₀	53.7 µg/m ³	29/03/2017	PB
Collie	PM ₁₀	57.8 µg/m ³	28/04/2017	PB
Collie	PM ₁₀	53.7 µg/m ³	02/05/2017	PB
Collie	PM ₁₀	54.9 µg/m ³	03/05/2017	PB
Collie	PM ₁₀	51.0 µg/m ³	31/05/2017	PB
Collie	PM ₁₀	57.6 µg/m ³	09/06/2017	PB
Collie	PM ₁₀	81.5 µg/m ³	10/06/2017	PB
Collie	PM ₁₀	55.4 µg/m ³	11/06/2017	PB
Collie	PM ₁₀	68.2 µg/m ³	12/06/2017	PB
Collie	PM ₁₀	54.7 µg/m ³	13/06/2017	PB
Collie	PM ₁₀	51.2 µg/m ³	14/09/2017	AS
DunCraig	PM _{2.5}	25.9 µg/m ³	05/04/2017	AS
DunCraig	PM _{2.5}	31.8 µg/m ³	13/05/2017	PB
DunCraig	PM _{2.5}	40.5 µg/m ³	07/06/2017	PB/BF
DunCraig	PM ₁₀	51.4 µg/m ³	07/06/2017	PB/BF
Geraldton	PM ₁₀	54.2 µg/m ³	08/02/2017	AS
Geraldton	PM ₁₀	73.5 µg/m ³	12/06/2017	AS
Geraldton	PM ₁₀	53.7 µg/m ³	14/11/2017	AS
South Lake	PM _{2.5}	26.1 µg/m ³	05/04/2017	AS
South Lake	PM _{2.5}	33.8 µg/m ³	13/05/2017	PB
South Lake	PM _{2.5}	46.6 µg/m ³	06/10/2017	PB

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)

B. Assessment of compliance with standards and goals

Table B1: 2017 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)	99.3	97.7	95.4	97.8	97.5	0	Met
Duncraig (North Metro)	99.6	97.3	96.2	94.4	96.9	0	Met
South Lake (Southeast Metro)	100	95.1	99.7	99.9	98.6	0	Met

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

Table B2: 2017 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)	99.3	98.4	88.1	95.6	95.3	0.005	0	Met	Met
Duncraig (North Metro)	99.5	97.4	98.6	97.1	98.2	0.006	0	Met	Met
Quinns Rocks (Outer North Coast)	87.1	0.0	0.0	0.0	21.5	0.002	0	ND	ND
Rockingham (South Coast)	98.7	85.9	94.8	94.4	93.4	0.004	0	Met	Met
Rolling Green (Outer East Rural)	96.9	100	99.9	99.7	99.1	0.002	0	Met	Met
South Lake (Southeast Metro)	99.9	95.0	95.0	99.2	97.3	0.007	0	Met	Met
Swanbourne (Inner West Coast)	99.9	99.8	99.6	99.9	99.8	0.004	0	Met	Met

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

Table B3: 2017 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	98.4	97.4	99.8	98.7	0	0	Met	Met
Quinns Rocks (Outer North Coast)	87.2	0.0	0.0	0.0	21.5	0	0	ND	ND
Rockingham (South Coast)	99.1	99.7	97.7	99.9	99.1	0	0	Met	Met
Rolling Green (Outer East Rural)	98.1	100	99.9	96.3	98.6	0	0	Met	Met
South Lake (Southeast Metro)	99.6	95.0	99.4	100	98.5	0	0	Met	Met
Swanbourne (Inner West Coast)	99.0	100	99.7	100	99.5	0	0	Met	Met

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

Table B4: 2017 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 (ppm)	Number of exceedences (days)		Performance against the standards and goal		
	Q1	Q2	Q3	Q4	Annual		1-hour	24-hour	1-hour	24-hour	1-year
Perth region											
Rockingham (South Coast)	96.9	94.6	94.8	97.1	95.8	0.001	0	0	Met	Met	Met
South Lake (Southeast Metro)	92.7	93.0	97.1	97.8	95.2	0.003	0	0	Met	Met	Met
Wattleup (South Metro)	95.7	94.5	97.7	97.4	96.3	0.001	0	0	Met	Met	Met

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

Table B5: 2017 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)	99.1	98.4	97.4	99.7	98.6	3	Not met	Met
Duncraig (North Metro)	99.7	97.4	99.5	97.1	98.4	1	Met	Met
South Lake (Southeast Metro)	99.6	94.9	99.4	99	98.2	0	Met	Met
Southwest region								
Albany	99.5	99.8	99.2	99.4	99.5	2	Not met	Met
Bunbury	99.4	99.2	99.8	99.8	99.6	0	Met	Met
Collie	97.5	97.6	92.6	99.6	96.8	11	Not met	Met
Midwest region								
Geraldton	99.7	99.9	99.9	99.9	99.8	3	Not met	Met

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

Table B6: 2017 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)	99.3	98.3	97.4	99.8	98.7	5	Not met	Not met
Duncraig (North Metro)	99.7	97.4	99.5	97.3	98.5	3	Not met	Not met
Quinns Rocks (Outer North Coast)	83.8	0	0	0	20.7	0	ND	ND
South Lake (Southeast Metro)	99.7	95.0	99.5	99.3	98.4	3	Not met	Not met
Southwest region								
Bunbury	99.3	99.1	99.8	99.8	99.5	6	Not met	Not met
Busselton	99.6	99.6	92.6	99.5	97.8	1	Met	Not met

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

C. Analysis of air quality monitoring

C.1 Carbon monoxide

The NEPM standard for carbon monoxide of 9.0 ppm averaged over eight hours was not exceeded at any site during 2017. 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 carbon monoxide in WA.

Table C1: 2017 summary statistics for daily peak eight-hour carbon monoxide

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

Regional performance monitoring station	Data availability rates (%)	Highest (ppm)	Highest (date) (time)		2nd highest (ppm)	2nd highest (date) (time)	
Perth region							
Caversham (Northeast Metro)	97.5	2.9	07/06/2017	1300	2.5	02/06/2017	0500
Duncraig (North Metro)	96.9	1.4	07/06/2017	1500	1.3	06/08/2017	0400
South Lake (Southeast Metro)	98.6	1.9	06/10/2017	0700	1.5	30/06/2017	0100

C.2 Nitrogen dioxide

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 2017. 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 nitrogen dioxide in WA.

Table C2: 2017 summary statistics for daily peak one-hour nitrogen dioxide

Regional performance monitoring station	Data availability rates (%)	Highest (ppm)	Highest		2nd highest (ppm)	2nd highest		
			(date)	(time)		(date)	(time)	
<i>AAQ NEPM standard 0.12 ppm (one-hour average)</i>								
Perth region								
Caversham (Northeast Metro)	95.3	0.042	18/09/2017	1900	0.038	15/09/2017	2100	
Duncraig (North Metro)	98.2	0.032	13/06/2017	2000	0.032	08/06/2017	1900	
Quinns Rocks (Outer North Coast)	21.5	0.019	08/03/2017	2300	0.016	17/03/2017	0700	
Rockingham (South Coast)	93.4	0.074	10/07/2017	0900	0.054	06/07/2017	1000	
Rolling Green (Outer East Rural)	99.1	0.018	21/04/2017	2100	0.018	01/08/2017	0800	
South Lake (Southeast Metro)	97.3	0.045	24/02/2017	2000	0.036	06/09/2017	2000	
Swanbourne (Inner West Coast)	99.8	0.033	12/06/2017	2000	0.033	09/06/2017	2000	

C.3 Photochemical smog as ozone

The NEPM standard for ozone of 0.10 ppm averaged over one hour was not exceeded at any site during 2017. 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 ozone in WA.

Table C3: 2017 summary statistics for daily peak one-hour ozone

Regional performance monitoring station	Data availability rates (%)	Highest (ppm)	Highest		2nd highest		2nd highest	
			(date)	(time)	(ppm)	(date)	(time)	
<i>AAQ NEPM standard</i>								
<i>0.10 ppm (one-hour average)</i>								
Perth region								
Caversham (Northeast Metro)	98.7	0.099	07/06/2017	1000	0.089	07/03/2017	1500	
Quinns Rocks (Outer North Coast)	21.5	0.066	04/01/2017	1300	0.063	03/01/2017	1400	
Rockingham (South Coast)	99.1	0.069	04/01/2017	1300	0.069	26/01/2017	1300	
Rolling Green (Outer East Rural)	98.6	0.069	27/02/2017	1600	0.068	10/01/2017	1600	
South Lake (South East Metro)	98.5	0.074	04/01/2017	1300	0.071	01/03/2017	1600	
Swanbourne (Inner West Coast)	99.5	0.079	05/04/2017	1500	0.079	04/01/2017	1300	

The NEPM standard for ozone of 0.08 ppm averaged over four hours was not exceeded at any site during 2017. The NEPM goal of no more than one exceedance at each site was met. Table C4 contains the summary statistics for daily peak four-hour ozone in WA.

Table C4: 2017 summary statistics for daily peak four-hour ozone

Regional performance monitoring station	Data availability rates (%)	Highest (ppm)	Highest		2nd highest		2nd highest	
			(date)	(time)	(ppm)	(date)	(time)	
Perth region								
Caversham (Northeast Metro)	98.7	0.077	07/03/2017	1600	0.072	01/03/2017	1800	
Quinns Rocks (Outer North Coast)	21.5	0.062	04/01/2017	1500	0.057	03/01/2017	1600	
Rockingham (South Coast)	99.1	0.062	11/12/2017	1500	0.059	24/02/2017	1800	
Rolling Green (Outer East Rural)	98.6	0.064	10/01/2017	1900	0.062	27/01/2017	1900	
South Lake (South East Metro)	98.5	0.067	01/03/2017	1600	0.058	08/11/2017	1500	
Swanbourne (Inner West Coast)	99.5	0.070	05/04/2017	1600	0.066	03/01/2017	1600	

AAQ NEPM standard

0.08 ppm (four-hour average)

C.4 Sulfur dioxide

The NEPM standard for sulfur dioxide of 0.20 ppm averaged over one hour was not exceeded at any site during 2017. The NEPM goal of no more than one exceedence at each site was met. Table C5 contains the summary statistics for daily peak one-hour sulfur dioxide in WA.

Table C5: 2017 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)	95.8	0.030	07/08/2017	2200	0.028	30/06/2017	0600
South Lake (Southeast Metro)	95.2	0.037	14/01/2017	1600	0.027	02/12/2017	1700
Wattleup (South Metro)	96.3	0.068	02/12/2017	1500	0.062	25/01/2017	1500

The NEPM standard for sulfur dioxide of 0.08 ppm averaged over 24 hours was not exceeded at any site during 2017. The NEPM goal of no more than one exceedence at each site was met. Table C6 contains the summary statistics for daily peak 24-hour sulfur dioxide in WA.

Table C6: 2017 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)	95.8	0.009	30/06/2017	2400	0.008	07/08/2017	2400
South Lake (Southeast Metro)	95.2	0.009	04/01/2017	2400	0.009	01/01/2017	2400
Wattleup (South Metro)	96.3	0.007	24/11/2017	2400	0.006	02/10/2017	2400

The NEPM standard for sulfur dioxide of 0.02 ppm averaged over one year was not exceeded at any site during 2017. Table C7 contains the summary statistics for annual sulfur dioxide in WA.

Table C7: 2017 summary statistics for annual sulfur dioxide

<i>AAQ NEPM standard</i>		
<i>0.02 ppm (annual average)</i>		
Regional performance monitoring station	Data availability rates (%)	Annual average (ppm)
Perth region		
Rockingham (South Coast)	95.8	0.001
South Lake (Southeast Metro)	95.2	0.003
Wattleup (South Metro)	96.3	0.001

C.5 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 2017. The NEPM goal was not met at Albany, Caversham, Collie and Geraldton. Table C8 contains the summary statistics for daily peak 24-hour PM₁₀ in WA.

Table C8: 2017 summary statistics for 24-hour particles as PM₁₀

Regional performance monitoring station	Data availability rates (%)	Highest (µg/m ³)	Highest		AAQ NEPM Standard 50 µg/m ³ (24-hour average)	
			(date)	(time)	6 th Highest (µg/m ³)	6 th Highest (date) (time)
Perth region						
Caversham ¹ (Northeast Metro)	98.6	79.2	01/06/2017	2400	40.0	27/01/2017 2400
Duncraig ¹ (North Metro)	98.4	51.4	07/06/2017	2400	32.1	06/04/2017 2400
South Lake ¹ (Southeast Metro)	98.2	49.6	06/10/2017	2400	34.9	12/11/2017 2400
Southwest region						
Albany ¹	99.5	61.8	04/01/2017	2400	44.8	27/04/2017 2400
Bunbury ¹	99.6	45.5	10/06/2017	2400	34.9	14/05/2017 2400
Collie ¹	96.8	81.5	10/06/2017	2400	54.9	03/05/2017 2400
Midwest region						
Geraldton ¹	99.8	73.5	12/06/2017	2400	41.3	31/03/2017 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 PM₁₀ of 25 micrograms per cubic metre averaged over one year was met at all sites during 2017. Table C9 contains the summary statistics for annual PM₁₀ in WA.

Table C9: 2017 summary statistics for annual particles as PM₁₀

Regional performance monitoring station	Data availability rates (%)	AAQ NEPM standard
		25 µg/m ³ (annual average)
Perth region		
Caversham ¹ (Northeast Metro)	98.6	16.1
Duncraig ¹ (North Metro)	98.4	15.7
South Lake ¹ (Southeast Metro)	98.2	16.7
Southwest region		
Albany ¹	99.5	16.6
Bunbury ¹	99.6	16.5
Collie ¹	96.8	21.7
Midwest region		
Geraldton ¹	99.8	21.3

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

C.6 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 2017. The NEPM goal was met at all sites. Table C10 contains the summary statistics for daily peak 24-hour PM_{2.5} in WA.

Table C10: 2017 summary statistics for 24-hour particles as PM_{2.5}

Regional Performance Monitoring Station	Data availability rates (%)	Highest (µg/m ³)	Highest		AAQ NEPM standard 25 µg/m ³ (24-hour average)		
			(date)	(time)	6 th highest (µg/m ³)	6th highest (date) (time)	
Perth region							
Caversham ¹ (Northeast Metro)	98.7	65.9	01/06/2017	2400	23.0	06/04/2017	2400
Duncraig ¹ (North Metro)	98.5	40.5	07/06/2017	2400	21.1	06/04/2017	2400
Quinns Rocks ¹ (Outer North Coast)	20.7	12.2	15/01/2017	2400	11.0	13/01/2017	2400
South Lake ¹ (Southeast Metro)	98.4	46.6	06/10/2017	2400	21.0	06/04/2017	2400
Southwest region							
Bunbury ¹	99.5	33.9	10/06/2017	2400	25.6	05/11/2017	2400
Busselton ¹	97.8	28.8	13/05/2017	2400	18.4	05/11/2017	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 2017. Table C11 contains the summary statistics for annual PM_{2.5} in WA.

Table C11: 2017 summary statistics for annual particles as PM_{2.5}

Regional performance monitoring station	AAQ NEPM standard 8 µg/m ³ (annual average)	
	Data availability rates (%)	Annual average (µg/m ³)
Perth region		
Caversham ¹ (Northeast Metro)	98.7	8.5
Duncraig ¹ (North Metro)	98.5	8.2
Quinns Rocks ¹ (Outer North Coast)	20.7	7.8
South Lake ¹ (Southeast Metro)	98.4	8.7
Southwest region		
Bunbury ¹	99.5	8.7
Busselton ¹	97.8	8.2

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

D. Data analysis

D.1 Maxima and percentiles by pollutant in 2017

Table D1: 2017 percentiles of daily peak eight-hour carbon monoxide concentrations

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)	AAQ NEPM standard
									9.0 ppm (eight-hour average)
Perth region									
Caversham (Northeast Metro)	97.5	2.9	1.1	0.8	0.5	0.4	0.2	0.1	
Duncraig (North Metro)	96.9	1.4	1.1	0.9	0.8	0.6	0.4	0.3	
South Lake (Southeast Metro)	98.6	1.9	1.4	1.3	1.0	0.7	0.5	0.4	

Table D2: 2017 percentiles of daily peak one-hour nitrogen dioxide concentrations

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)	AAQ NEPM standard
									0.12 ppm (one-hour average)
Perth region									
Caversham (Northeast Metro)	95.3	0.042	0.032	0.031	0.028	0.025	0.019	0.014	
Duncraig (North Metro)	98.2	0.032	0.031	0.030	0.027	0.026	0.021	0.015	
Quinns Rocks (Outer North Coast)	21.5	0.019	0.017	0.016	0.015	0.014	0.010	0.007	
Rockingham (South Coast)	93.4	0.074	0.047	0.034	0.026	0.023	0.017	0.010	
Rolling Green (Outer East Rural)	99.1	0.018	0.017	0.016	0.014	0.013	0.009	0.006	
South Lake (Southeast Metro)	97.3	0.045	0.034	0.030	0.028	0.026	0.021	0.016	
Swanbourne (Inner West Coast)	99.8	0.033	0.032	0.030	0.026	0.022	0.016	0.010	

Table D3: 2017 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)	98.7	0.099	0.077	0.069	0.059	0.049	0.037	0.031
Quinns Rocks (Outer North Coast)	21.5	0.066	0.064	0.061	0.056	0.051	0.045	0.035
Rockingham (South Coast)	99.1	0.069	0.060	0.058	0.051	0.042	0.035	0.032
Rolling Green (Outer East Rural)	98.6	0.069	0.064	0.058	0.052	0.043	0.033	0.029
South Lake (Southeast Metro)	98.5	0.074	0.061	0.058	0.050	0.043	0.035	0.031
Swanbourne (Inner West Coast)	99.5	0.079	0.074	0.064	0.056	0.049	0.040	0.036

Table D4: 2017 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)	98.7	0.077	0.068	0.060	0.050	0.044	0.034	0.029
Quinns Rocks (Outer North Coast)	21.5	0.062	0.058	0.054	0.049	0.047	0.040	0.033
Rockingham (South Coast)	99.1	0.062	0.057	0.053	0.046	0.039	0.034	0.030
Rolling Green (Outer East Rural)	98.6	0.064	0.057	0.051	0.045	0.039	0.031	0.028
South Lake (Southeast Metro)	98.5	0.067	0.055	0.052	0.045	0.038	0.033	0.029
Swanbourne (Inner West Coast)	99.5	0.070	0.060	0.057	0.051	0.046	0.039	0.035

Table D5: 2017 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)	95.8	0.030	0.024	0.017	0.012	0.008	0.004	0.002
South Lake (Southeast Metro)	95.2	0.037	0.023	0.019	0.017	0.013	0.006	0.004
Wattleup (South Metro)	96.3	0.068	0.051	0.036	0.026	0.021	0.011	0.003

Table D6: 2017 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)	95.8	0.009	0.004	0.003	0.003	0.002	0.001	0.001
South Lake (Southeast Metro)	95.2	0.009	0.008	0.008	0.006	0.005	0.003	0.002
Wattleup (South Metro)	96.3	0.007	0.005	0.005	0.004	0.003	0.002	0.001

Table D7: 2017 percentiles of daily peak 24-hour particles as PM_{10} concentrations

Regional performance monitoring station	Data availability rates (%)	Max conc. ($\mu\text{g}/\text{m}^3$)	99 th percentile ($\mu\text{g}/\text{m}^3$)	98 th percentile ($\mu\text{g}/\text{m}^3$)	95 th percentile ($\mu\text{g}/\text{m}^3$)	AAQ NEPM standard 50 $\mu\text{g}/\text{m}^3$ (24-hour average)		
						90 th percentile ($\mu\text{g}/\text{m}^3$)	75 th percentile ($\mu\text{g}/\text{m}^3$)	50 th percentile ($\mu\text{g}/\text{m}^3$)
Perth region								
Caversham (Northeast Metro)	98.6	79.2	43.3	32.6	27.8	25.0	19.6	14.8
Duncraig (North Metro)	98.4	51.4	33.4	30.1	26.4	22.5	19.2	14.8
South Lake (Southeast Metro)	98.2	49.6	37.7	31.3	28.6	26.2	20.6	15.9
Southwest region								
Albany	99.5	61.8	46.7	41.4	30.7	25.8	19.8	14.6
Bunbury	99.6	45.5	36.1	32.9	27.8	24.5	20.1	15.9
Collie	96.8	81.5	56.3	53.7	42.5	33.7	25.6	20.1
Midwest region								
Geraldton	99.8	73.5	44.3	40.0	36.9	33.7	27.8	19.9

Bold numerals indicate where a relevant standard has been exceeded.

Table D8: 2017 percentiles of daily peak 24-hour particles as $PM_{2.5}$ concentrations

Regional performance monitoring station	Data availability rates (%)	Max conc. ($\mu\text{g}/\text{m}^3$)	99 th percentile ($\mu\text{g}/\text{m}^3$)	98 th percentile ($\mu\text{g}/\text{m}^3$)	95 th percentile ($\mu\text{g}/\text{m}^3$)	AAQ NEPM standard 25 $\mu\text{g}/\text{m}^3$ (24-hour average)		
						90 th percentile ($\mu\text{g}/\text{m}^3$)	75 th percentile ($\mu\text{g}/\text{m}^3$)	50 th percentile ($\mu\text{g}/\text{m}^3$)
Perth region								
Caversham (Northeast Metro)	98.7	65.9	31.3	21.8	15.7	11.8	9.3	7.5
Duncraig (North Metro)	98.5	40.5	22.9	19.0	14.2	11.5	9.3	7.6
Quinns Rocks (Outer North Coast)	20.7	12.2	12.2	11.8	11.1	10.8	9.5	7.6
South Lake (Southeast Metro)	98.4	46.6	24.2	19.8	14.5	12.8	10.1	7.8
Southwest region								
Bunbury	99.5	33.9	27.2	21.5	14.3	12.7	9.8	7.7
Busselton	97.8	28.8	22.8	18.0	14.9	12.2	9.5	7.3

Bold numerals indicate where a relevant standard has been exceeded.

D.2 Maxima and percentiles by site 2008 - 2017

*Table D9: Daily peak eight-hour carbon monoxide at Caversham (2008–2017)
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)
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
2017	97.5	0	2.9	1.1	0.8	0.5	0.4

*Table D10: Daily peak eight-hour carbon monoxide at Duncraig (2008–2017)
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)
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
2017	96.9	0	1.4	1.1	0.9	0.8	0.6

Table D11: Daily peak eight-hour carbon monoxide at South Lake (2008–2017)
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)
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
2017	98.6	0	1.9	1.4	1.3	1.0	0.7

Table D12: Daily peak one-hour nitrogen dioxide at Caversham (2008–2017)
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)
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
2017	95.3	0	0.042	0.032	0.031	0.028	0.025

Table D13: Daily peak one-hour nitrogen dioxide at Duncraig (2008–2017)
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)
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
2017	98.2	0	0.032	0.031	0.030	0.027	0.026

Table D14: Daily peak one-hour nitrogen dioxide at Quinns Rocks (2008–2017)
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)
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
2017	21.5	0	0.019	0.017	0.016	0.015	0.014

Table D15: Daily peak one-hour nitrogen dioxide at Rockingham (2008–2017)
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)
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
2017	93.4	0	0.074	0.047	0.034	0.026	0.023

Table D16: Daily peak one-hour nitrogen dioxide at Rolling Green (2008–2017)
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)
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
2017	99.1	0	0.018	0.017	0.016	0.014	0.013

Table D17: Daily peak one-hour nitrogen dioxide at South Lake (2008–2017)
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)
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
2017	97.3	0	0.045	0.034	0.030	0.028	0.026

Table D18: Daily peak one-hour nitrogen dioxide at Swanbourne (2008–2017)
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)
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
2017	99.8	0	0.033	0.032	0.030	0.026	0.022

Table D19: Daily peak one-hour ozone at Caversham (2008–2017)
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)
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
2017	98.7	0	0.099	0.077	0.069	0.059	0.049

Bold numerals indicate where a relevant standard has been exceeded

Table D20: Daily peak one-hour ozone at Quinns Rocks (2008–2017)
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)
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
2017	21.5	0	0.066	0.064	0.061	0.056	0.051

Table D21: Daily peak one-hour ozone at Rockingham (2008–2017)
 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)
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
2017	99.1	0	0.069	0.060	0.058	0.051	0.042

Table D22: Daily peak one-hour ozone at Rolling Green (2008–2017)
 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)
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
2017	98.6	0	0.069	0.064	0.058	0.052	0.043

Bold numerals indicate where a relevant standard has been exceeded

Table D23: Daily peak one-hour ozone at South Lake (2008–2017)
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)
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
2017	98.5	0	0.074	0.061	0.058	0.050	0.043

Table D24: Daily peak one-hour ozone at Swanbourne (2008–2017)
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)
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
2017	99.5	0	0.079	0.074	0.064	0.056	0.049

Bold numerals indicate where a relevant standard has been exceeded

Table D25: Daily peak four-hour ozone at Caversham (2008–2017)
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)
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
2017	98.7	0	0.077	0.068	0.060	0.050	0.044

Bold numerals indicate where a relevant standard has been exceeded

Table D26: Daily peak four-hour ozone at Quinns Rocks (2008–2017)
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)
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
2017	21.5	0	0.062	0.058	0.054	0.049	0.047

Bold numerals indicate where a relevant standard has been exceeded

Table D27: Daily peak four-hour ozone at Rockingham (2008–2017)
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)
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
2017	99.1	0	0.062	0.057	0.053	0.046	0.039

Table D28: Daily peak four-hour ozone at Rolling Green (2008–2017)
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)
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
2017	98.6	0	0.064	0.057	0.051	0.045	0.039

Bold numerals indicate where a relevant standard has been exceeded

Table D29: Daily peak four-hour ozone at South Lake (2008–2017)
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)
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
2017	98.5	0	0.067	0.055	0.052	0.045	0.038

Table D30: Daily peak four-hour ozone at Swanbourne (2008–2017)
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)
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
2017	99.5	0	0.070	0.060	0.057	0.051	0.046

Bold numerals indicate where a relevant standard has been exceeded

Table D31: Daily peak one-hour sulfur dioxide at Rockingham (2008–2017)
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)
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
2017	95.8	0	0.030	0.024	0.017	0.012	0.008

Table D32: Daily peak one-hour sulfur dioxide at South Lake (2008–2017)
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)
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
2017	95.2	0	0.037	0.023	0.019	0.017	0.013

Table D33: Daily peak one-hour sulfur dioxide at Wattleup (2008–2017)
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)
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
2017	96.3	0	0.068	0.051	0.036	0.026	0.021

Table D34: Daily peak 24-hour sulfur dioxide at Rockingham (2008–2017)
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)
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
2017	95.8	0	0.009	0.004	0.003	0.003	0.002

Table D35: Daily peak 24-hour sulfur dioxide at South Lake (2008–2017)
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)
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
2017	95.2	0	0.009	0.008	0.008	0.006	0.005

Table D36: Daily peak 24-hour sulfur dioxide at Wattleup (2008–2017)
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)
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
2017	96.3	0	0.007	0.005	0.005	0.004	0.003

Table D37: Daily peak 24-hour particles as PM₁₀ at Caversham (2008–2017)
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)
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
2017	98.6	3	79.2	43.3	32.6	27.8	25.0

Bold numerals indicate where a relevant standard has been exceeded

Table D38: Daily peak 24-hour particles as PM₁₀ at Duncraig (2008–2017)
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)
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
2017	98.4	1	51.4	33.4	30.1	26.4	22.5

Bold numerals indicate where a relevant standard has been exceeded

Table D39: Daily peak 24-hour particles as PM₁₀ at South Lake (2008–2017)
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)
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
2017	98.2	0	49.6	37.7	31.3	28.6	26.2

Bold numerals indicate where a relevant standard has been exceeded

Table D40: Daily peak 24-hour particles as PM₁₀ at Albany (2008–2017)
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)
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
2017	99.5	2	61.8	46.7	41.4	30.7	25.8

Bold numerals indicate where a relevant standard has been exceeded

Table D41: Daily peak 24-hour particles as PM₁₀ at Bunbury (2008–2017)
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)
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
2017	99.6	0	45.5	36.1	32.9	27.8	24.5

Bold numerals indicate where a relevant standard has been exceeded

Table D42: Daily peak 24-hour particles as PM₁₀ at Collie (2008–2017)
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)
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
2017	96.8	11	81.5	56.3	53.7	42.5	33.7

Bold numerals indicate where a relevant standard has been exceeded.

Table D43: Daily peak 24-hour particles as PM₁₀ at Geraldton (2008–2017)
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)
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
2017	99.8	3	73.5	44.3	40.0	36.9	33.7

Bold numerals indicate where a relevant standard has been exceeded

Table D44: Daily peak 24-hour particles as PM_{2.5} at Caversham (2008–2017)
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)
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
2017	98.7	5	65.9	31.3	21.8	15.7	11.8

Bold numerals indicate where a relevant standard has been exceeded

Table D45: Daily peak 24-hour particles as PM_{2.5} at Duncraig (2008–2017)
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)
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
2017	98.5	3	40.5	22.9	19.0	14.2	11.5

Bold numerals indicate where a relevant standard has been exceeded

Table D46: Daily peak 24-hour particles as PM_{2.5} at Quinns Rocks (2008–2017)
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)
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
2017	20.7	0	12.2	12.2	11.8	11.1	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 (2008–2017)
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)
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
2017	98.4	3	46.6	24.2	19.8	14.5	12.8

Bold numerals indicate where a relevant standard has been exceeded

Table D48: Daily peak 24-hour particles as PM_{2.5} at Bunbury (2008–2017)
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)
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
2017	99.5	6	33.9	27.2	21.5	14.3	12.7

Bold numerals indicate where a relevant standard has been exceeded

Table D49: Daily peak 24-hour particles as PM_{2.5} at Busselton (2008–2017)
Trend station/region: Busselton

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

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (µg/m ³)	98th percentile (µg/m ³)	95th percentile (µg/m ³)	90th percentile (µg/m ³)
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
2017	97.8	1	28.8	22.8	18.0	14.9	12.2

Bold numerals indicate where a relevant standard has been exceeded

D.3 Maxima by pollutant 2008 - 2017

Table D50: Annual daily peak eight-hour carbon monoxide concentrations (ppm) for 2008–2017

Regional performance monitoring station	AAQ NEPM standard 9.0 ppm (eight-hour average)									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Perth region										
Caversham (Northeast Metro)	0.8	1.0	1.6	1.5	0.9	0.9	0.7	1.2	0.9	2.9
Duncraig (North Metro)	3.1	2.6	2.3	1.9	2.4	2.1	1.9	1.7	1.4	1.4
South Lake (Southeast Metro)	2.0	1.8	2.2	1.7	2.2	1.7	1.8	1.9	2.3	1.9

Table D51: Annual daily peak one-hour nitrogen dioxide concentrations (ppm) for 2008–2017

Regional performance monitoring station	AAQ NEPM standard 0.12 ppm (one-hour average)									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Perth region										
Caversham (Northeast Metro)	0.036	0.044	0.054	0.035	0.037	0.043	0.033	0.041	0.036	0.042
Duncraig (North Metro)	0.038	0.042	0.038	0.035	0.047	0.040	0.048	0.036	0.033	0.032
Quinns Rocks (Outer North Coast)	0.037	0.034	0.040	0.031	0.041	0.032	0.031	0.030	0.029	0.019
Rockingham (South Coast)	0.031	0.031	0.036	0.034	0.053	0.035	0.034	0.062	0.029	0.074
Rolling Green (Outer East Rural)	0.023	0.035	0.030	0.023	0.029	0.030	0.021	0.023	0.023	0.018
South Lake (South East Metro)	0.044	0.048	0.058	0.041	0.046	0.043	0.034	0.043	0.038	0.045
Swanbourne (Inner West Coast)	0.035	0.037	0.038	0.032	0.045	0.037	0.036	0.036	0.030	0.033

Table D52: Annual daily peak one-hour ozone concentrations (ppm) for 2008–2017

AAQ NEPM standard
0.10 ppm (one-hour average)

Regional performance monitoring station	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Perth region										
Caversham (Northeast Metro)	0.083	0.104	0.082	0.077	0.098	0.101	0.091	0.103	0.096	0.099
Quinns Rocks (Outer North Coast)	0.083	0.070	0.091	0.083	0.130	0.087	0.073	0.083	0.089	0.066
Rockingham (South Coast)	0.077	0.078	0.067	0.065	0.095	0.084	0.076	0.069	0.087	0.069
Rolling Green (Outer East Rural)	0.087	0.103	0.088	0.073	0.103	0.099	0.080	0.105	0.075	0.069
South Lake (South East Metro)	0.082	0.065	0.070	0.076	0.085	0.087	0.065	0.067	0.091	0.074
Swanbourne (Inner West Coast)	0.076	0.068	0.066	0.085	0.128	0.083	0.066	0.074	0.103	0.079

Bold numerals indicate where a relevant standard has been exceeded

Table D53: Annual daily peak four-hour ozone concentrations (ppm) for 2008–2017

AAQ NEPM standard
0.08 ppm (one-hour average)

Regional performance monitoring station	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Perth region										
Caversham (Northeast Metro)	0.076	0.092	0.072	0.063	0.086	0.075	0.073	0.084	0.085	0.077
Quinns Rocks (Outer North Coast)	0.073	0.062	0.065	0.075	0.108	0.079	0.062	0.071	0.079	0.062
Rockingham (South Coast)	0.072	0.066	0.064	0.061	0.079	0.075	0.067	0.064	0.079	0.062
Rolling Green (Outer East Rural)	0.075	0.083	0.080	0.061	0.081	0.083	0.070	0.093	0.066	0.064
South Lake (South East Metro)	0.067	0.057	0.061	0.064	0.080	0.074	0.058	0.060	0.080	0.067
Swanbourne (Inner West Coast)	0.070	0.063	0.055	0.073	0.108	0.068	0.057	0.067	0.081	0.070

Bold numerals indicate where a relevant standard has been exceeded

Table D54: Annual daily peak one-hour sulfur dioxide concentrations (ppm) for 2008–2017

Regional performance monitoring station	AAQ NEPM standard 0.20 ppm (one-hour average)									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Perth region										
Rockingham (South Coast)	0.079	0.032	0.037	0.040	0.040	0.037	0.036	0.051	0.064	0.030
South Lake (South East Metro)	0.046	0.036	0.073	0.044	0.039	0.044	0.051	0.037	0.034	0.037
Wattleup (South Metro)	0.077	0.059	0.057	0.067	0.043	0.090	0.061	0.067	0.072	0.068

Table D55: Annual daily peak one-hour sulfur dioxide concentrations (ppm) for 2008–2017

Regional performance monitoring station	AAQ NEPM standard 0.08 ppm (one-hour average)									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Perth region										
Rockingham (South Coast)	0.007	0.008	0.007	0.008	0.006	0.007	0.007	0.013	0.014	0.009
South Lake (South East Metro)	0.005	0.006	0.009	0.006	0.006	0.014	0.010	0.007	0.010	0.009
Wattleup (South Metro)	0.011	0.008	0.010	0.008	0.008	0.010	0.008	0.009	0.011	0.007

Table D56: Annual daily peak 24-hour particles as PM₁₀ concentrations (µg/m³) for 2008–2017

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

Regional performance monitoring station	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Perth region										
Caversham (Northeast Metro)	39.1	45.7	63.4	76.1	68.7	62.4	52.6	46.8	38.1	79.2
Duncraig (North Metro)	46.9	45.5	47.9	65.9	89.5	37.6	53.0	82.7	40.0	51.4
South Lake (Southeast Metro)	55.0	49.0	61.0	66.2	81.5	38.8	44.5	53.3	47.0	49.6
Southwest region										
Bunbury	39.1	53.8	134.0	68.4	53.5	46.8	44.5	62.9	74.6	45.5
Collie	85.9	80.4	163.0	61.5	91.7	61.6	73.3	111.9	89.9	81.5
Albany	56.3	36.7	52.5	37.3	37.0	110.8	43.5	76.7	94.9	61.8
Midwest region										
Geraldton	150.7	128.9	55.6	63.0	61.5	63.1	55.7	68.1	66.0	73.5

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 2008–2017

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

Regional performance monitoring station	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Perth region										
Caversham (Northeast Metro)	26.3	25.5	45.2	41.5	45.9	22.6	39.3	30.0	24.1	65.9
Duncraig (North Metro)	38.3	32.7	36.4	52.1	77.3	18.7	47.6	35.8	27.0	40.5
Quinns Rocks (Outer North Coast)	53.3	31.3	33.7	43.2	74.5	19.3	39.5	37.9	28.8	12.2
South Lake (Southeast Metro)	45.2	32.0	40.0	48.2	71.6	17.1	29.8	34.5	30.4	46.6
Southwest region										
Bunbury	27.8	40.0	115.3	45.5	43.0	38.3	34.6	52.1	61.5	33.9
Busselton	35.6	69.0	62.5	85.2	78.0	17.9	25.1	37.8	61.1	28.8

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 PM_{10} concentrations ($\mu\text{g}/\text{m}^3$) for 2008–2017

Regional performance monitoring station	AAQ NEPM standard $25 \mu\text{g}/\text{m}^3$ (annual average)									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Perth region										
Caversham (Northeast Metro)	14.5	17.1	17.0	16.2	16.8	15.4	17.4	16.7	15.0	16.1
Duncraig (North Metro)	15.0	15.9	15.8	15.3	16.2	15.5	15.5	16.5	14.4	15.7
South Lake (Southeast Metro)	16.3	17.7	19.0	16.3	16.9	16.6	17.4	17.9	15.8	16.7
Southwest region										
Bunbury	15.8	17.6	17.6	17.0	17.5	16.8	16.1	17.5	16.5	16.5
Collie	19.2	20.0	22.8	19.6	20.0	20.1	19.2	22.4	19.3	21.7
Albany	14.6	14.3	15.9	14.5	15.0	15.4	16.0	15.9	17.5	16.6
Midwest region										
Geraldton	22.4	23.9	21.7	19.6	21.3	20.9	22.3	20.2	18.8	21.3

Table D59: Annual averaged particles as $PM_{2.5}$ concentrations ($\mu\text{g}/\text{m}^3$) for 2008–2017

Regional performance monitoring station	AAQ NEPM standard $8 \mu\text{g}/\text{m}^3$ (annual average)									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Perth region										
Caversham (Northeast Metro)	7.1	7.8	8.2	7.0	7.8	7.9	8.1	8.5	7.7	8.5
Duncraig (North Metro)	7.7	8.2	8.2	7.8	8.2	7.6	7.6	8.4	7.5	8.2
Quinns Rocks (Outer North Coast)	7.2	7.8	7.8	7.2	7.9	7.8	8.0	8.3	7.5	7.8
South Lake (Southeast Metro)	7.7	8.2	8.7	7.8	8.9	8.0	8.1	8.8	8.0	8.7
Southwest region										
Bunbury	7.6	8.3	9.2	8.0	8.6	7.8	7.8	9.3	8.4	8.7
Busselton	7.3	9.0	8.5	8.5	8.6	7.7	7.2	8.6	8.1	8.2

Bold numerals indicate where a relevant standard has been exceeded.

E. 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)

E.1 Carbon monoxide

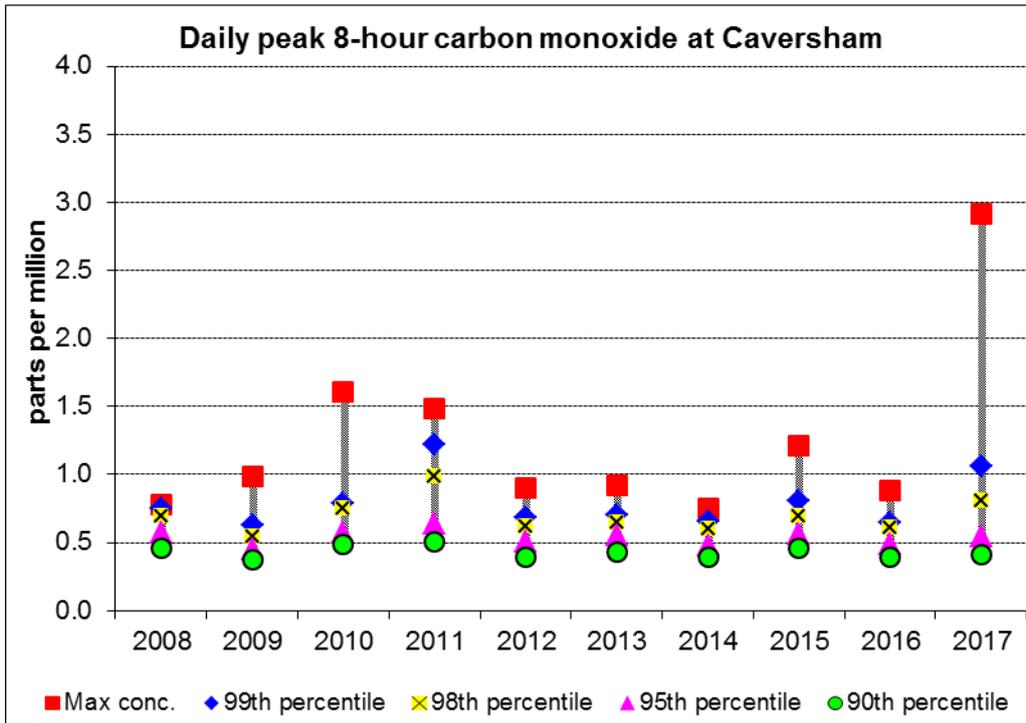


Figure E1-1 – eight-hour carbon monoxide at Caversham

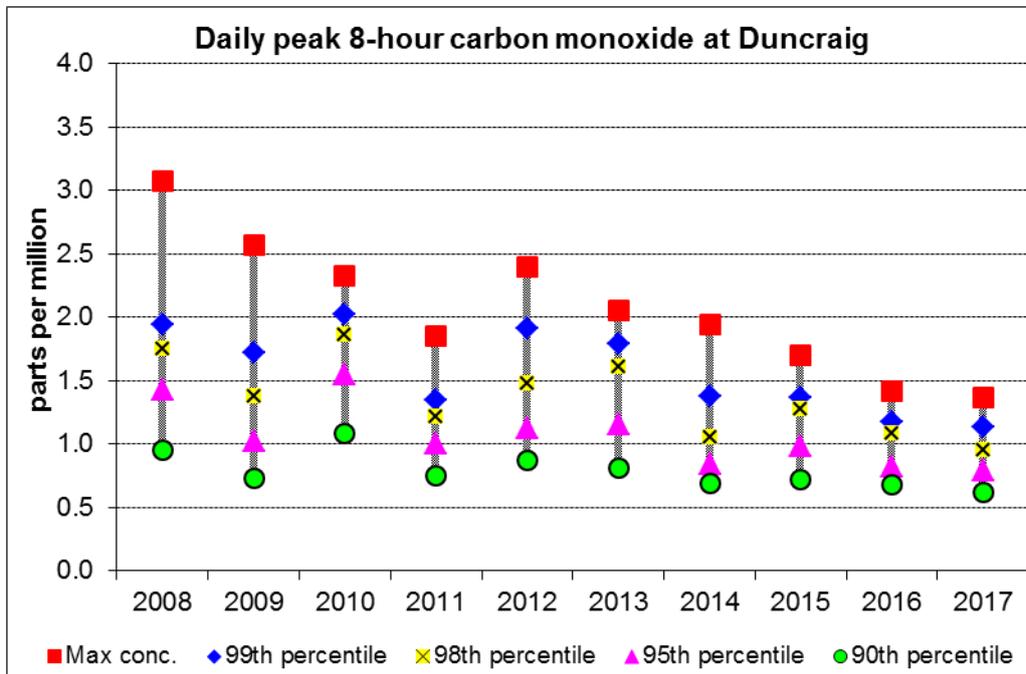


Figure E1-2 – eight-hour carbon monoxide at Duncraig

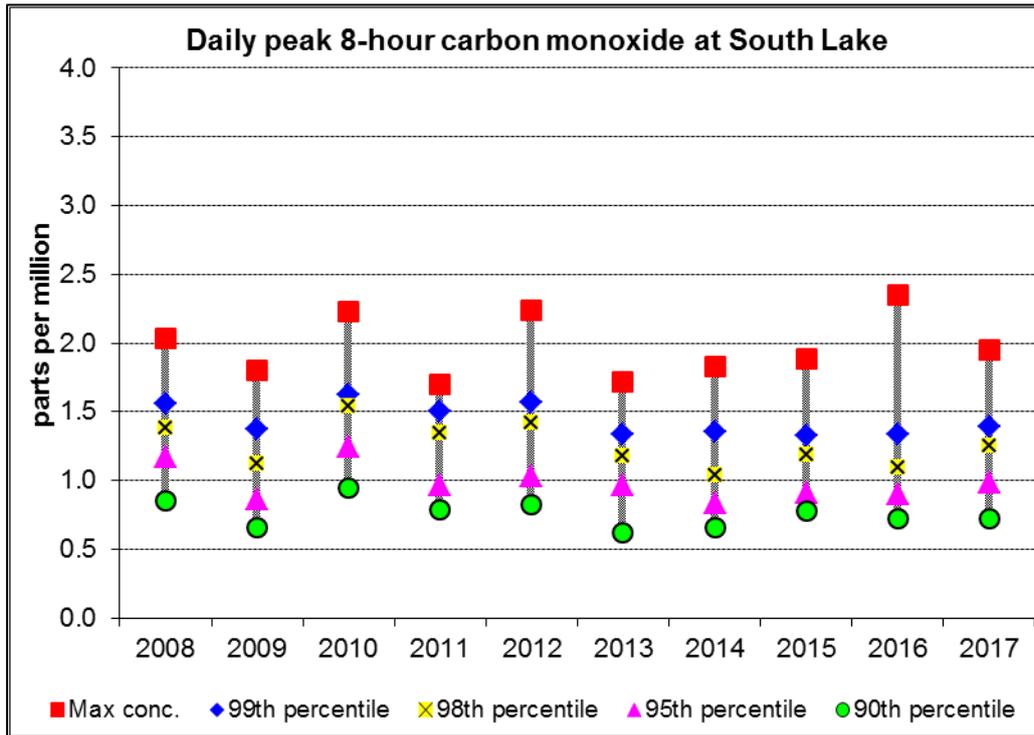


Figure E1-3 – eight-hour carbon monoxide at South Lake

E.2 Nitrogen dioxide

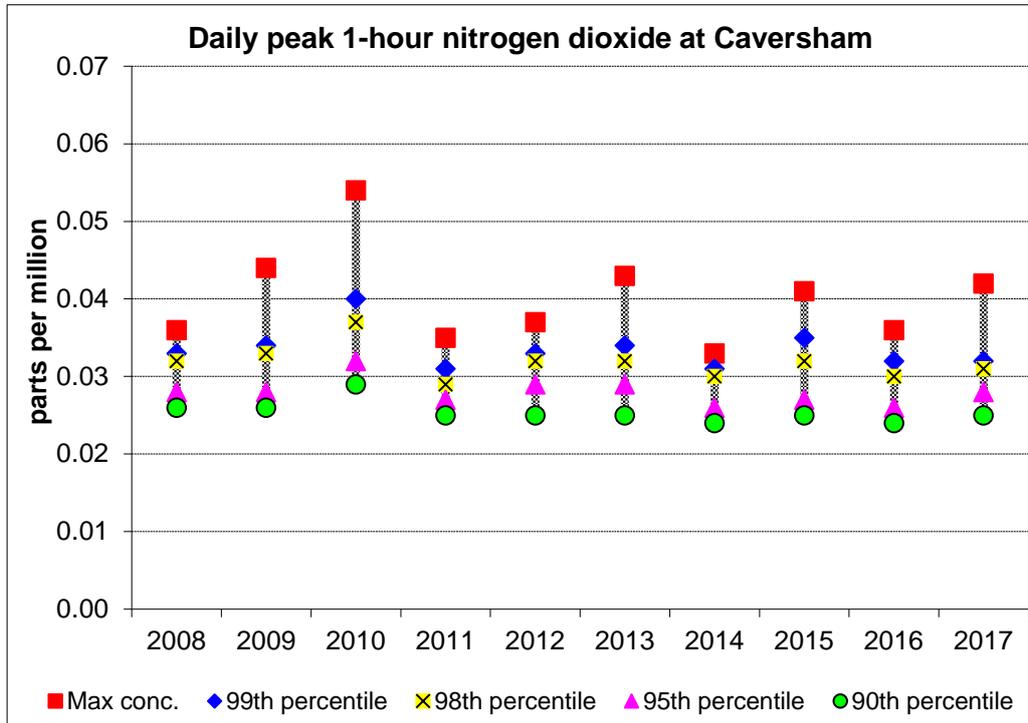


Figure E2-1 – one-hour nitrogen dioxide at Caversham

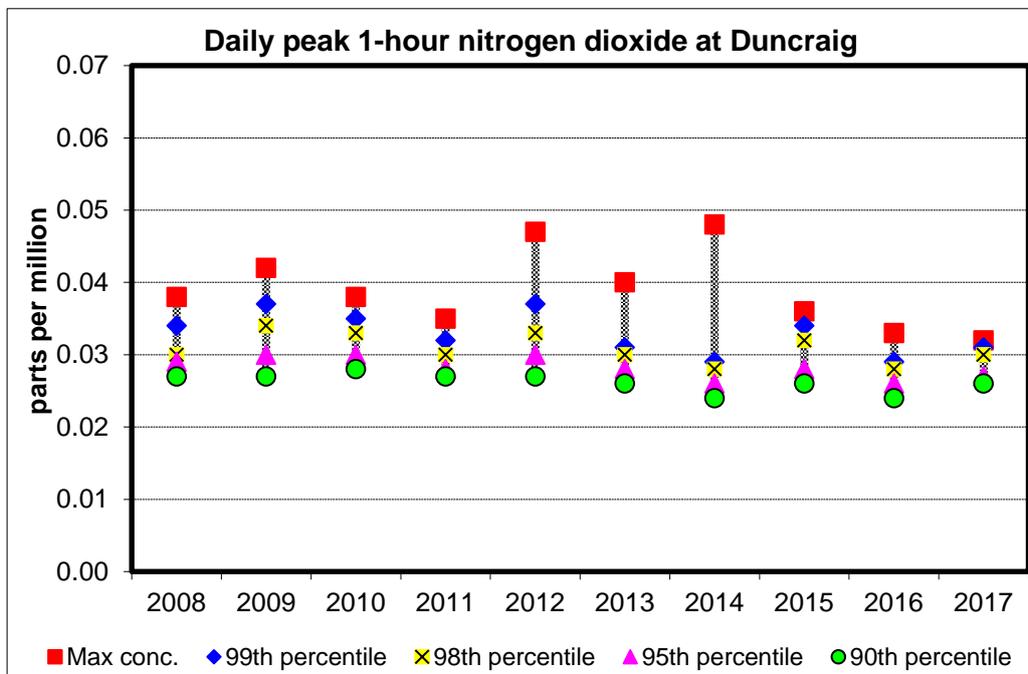


Figure E2-2 – one-hour nitrogen dioxide at Duncraig

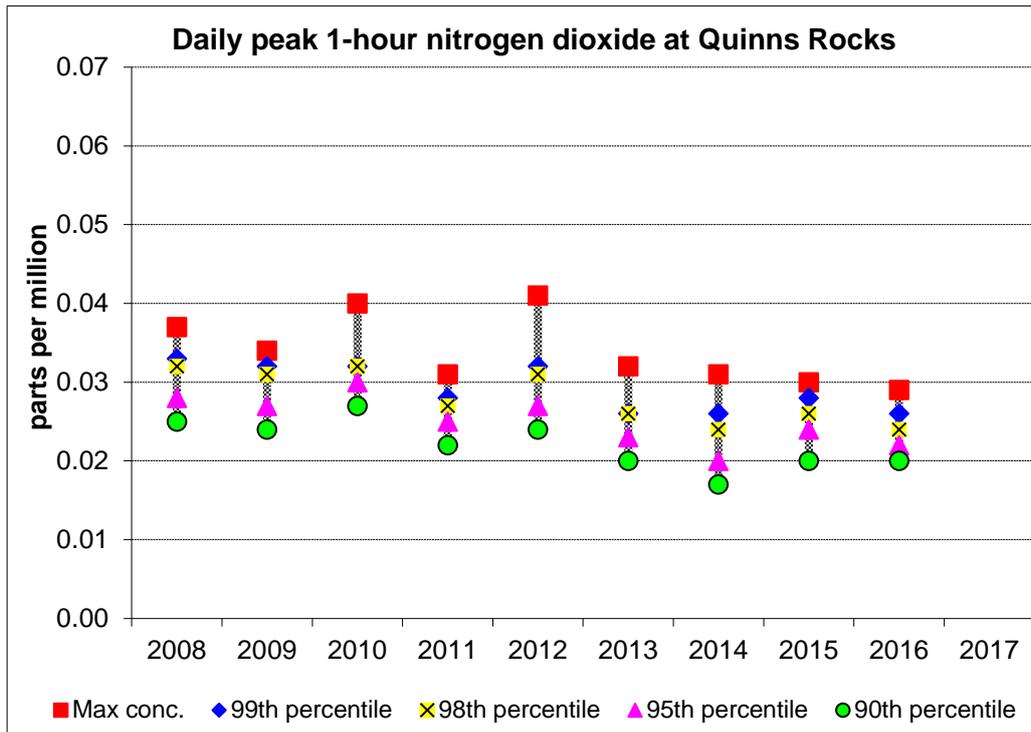


Figure E2-3 – one-hour nitrogen dioxide at Quinns Rocks (2017 not included)

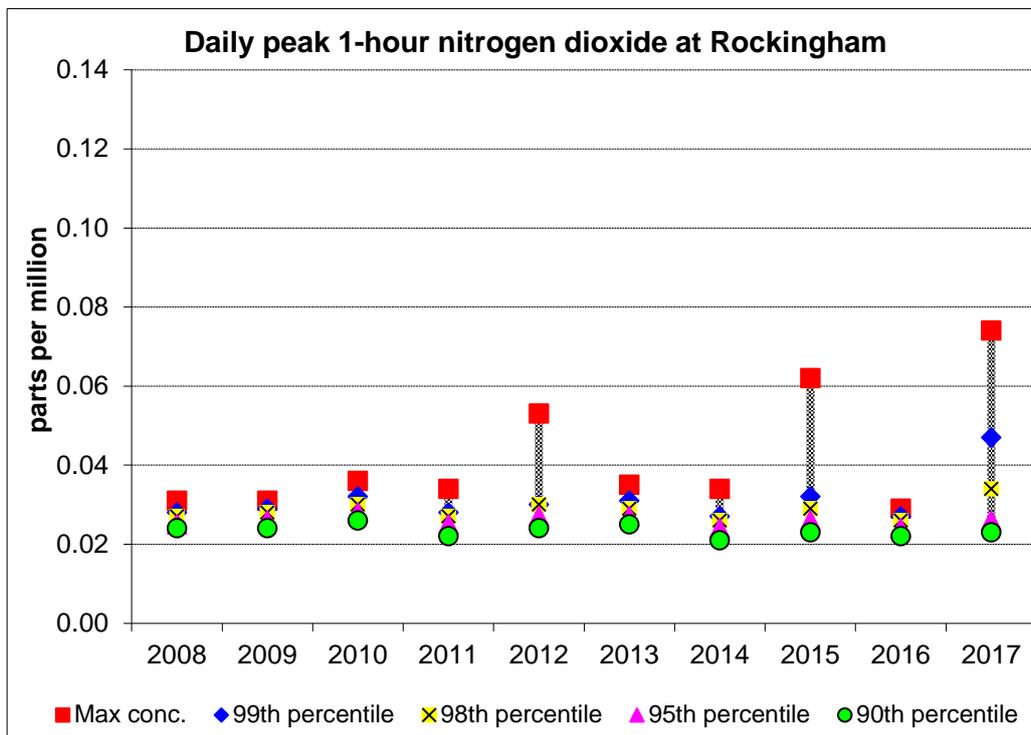


Figure E2-4 – one-hour nitrogen dioxide at Rockingham

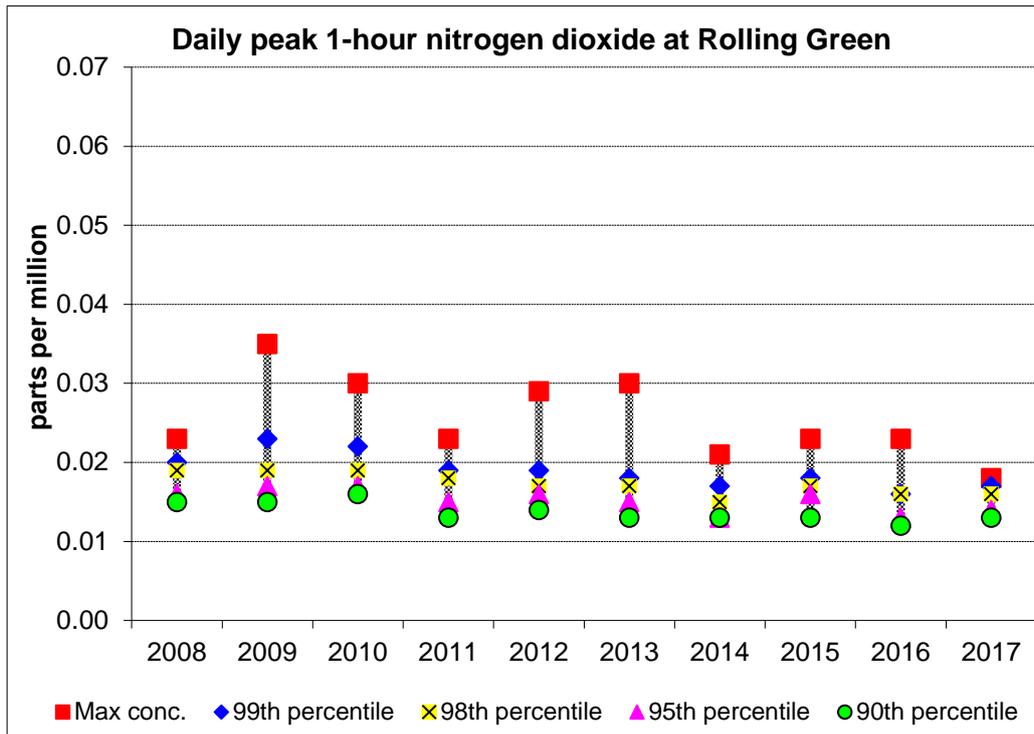


Figure E2-5 – one-hour nitrogen dioxide at Rolling Green

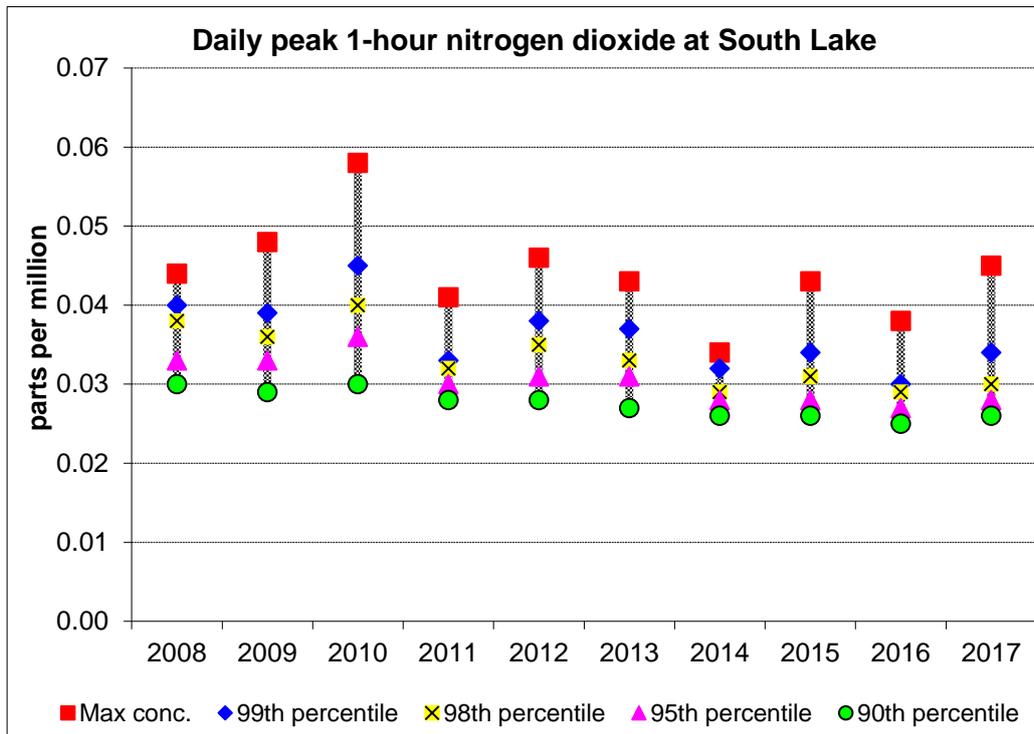


Figure E2-6 – one-hour nitrogen dioxide at South Lake

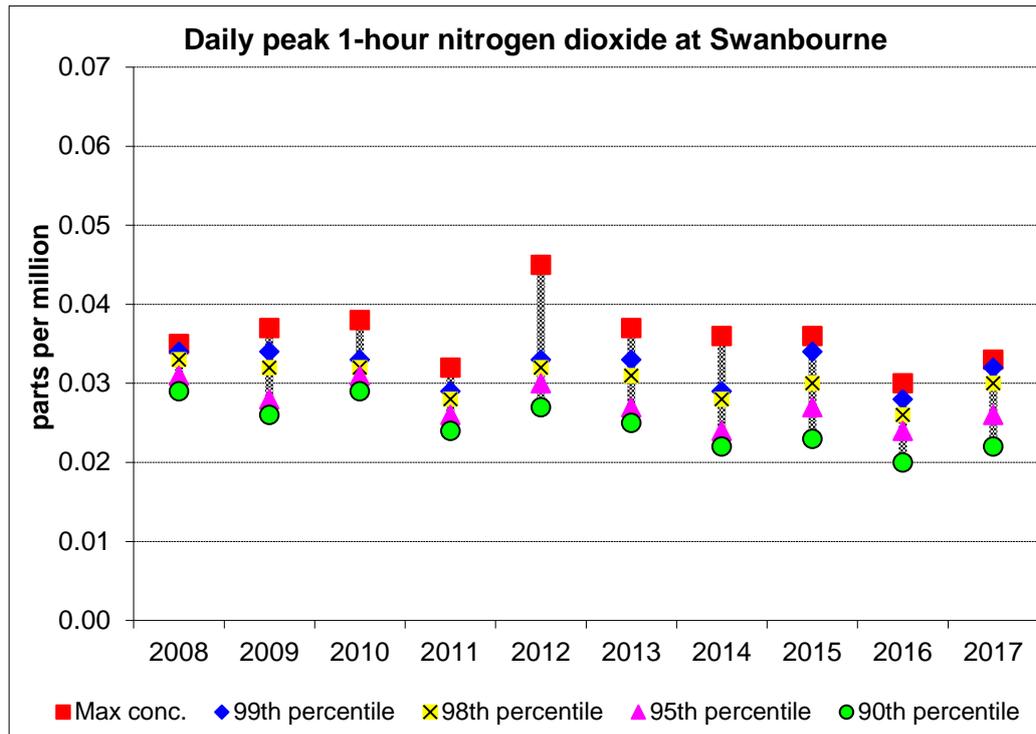


Figure E2-7 – one-hour nitrogen dioxide at Swanbourne

E.3 Ozone

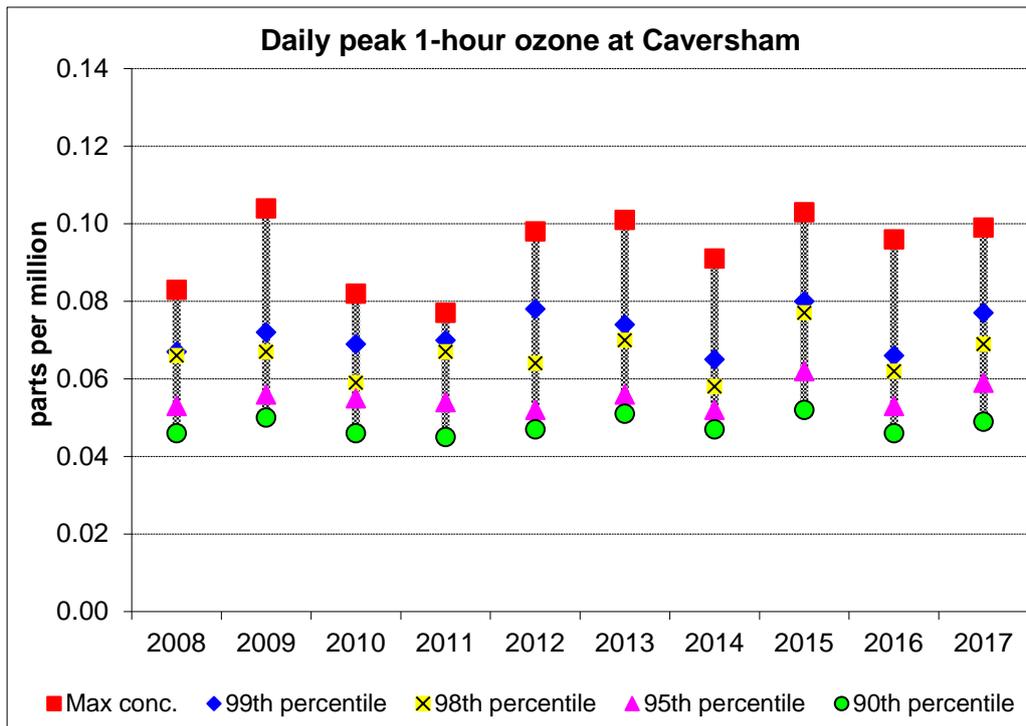


Figure E3-1 – one-hour ozone at Caversham

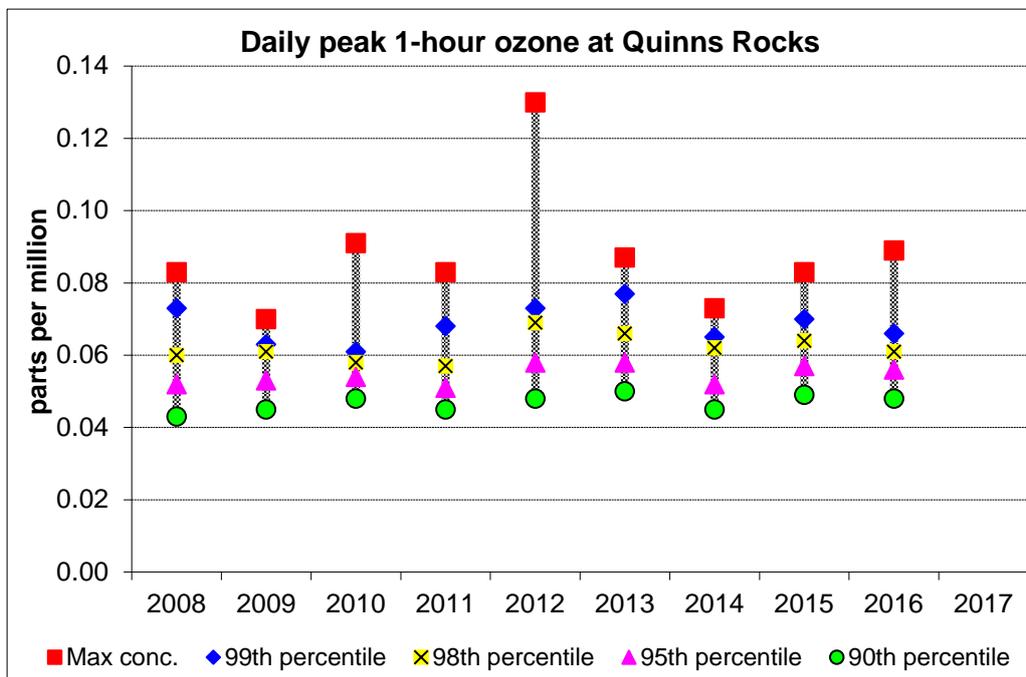


Figure E3-2 – one-hour ozone at Quinns Rocks (2017 not included)

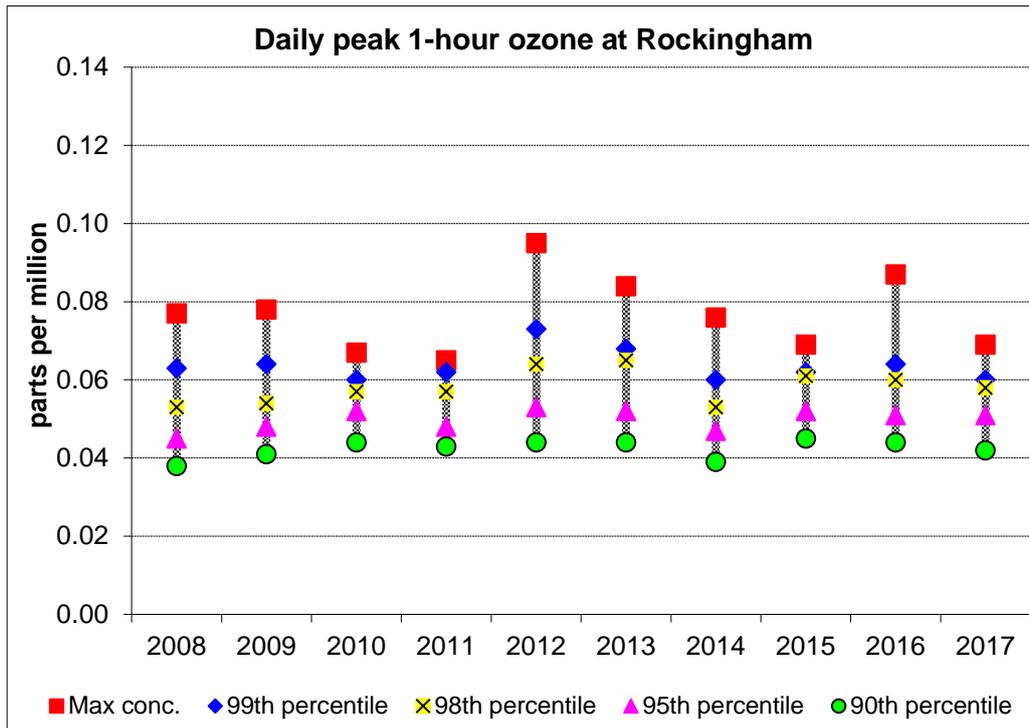


Figure E3-3 – one-hour ozone at Rockingham

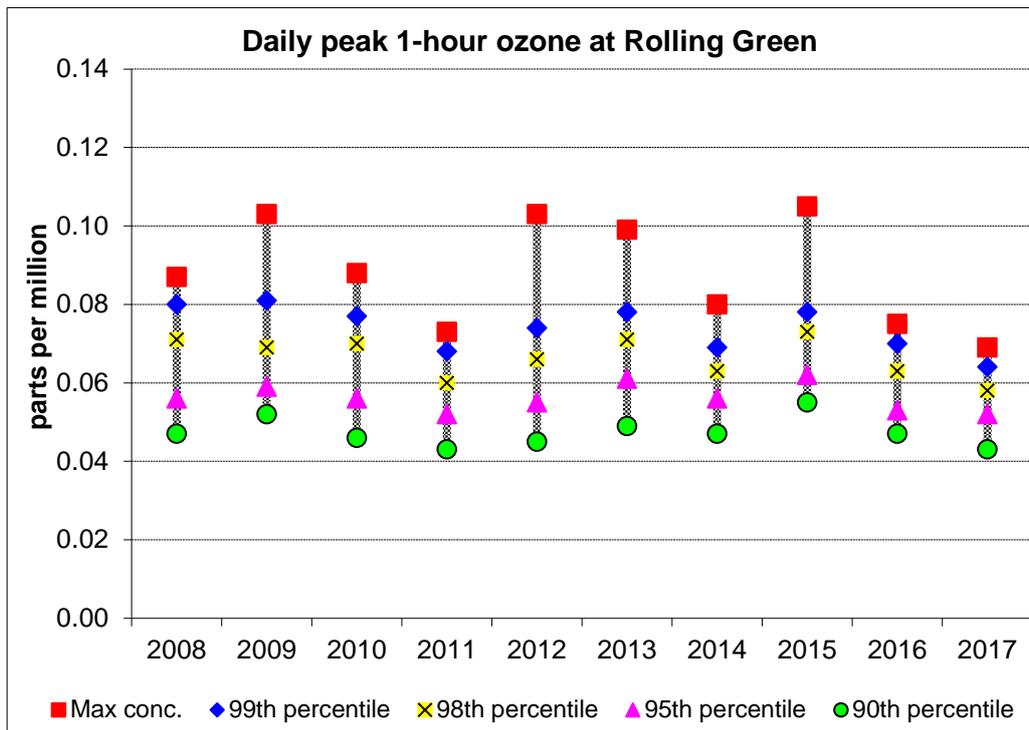


Figure E3-4 – one-hour ozone at Rolling Green

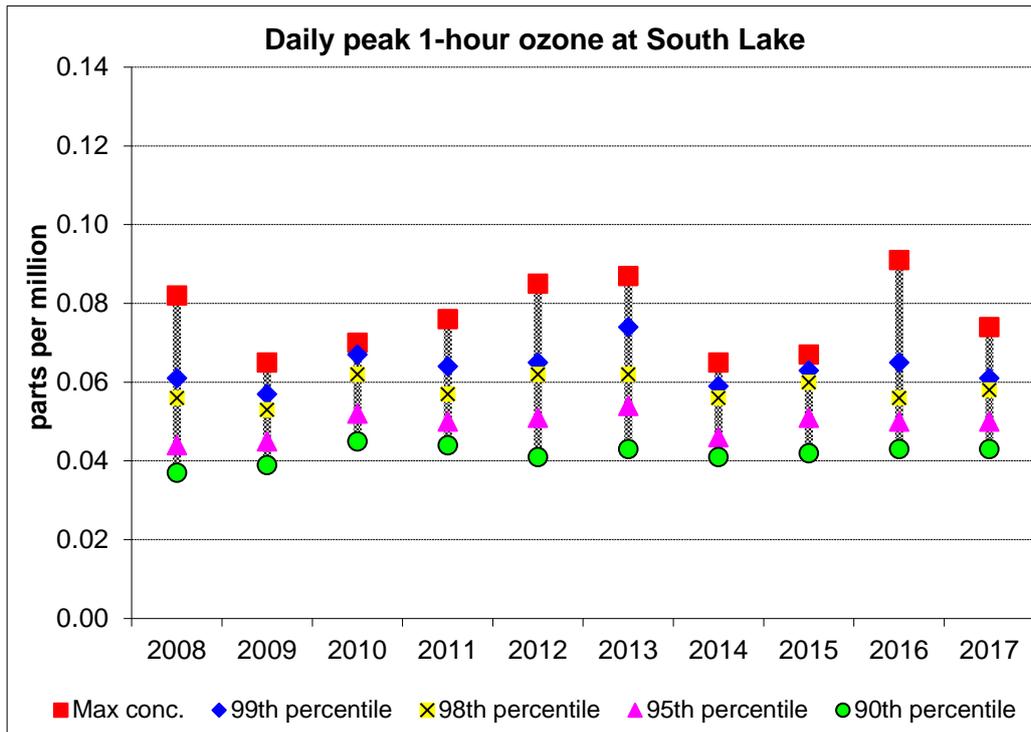


Figure E3-5 – one-hour ozone at South Lake

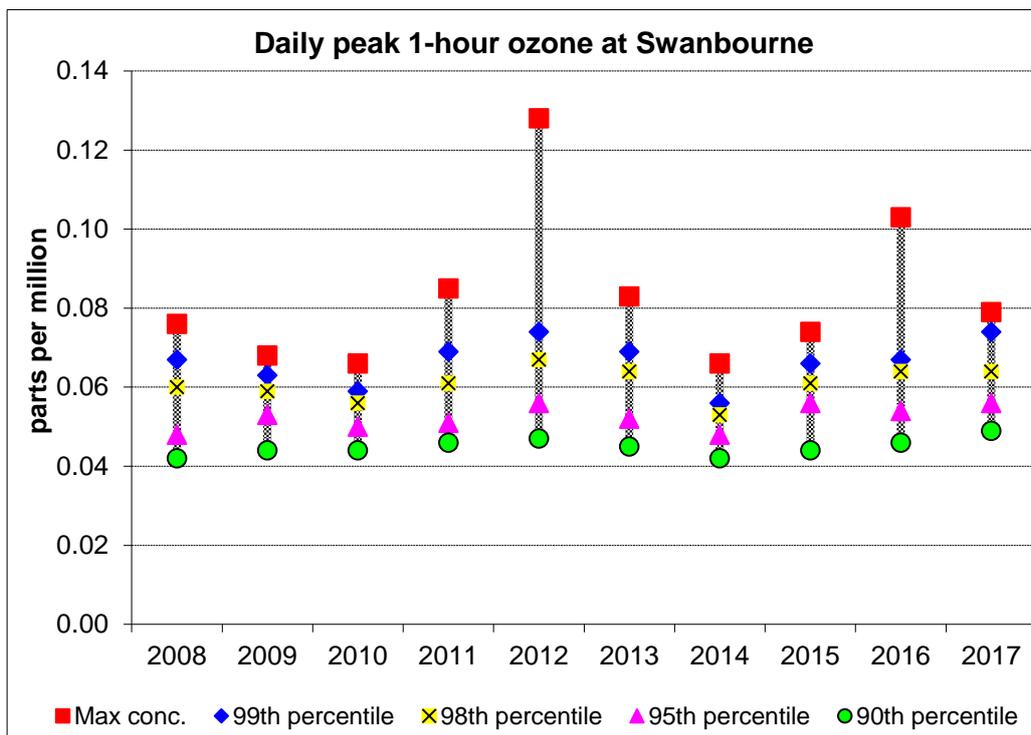


Figure E3-6 – one-hour ozone at Swanbourne

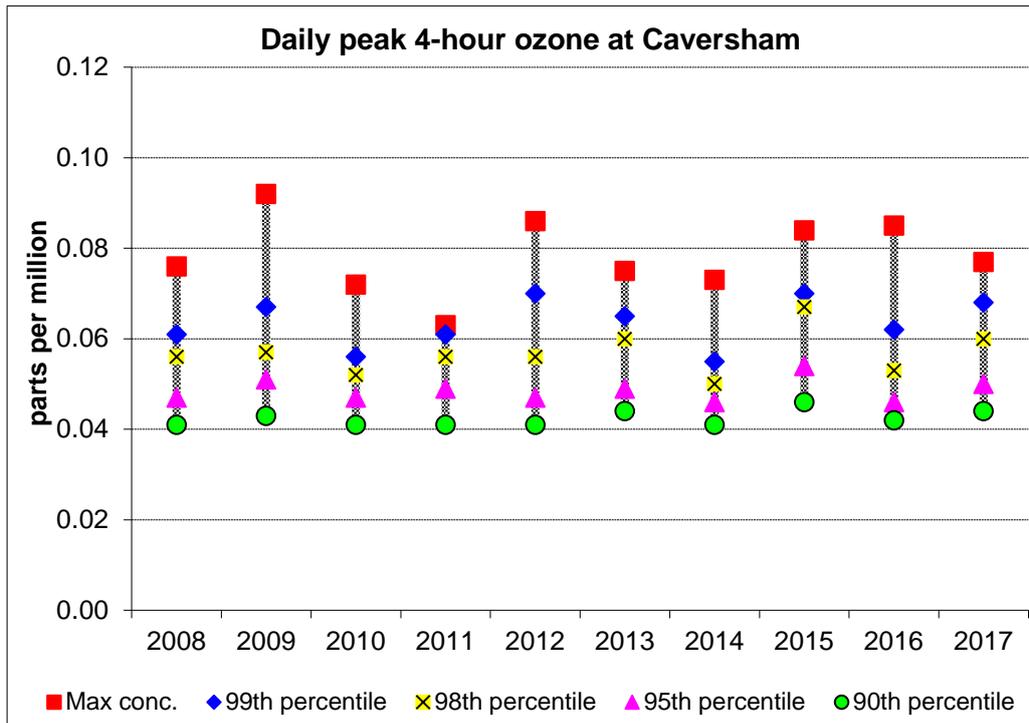


Figure E3-7 – four-hour ozone at Caversham

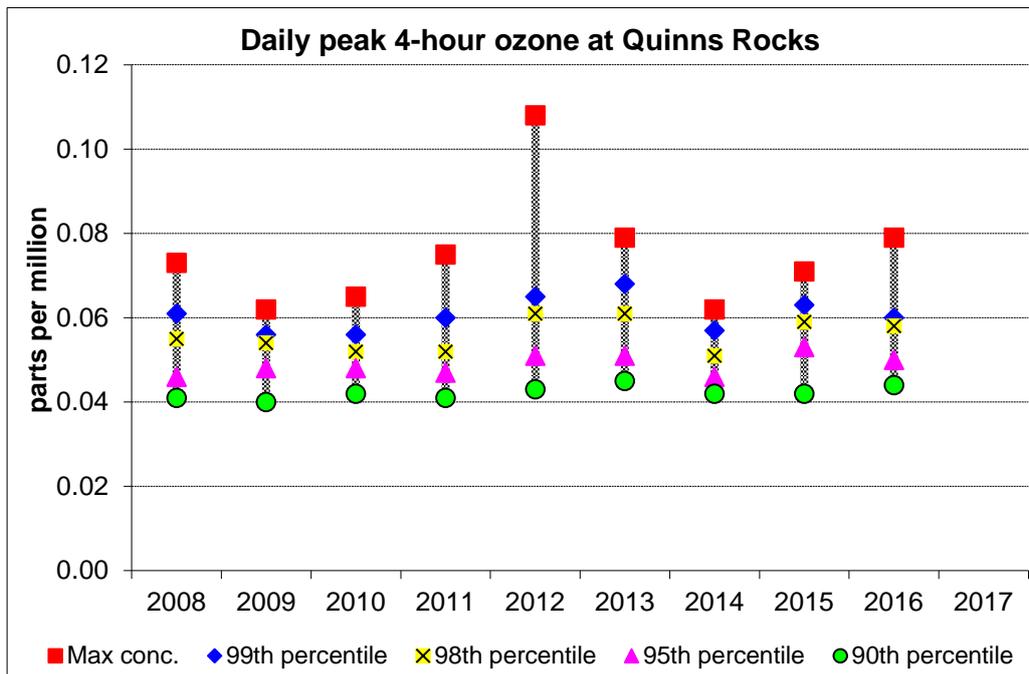


Figure E3-8 – four-hour ozone at Quinns Rocks (2017 not included)

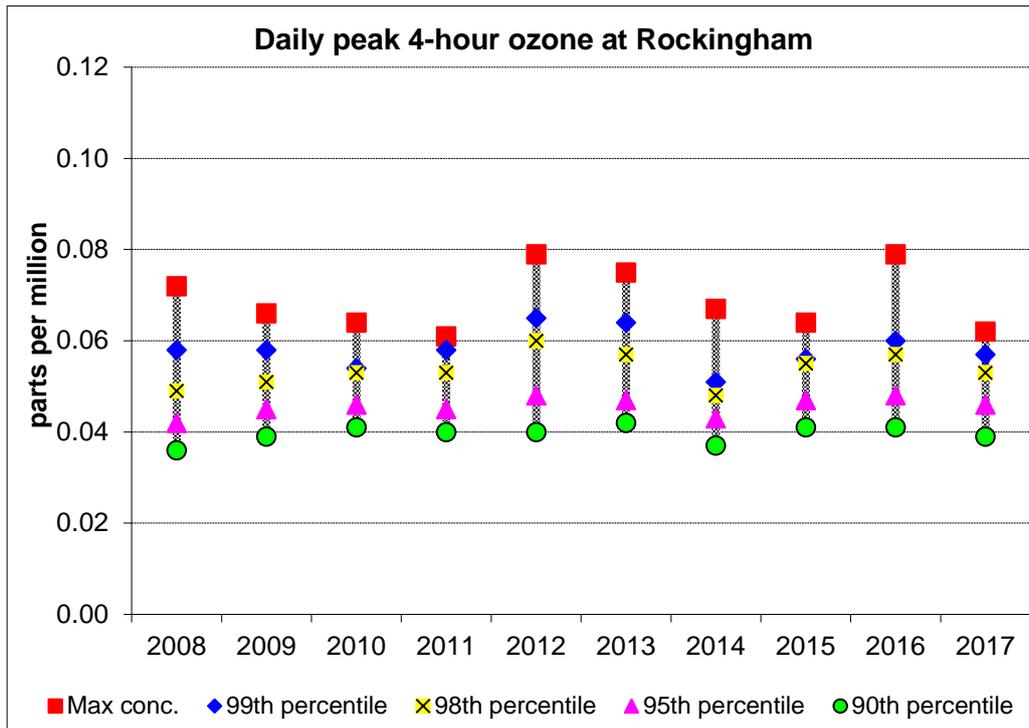


Figure E3-9 – four-hour ozone at Rockingham

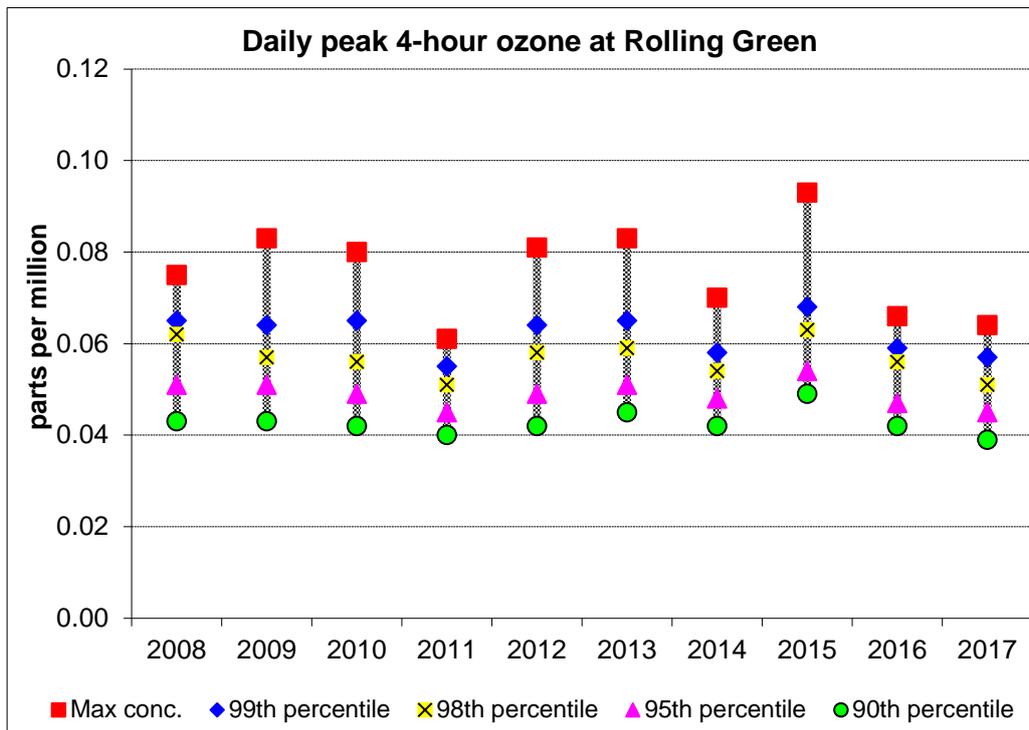


Figure E3-10 – four-hour ozone at Rolling Green

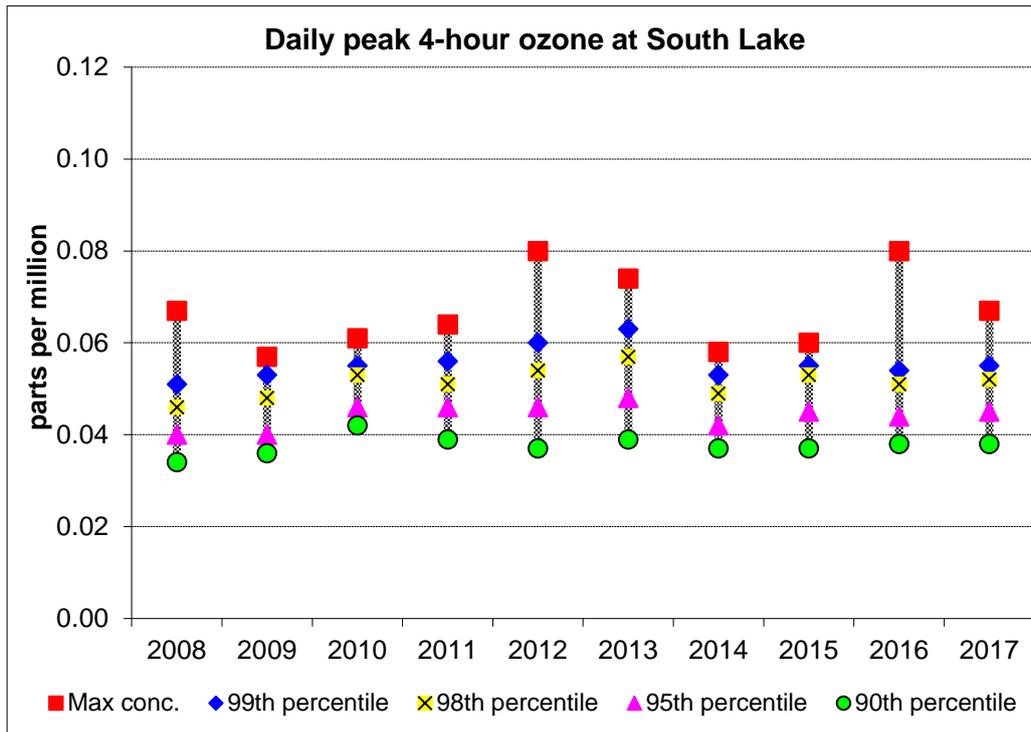


Figure E3-11 – four-hour ozone at South Lake

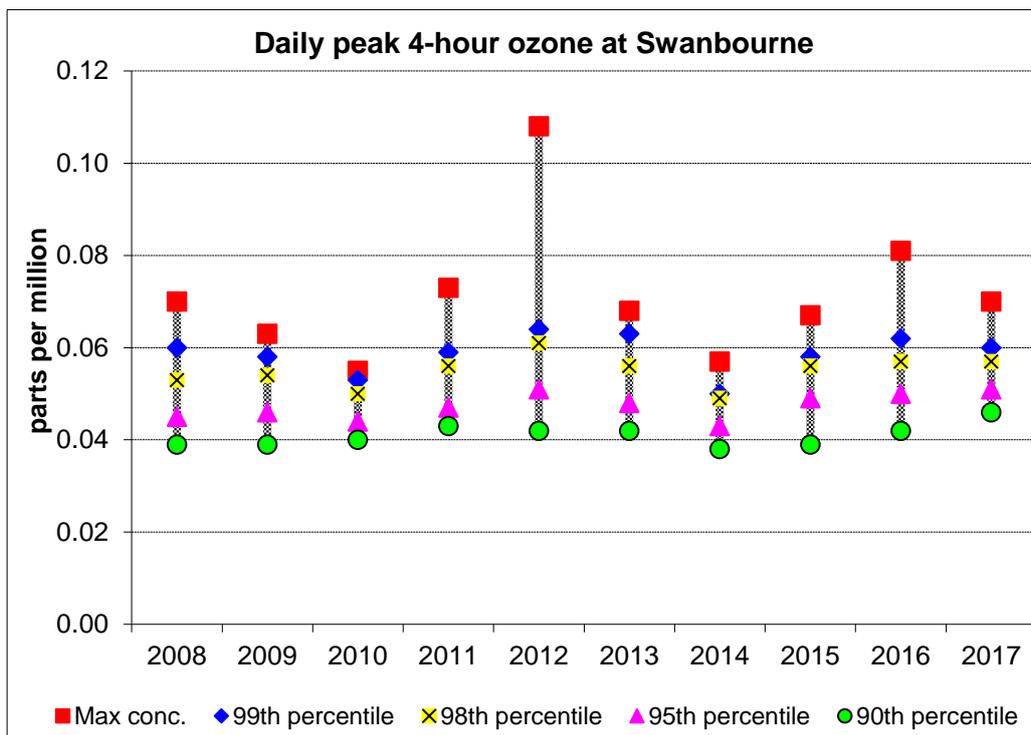


Figure E3-12 – four-hour ozone at Swanbourne

E.4 Sulfur dioxide

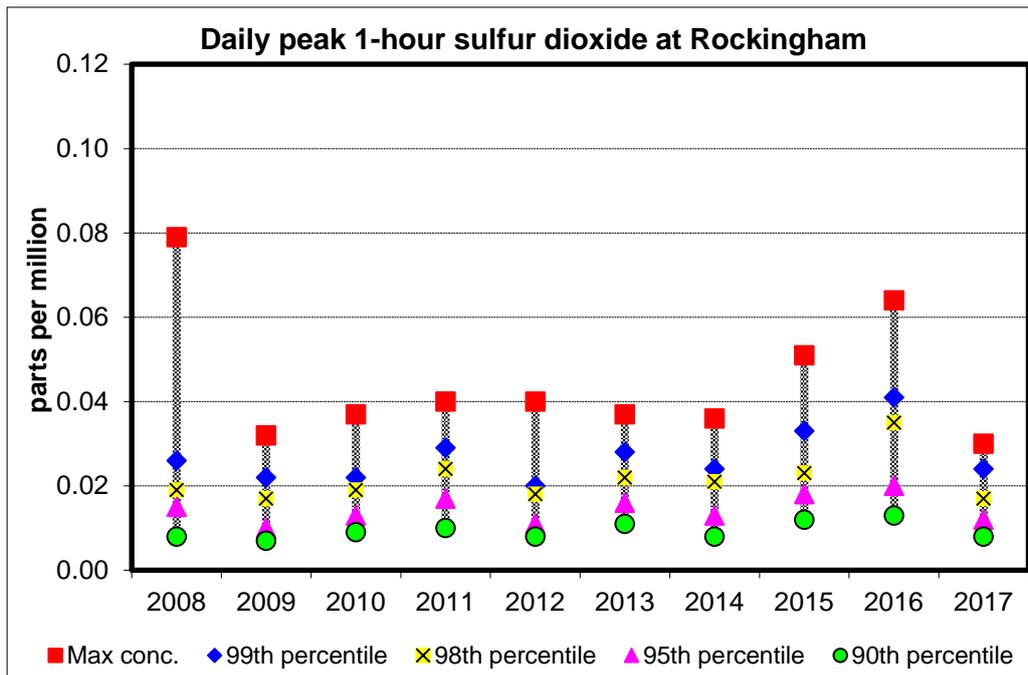


Figure E4-1 – one-hour sulfur dioxide at Rockingham

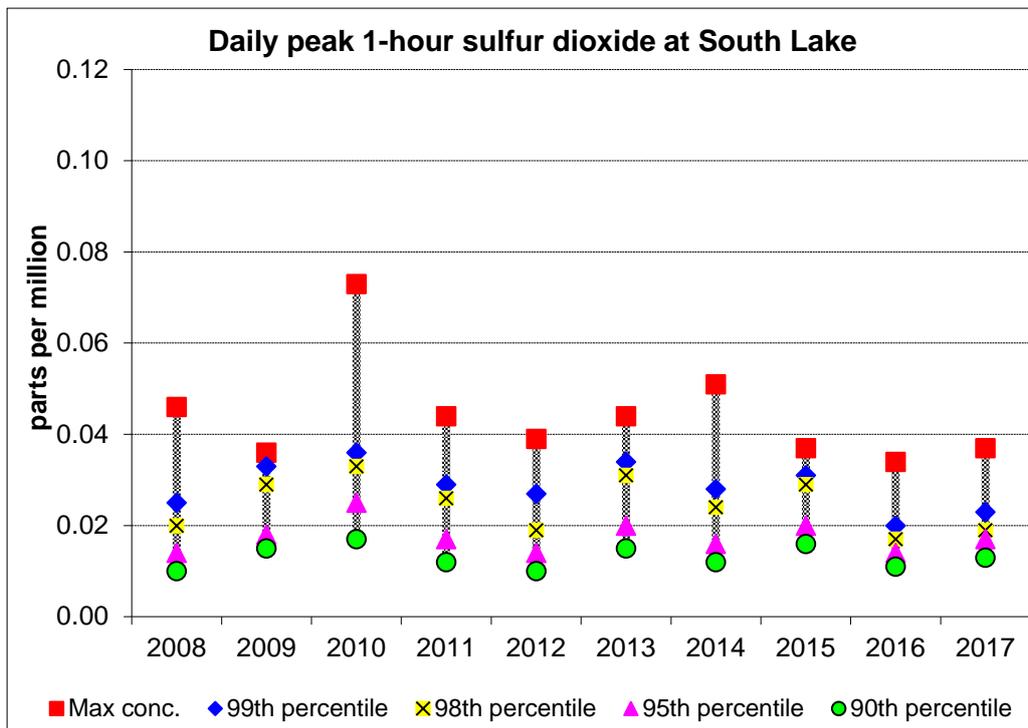


Figure E4-2 – one-hour sulfur dioxide at South Lake

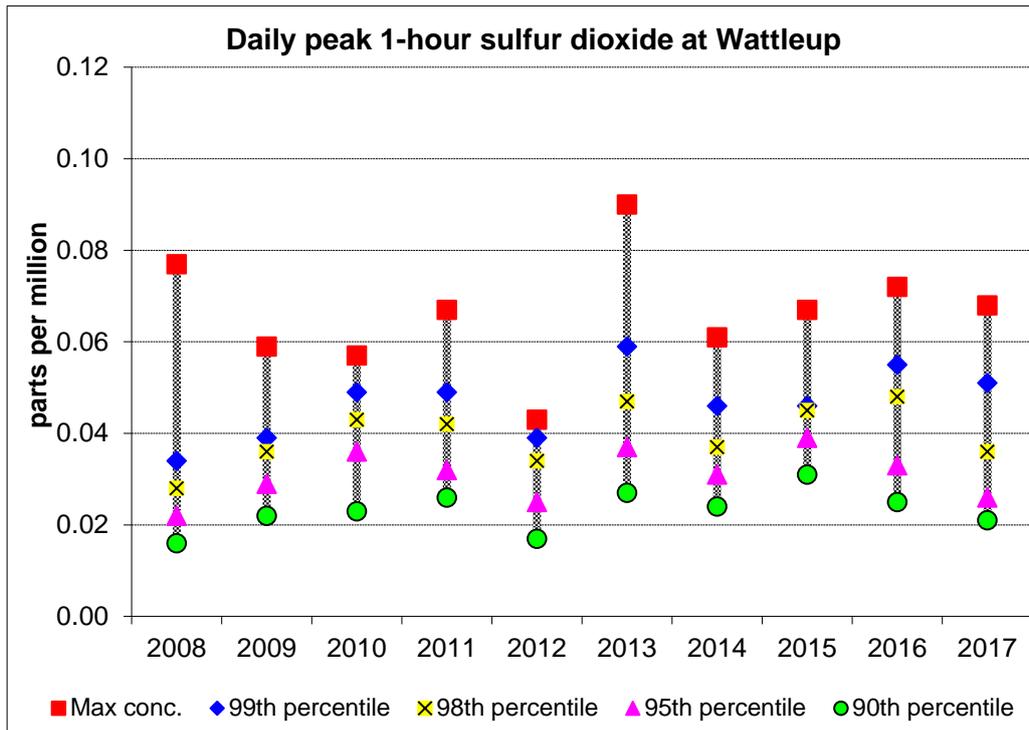


Figure E4-3 – one-hour sulfur dioxide at Wattleup

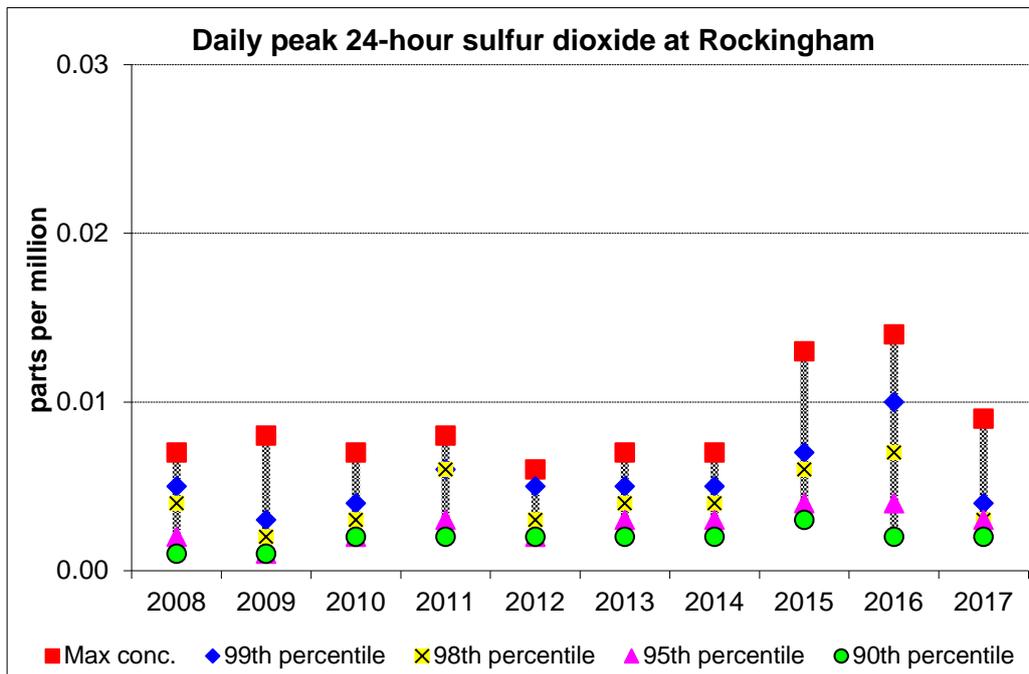


Figure E4-4 – 24-hour sulfur dioxide at Rockingham

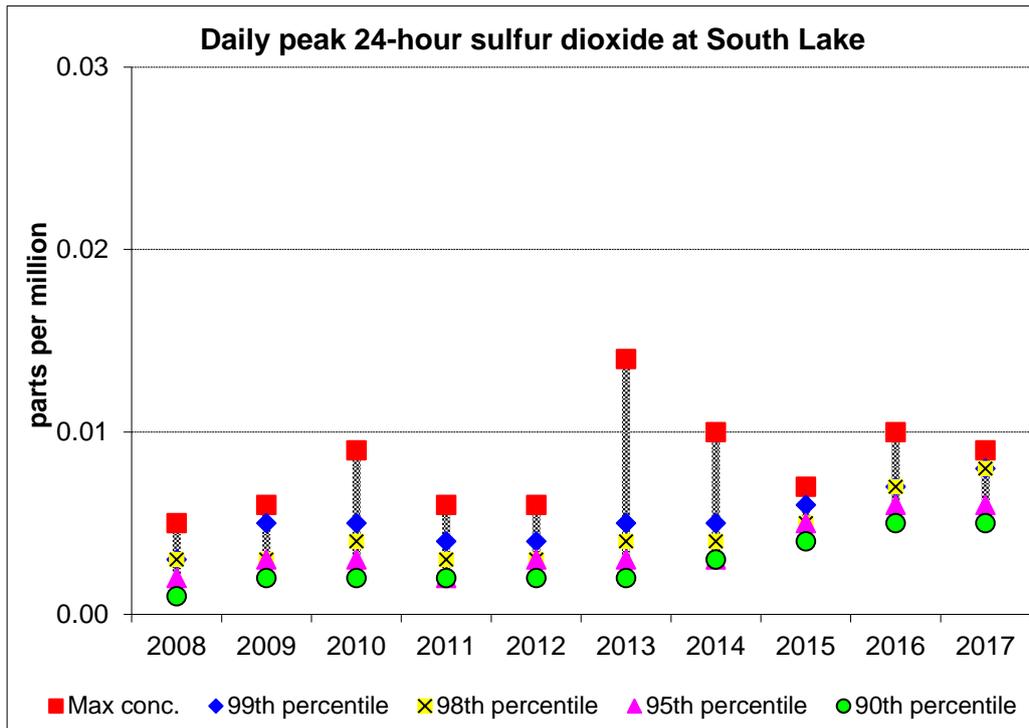


Figure E4-5 – 24-hour sulfur dioxide at South Lake

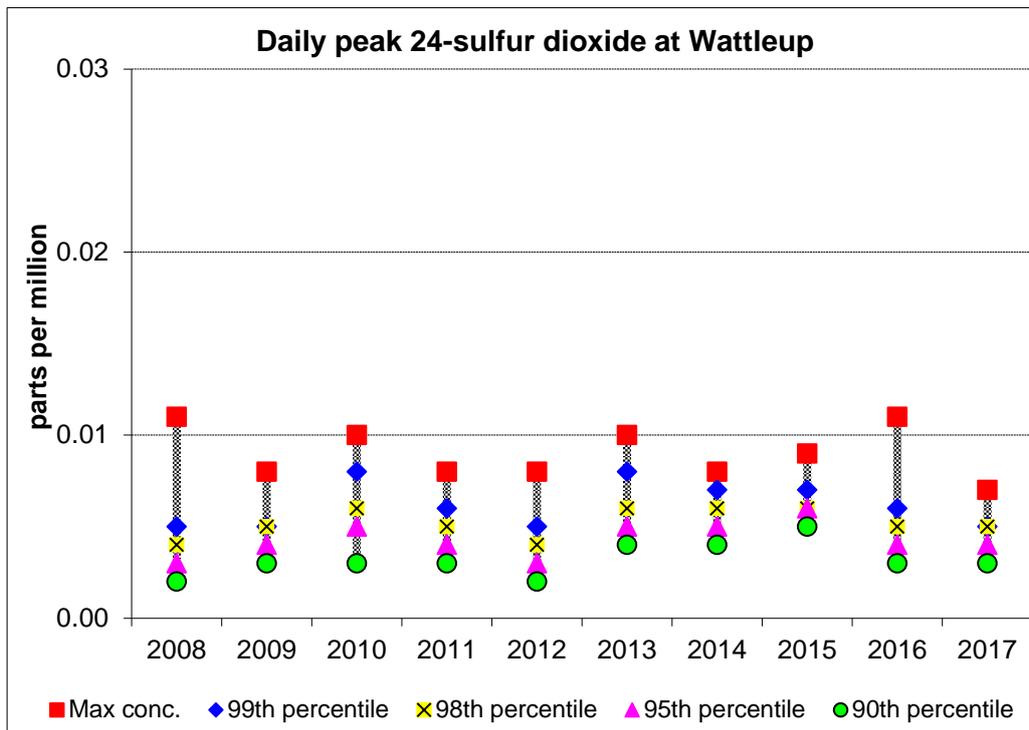


Figure E4-6 – 24-hour sulfur dioxide at Wattleup

E.5 Particles as PM10

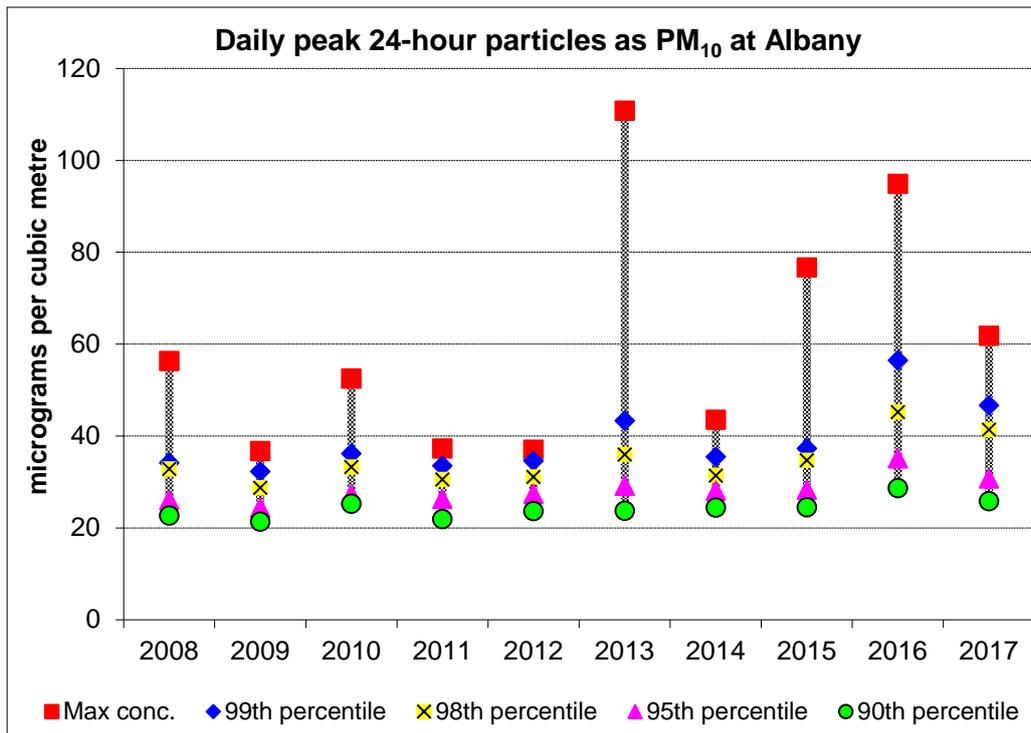


Figure E5-1 – 24-hour PM₁₀ at Albany

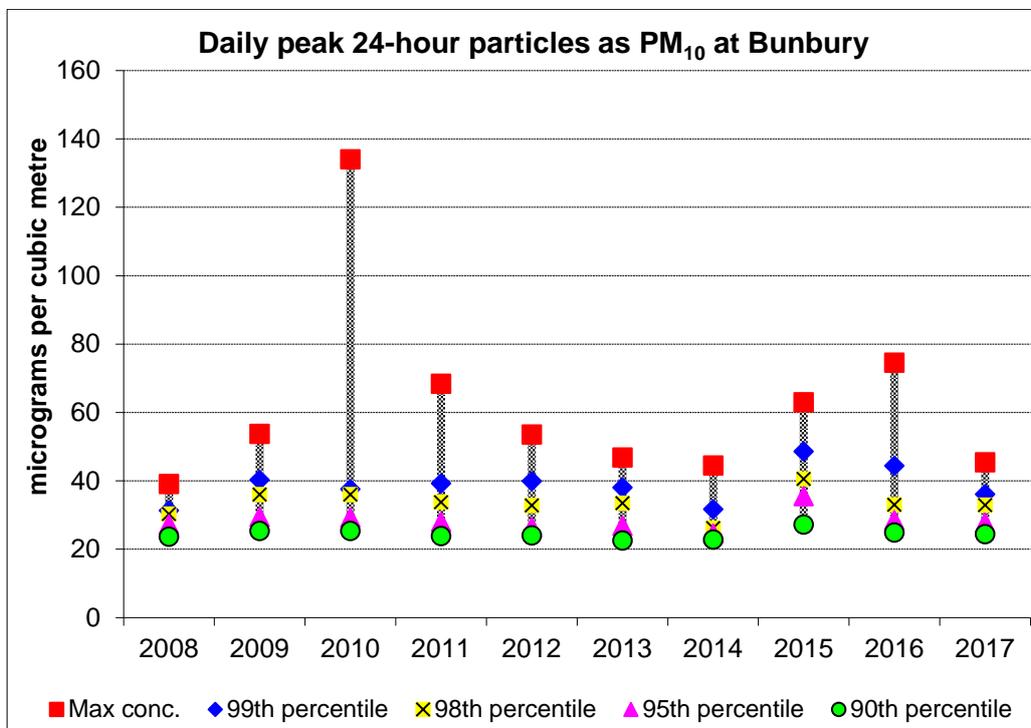


Figure E5-2 – 24-hour PM₁₀ at Bunbury

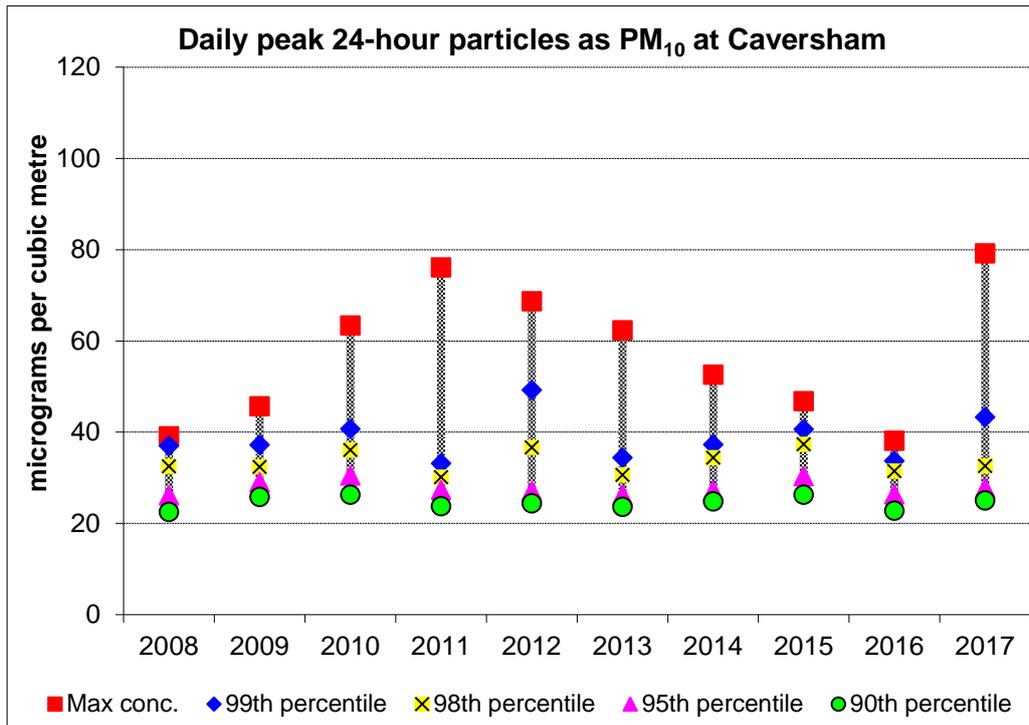


Figure E5-3 – 24-hour PM₁₀ at Caversham

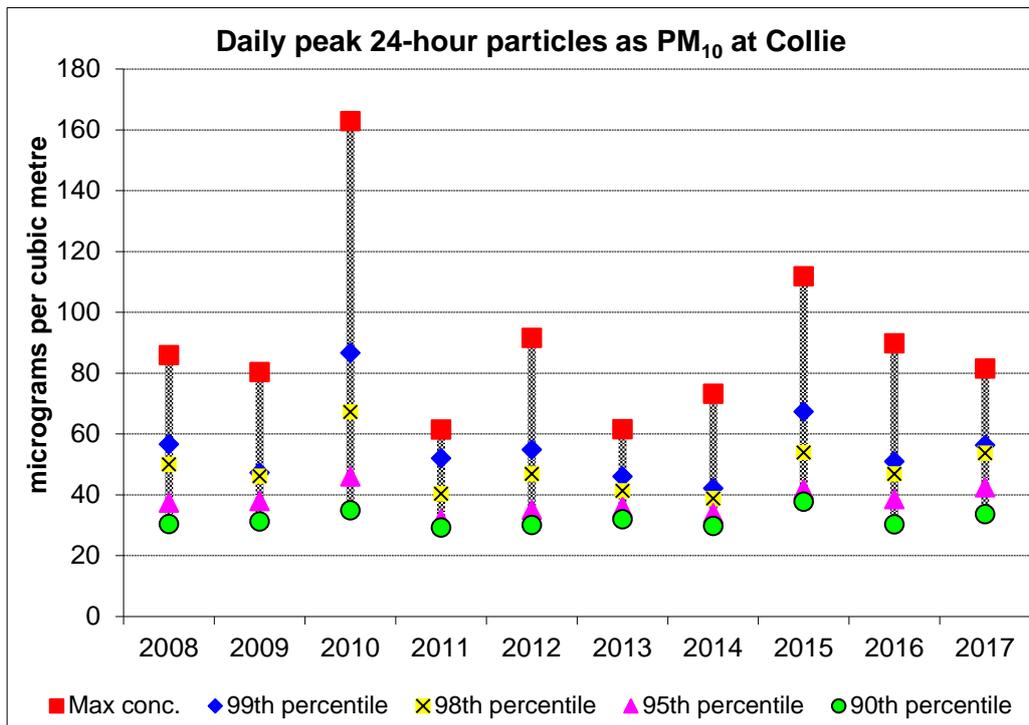


Figure E5-4 – 24-hour PM₁₀ at Collie

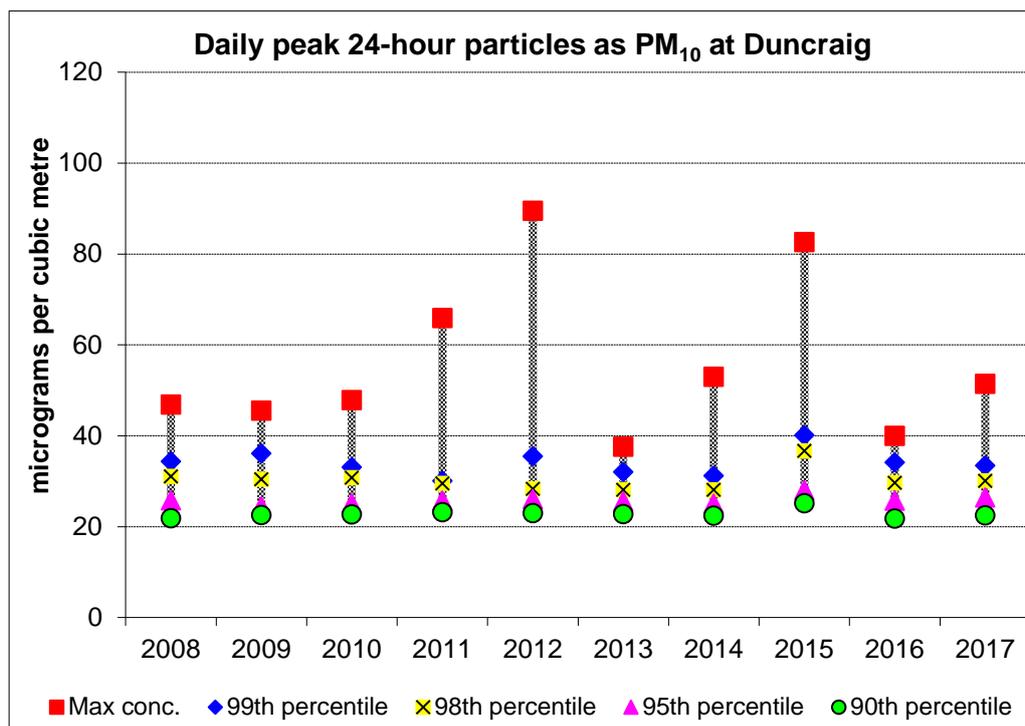


Figure E5-5 – 24-hour PM₁₀ at Duncairg

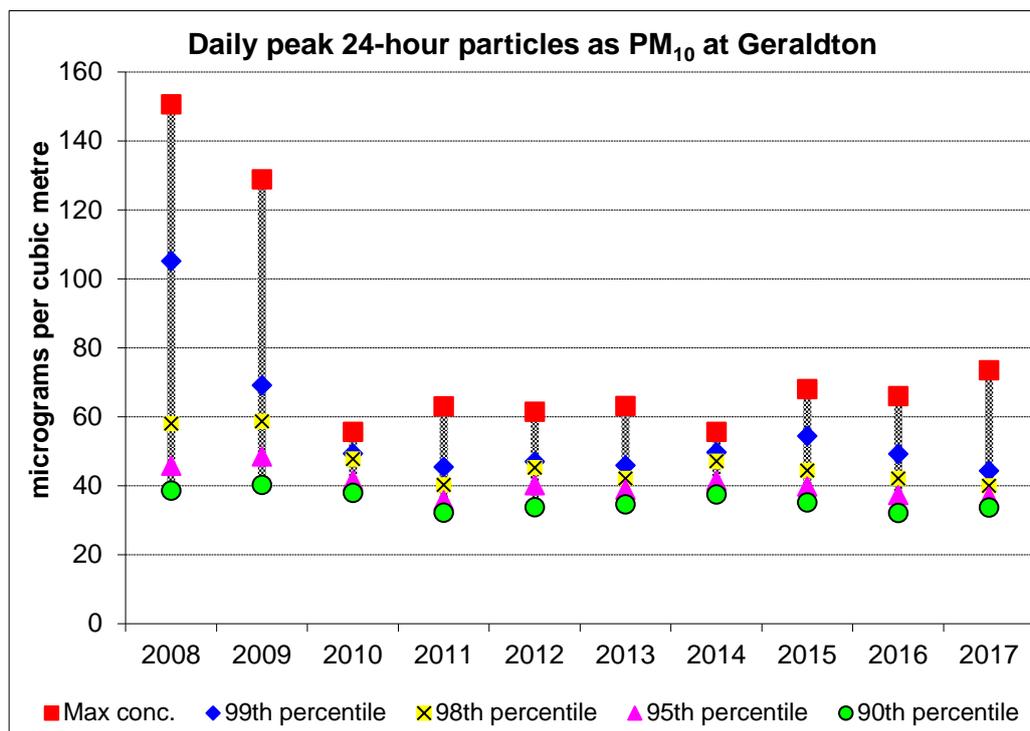


Figure E5-6 – 24-hour PM₁₀ at Geraldton

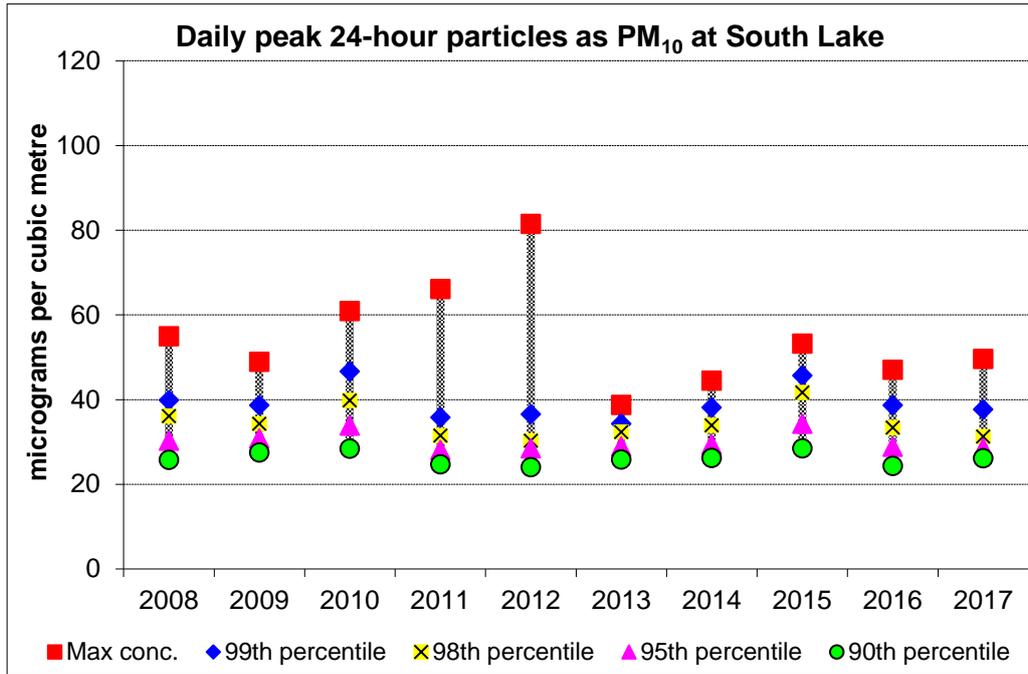


Figure E5-7 – 24-hour PM₁₀ at South Lake

E.6 Particles as PM_{2.5}

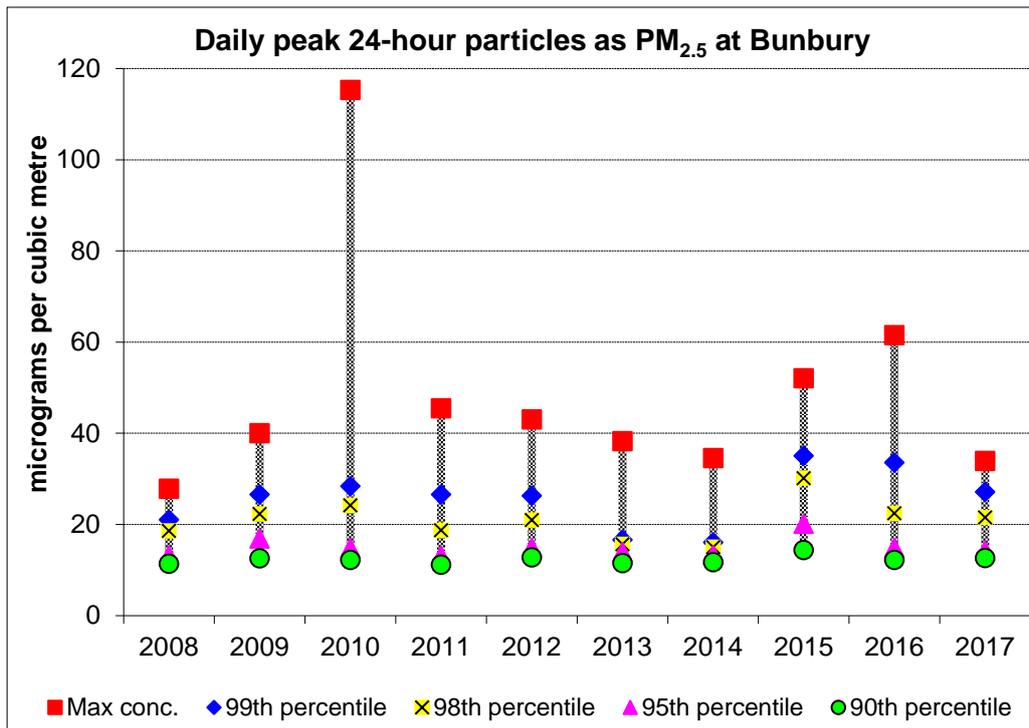


Figure E6-1 – 24-hour PM_{2.5} at Bunbury

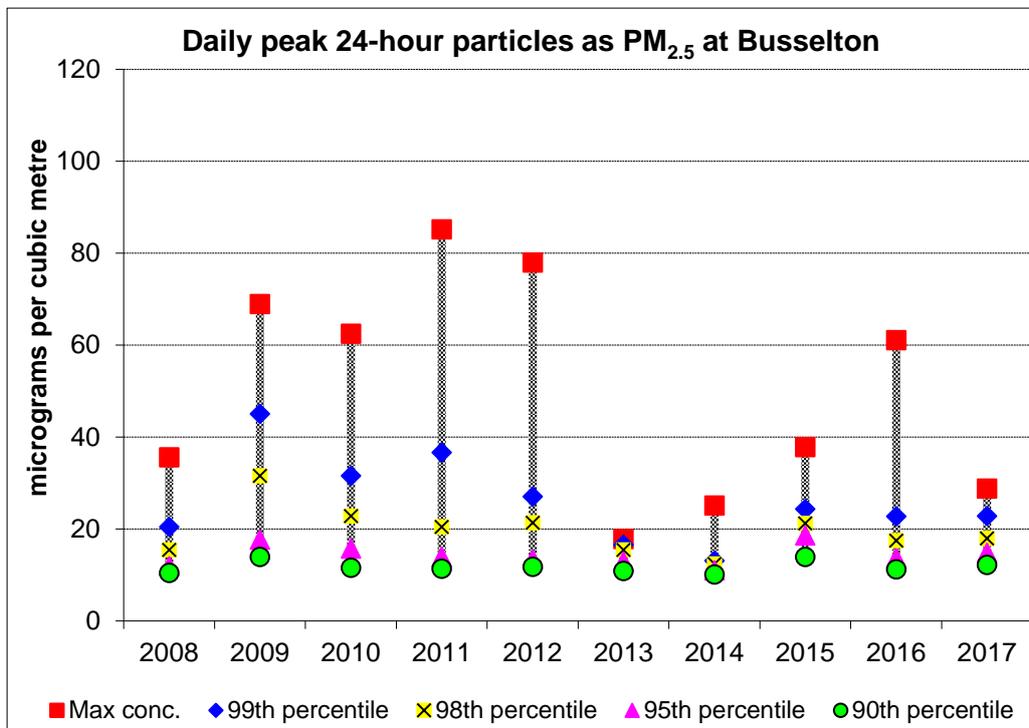


Figure E6-2 – 24-hour PM_{2.5} at Busselton

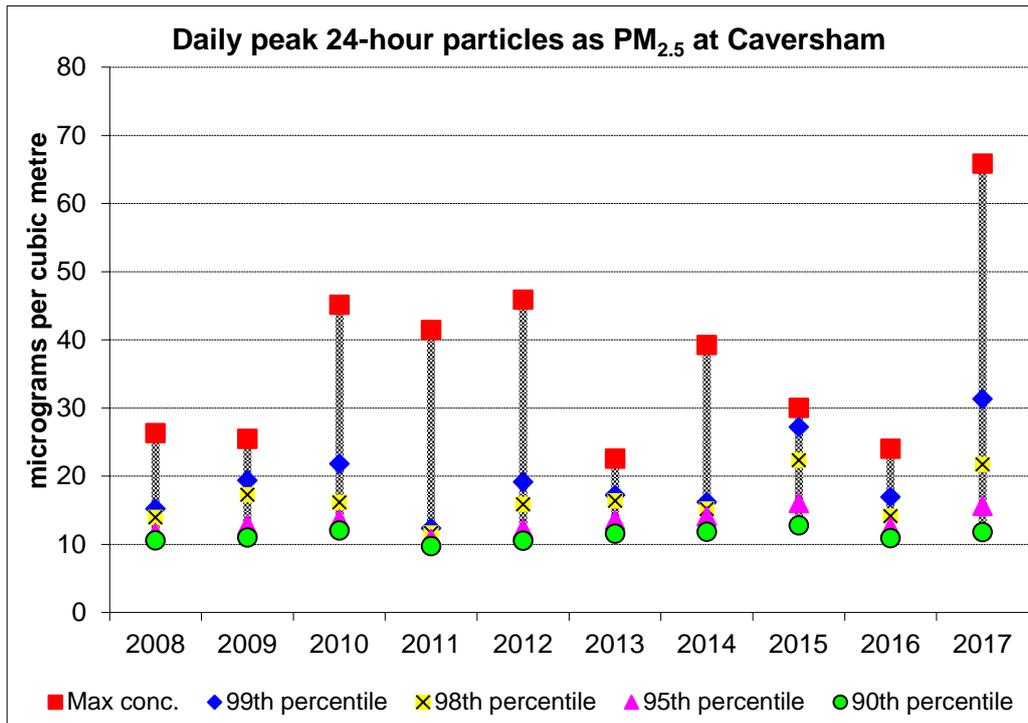


Figure E6-3 – 24-hour PM_{2.5} at Caversham

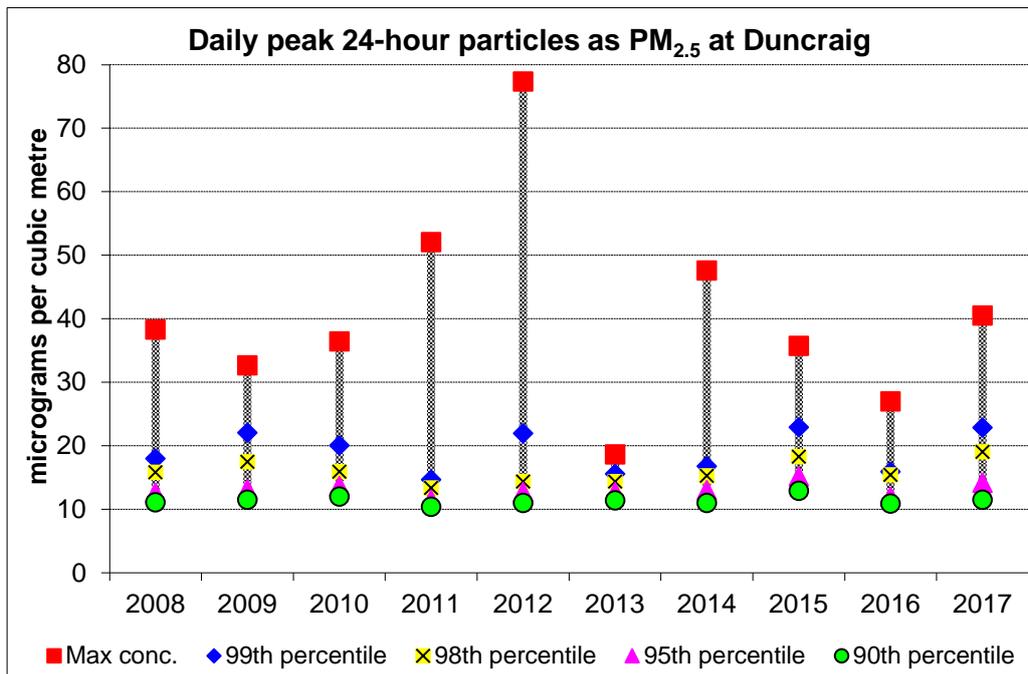


Figure E6-4 – 24-hour PM_{2.5} at Duncraig

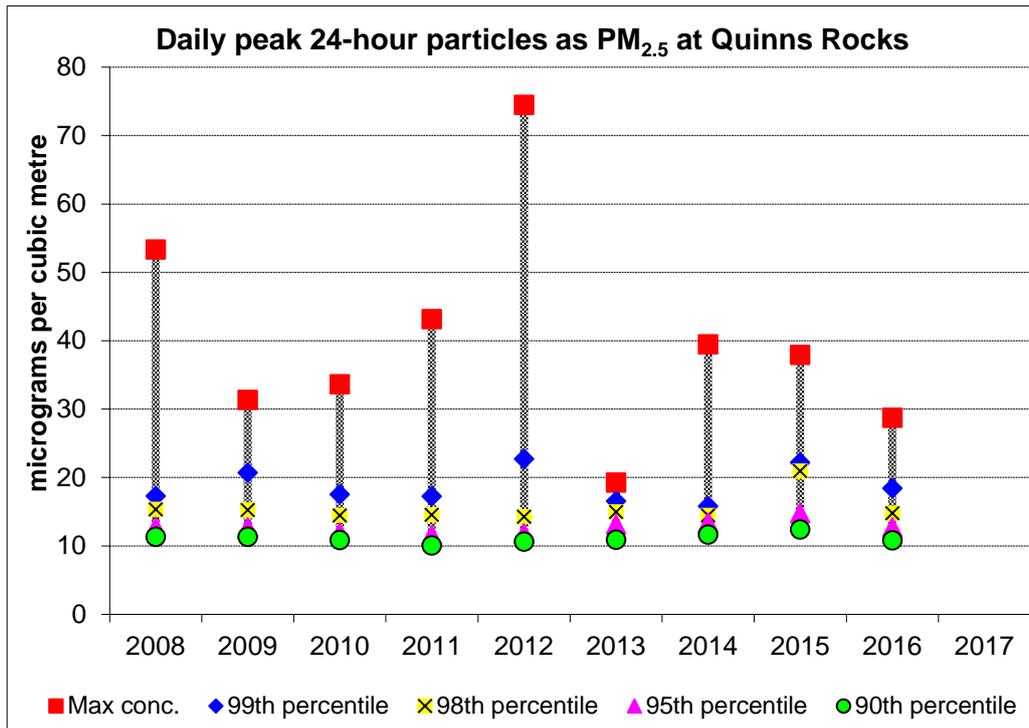


Figure E6-5 – 24-hour PM_{2.5} at Quinns Rocks (2017 not included)

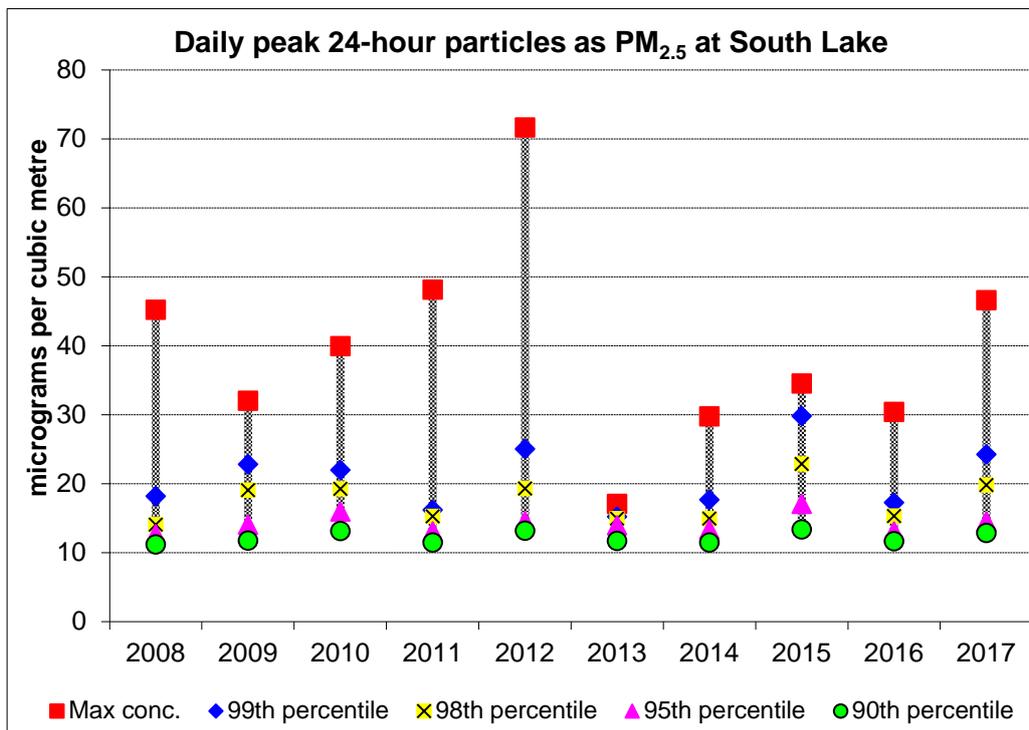


Figure E6-6 – 24-hour PM_{2.5} at South Lake

F. Exceedence summary

The following pages contain information specific to each parameter exceeding the relevant NEPM standard during 2017. Each analysis is provided in date order and may include one or more 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:

- 3 am (red)
- 6 am (orange)
- 9 am (yellow)
- noon (green)
- 3 pm (blue)
- 6 pm (mauve)
- 9 pm (purple)
- 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 no air dispersion throughout the path, create large uncertainties in the indicated 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
Bn	Bunbury
Bs	Busselton
Co	Collie
Ge	Geraldton

4 January 2017



Google Earth view of the construction activity to the east of the monitoring site

Pollutant

PM₁₀

Monitoring Site

Albany

NEPM Standard

50 µg/m³

Averaging Period

24 hours

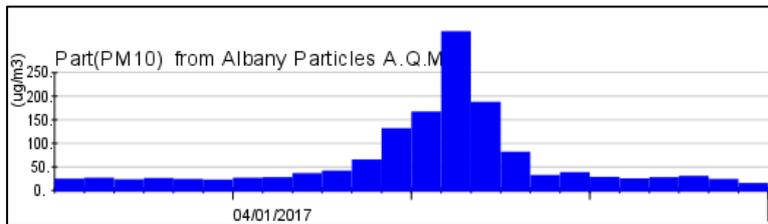
Concentration

61.8 µg/m³

Description of Event

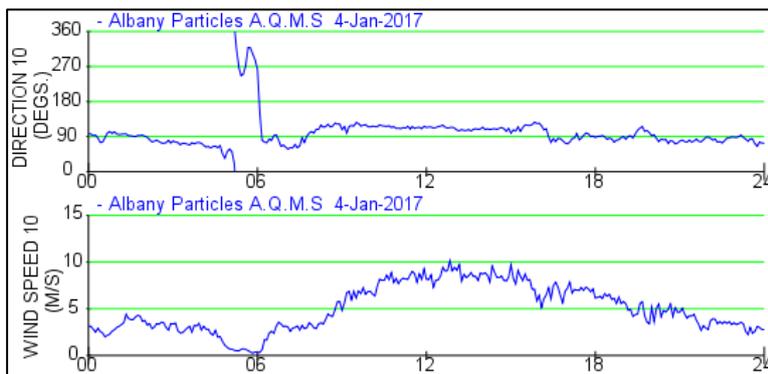
No fire events were detected by MODIS hotspot east of Albany.

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



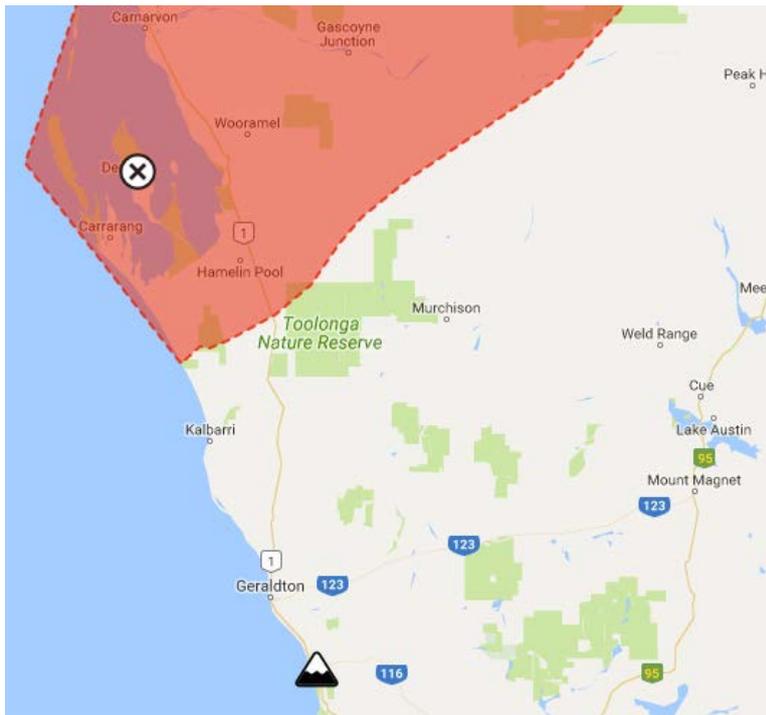
60 minute clock averaged time series plot

Assessable Event



Five minute averaged time series plot of wind speed and direction

8 February 2017



Storm (■) and flood warnings (▲) in operation for 08/02/2017 (<https://www.emergency.wa.gov.au/>)

Pollutant

PM₁₀

Monitoring Site

Geraldton

NEPM Standard

50 µg/m³

Averaging Period

24 hours

Concentration

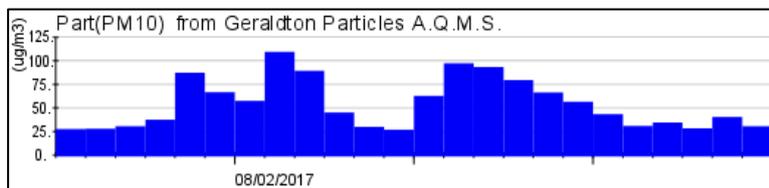
54.2 µg/m³

Description of Event

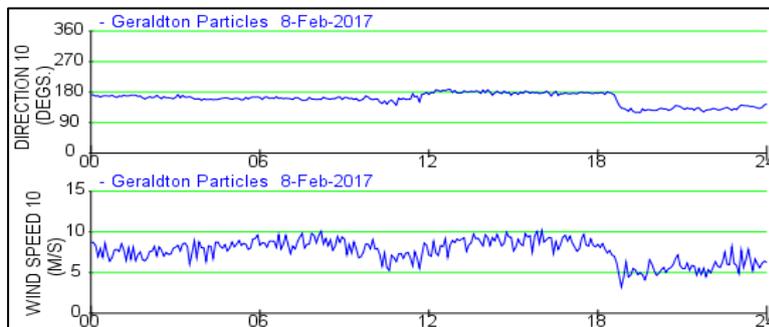
High southerly winds and storm activity caused local dust lift-off.

No fire events were detected by MODIS hotspot.

Assessable Event



60 minute running averaged time series plot



Five minute averaged time series plot of wind speed and direction

29 March 2017



<https://worldview.earthdata.nasa.gov> for this event (Aqua/MODIS)

Pollutant

PM₁₀

Monitoring Site

Collie

NEPM Standard

50 µg/m³

Averaging Period

24 hours

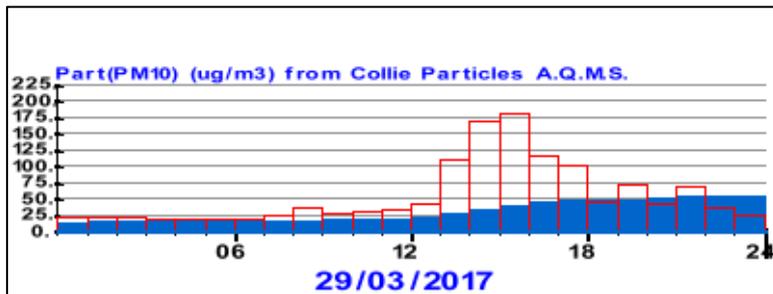
Concentration

53.7 µg/m³

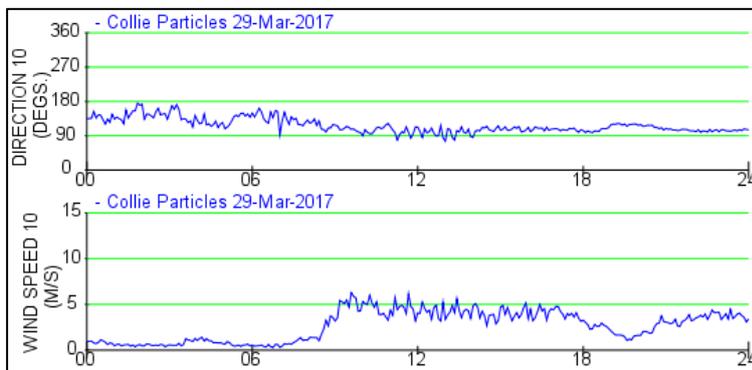
Description of Event

Department of Parks and Wildlife (DPaW) controlled burning activity in the region at WTN_039; Block: Hamilton 027; Position: 16km NW of Collie

Exceptional Event

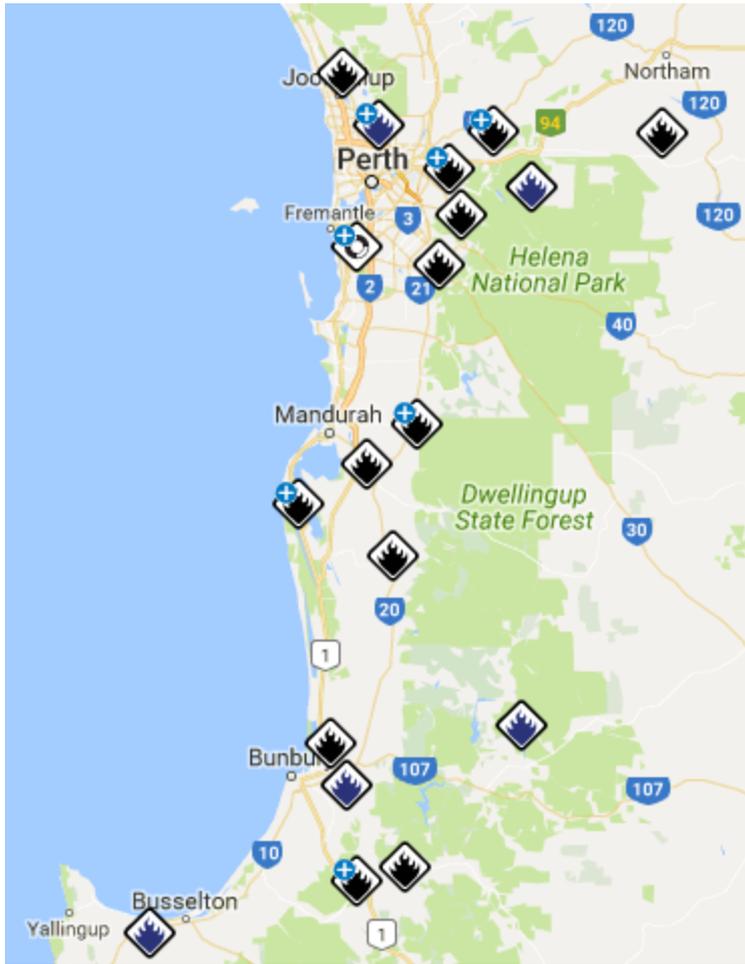


60 minute running averaged time series plot



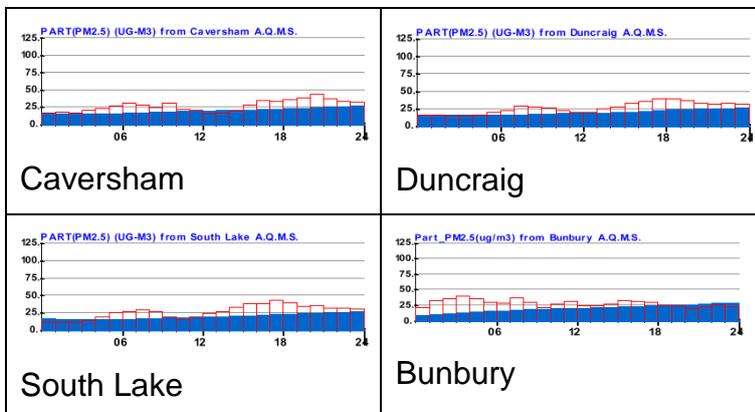
Five minute averaged time series plot of wind speed and direction at

5 April 2017



Burnoff's (♠) and fires (♠) in operation for 05/04/2017 (<https://www.emergency.wa.gov.au/>)

60 minute averaged plots



Blue bars are 24 hour averages. Red bars are hourly averaged

Pollutant

PM_{2.5}

Monitoring Site

Metropolitan

NEPM Standard

25 µg/m³

Averaging Period

24 hours

Concentration (µg/m³)

Location	PM ₁₀	PM _{2.5}
Caversham	43.3	26.6
Duncraig	36.3	25.9
South Lake	39.2	26.1
Bunbury	38.2	28.1

Description of Event

A number of Shire burn-offs and fires were current within the metropolitan area resulting in elevated particle levels throughout the day.

DPaW activities were active at the following locations:

DON_048 Unicup/Bolbelup 50km ESE of Manjimup (5/4/2017)

WTN_030 Darrell (029) 9km NNE of Collie (4/4/2017)

DON_048 Unicup/Bolbelup 50km ESE of Manjimup (4/4/2017)

<http://www.dpaw.wa.gov.au/management/fire/prescribed-burning/burns>

Assessable Event

28 April 2017



<https://worldview.earthdata.nasa.gov> for this event
(Aqua/MODIS)

Pollutant

PM₁₀

Monitoring Site

Collie

NEPM Standard

50 µg/m³

Averaging Period

24 hours

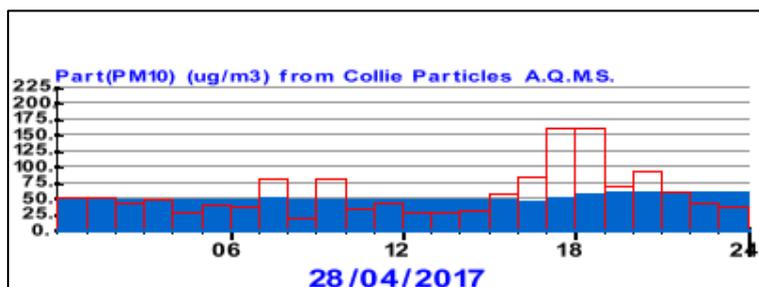
Concentration

57.8 µg/m³

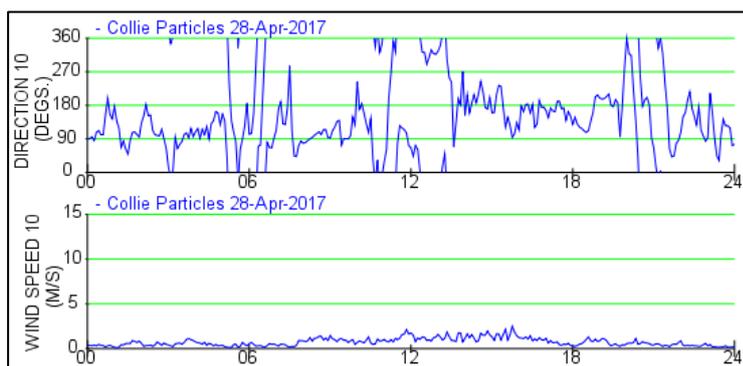
Description of Event

DPaW controlled burning activity in the region at WTN_039 Hamilton 16km NW of Collie

Exceptional Event

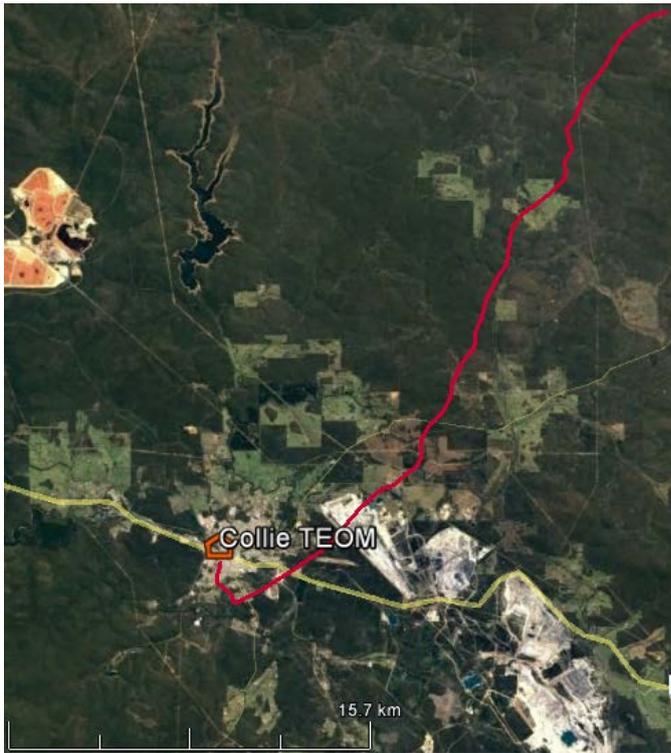


60 minute running averaged time series plot



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

2 May 2017



Back trajectory over 360 minutes ending at 2/5/2017 19:00.

Pollutant

PM₁₀

Monitoring Site

Collie

NEPM Standard

50 µg/m³

Averaging Period

24 hours

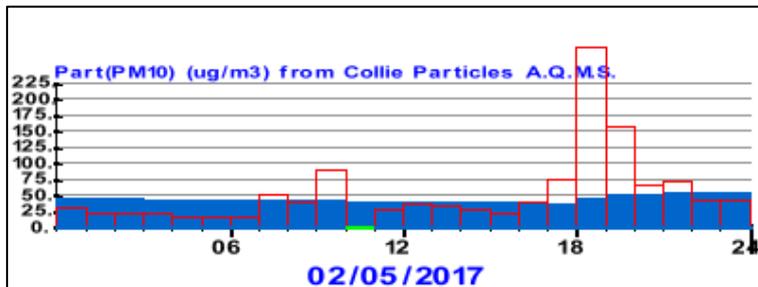
Concentration

53.7 µg/m³

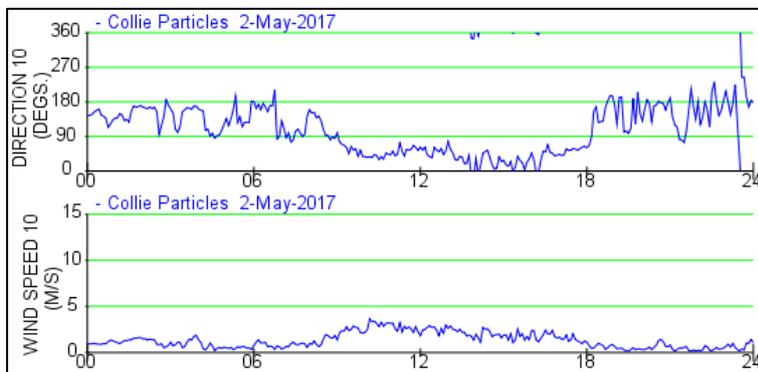
Description of Event

Possibility of residual smoke from the Hamilton burn which was ignited on 28/04/2017 and again on 03/05/2017.

Exceptional Event

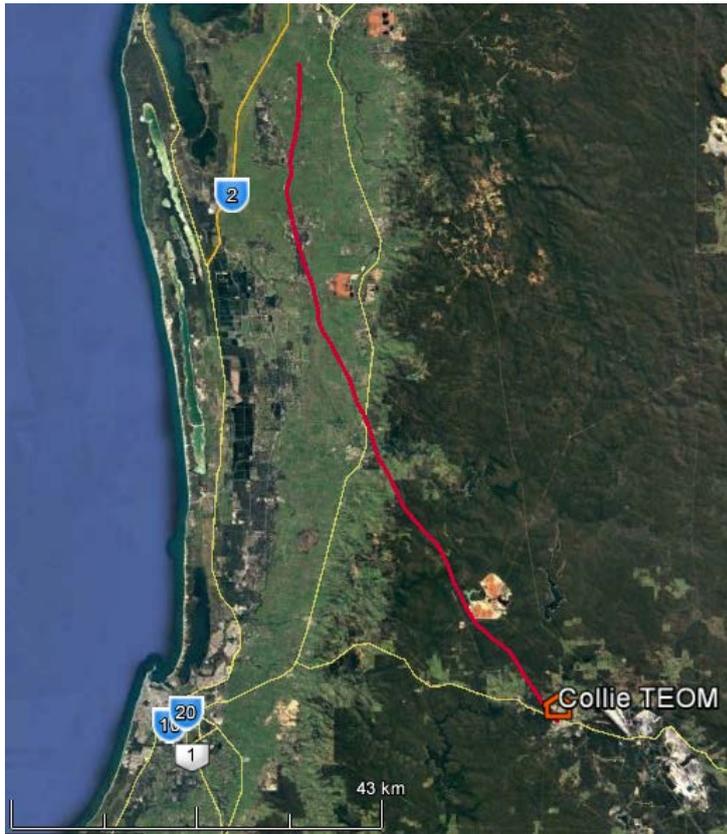


60 minute running averaged time series plot



Five minute averaged time series plot of wind speed and direction

3 May 2017



Pollutant

PM₁₀

Monitoring Site

Collie

NEPM Standard

50 µg/m³

Averaging Period

24 hours

Concentration

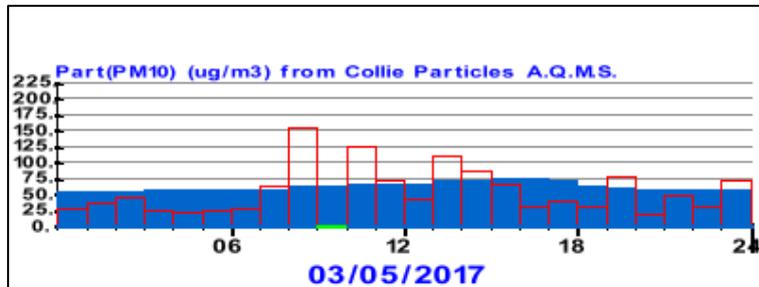
54.9 µg/m³

Description of Event

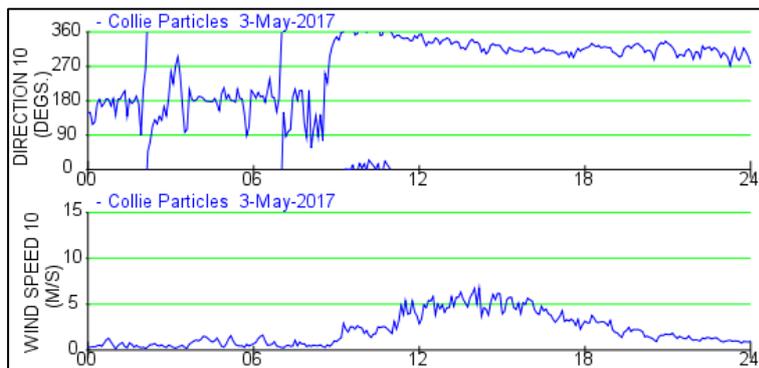
DPaW controlled burning activity in the region at WTN_039 Hamilton 16km NW of Collie

Exceptional Event

Back trajectory over Collie showing winds were from the northwest



60 minute running averaged time series plot

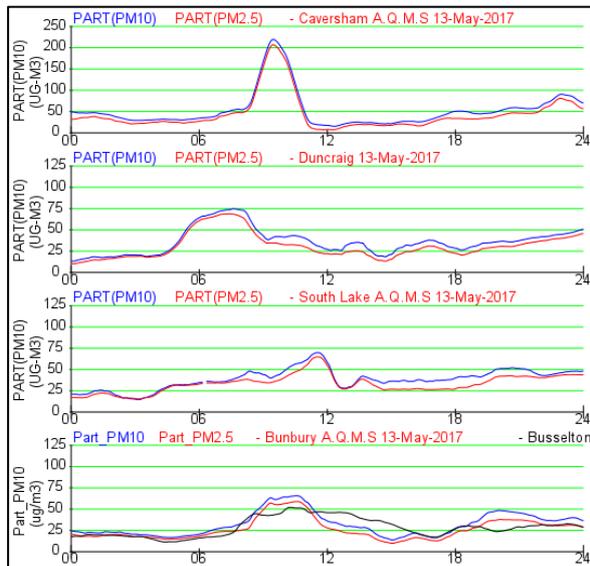


Five minute averaged time series plot of wind speed and direction at Collie

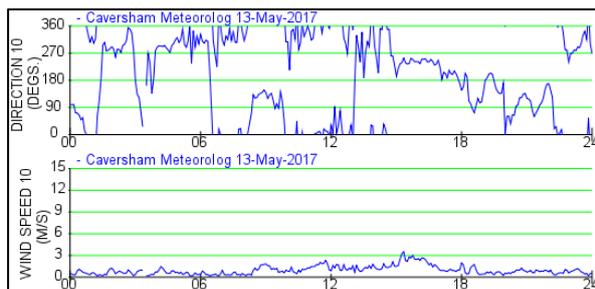
13 May 2017



<https://worldview.earthdata.nasa.gov> for this event (Terra/MODIS)



60 minute running averaged time series plot



5 minute averaged wind speed and direction

Pollutant

PM₁₀ and PM_{2.5}

Monitoring Site

Metropolitan and Regional

NEPM Standard

PM₁₀ 50 µg/m³

PM_{2.5} 25 µg/m³

Averaging Period

24 hours

Concentration (µg/m³)

Location	PM ₁₀	PM _{2.5}
Caversham	53.4	44.2
Duncraig	37.2	31.8
South Lake	39.1	33.8
Bunbury	32.2	26.6
Busselton	-	28.8

Exceedences are shown in bold

Description of Event

DPAW issued a smoke alert for the Perth metropolitan area, Perth Hills and southern suburbs to Mandurah for this event.

The smoke was the result of a number of prescribed burns by DPAW, including a burn 10km south-east of Mundaring and a burn 30km south-east of Jarrahdale.

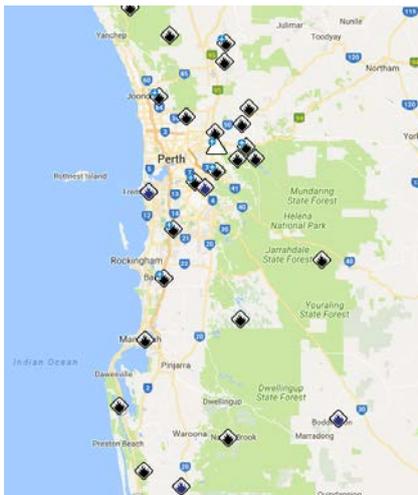
Low wind speeds and variable wind directions were prevalent throughout the day

Exceptional Event

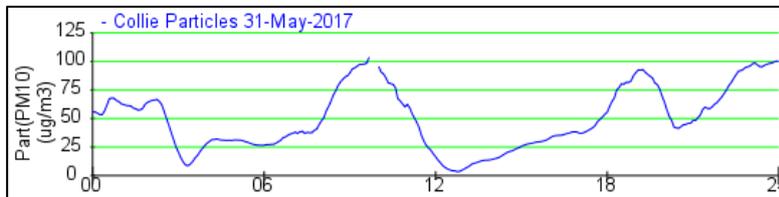
31 May 2017



<https://worldview.earthdata.nasa.gov> for this event (Aqua/MODIS)



Burnoff's (🔹) and fires (🔥) in progress (<https://www.emergency.wa.gov.au/>)



60 minute running averaged time series plot

Pollutant

PM₁₀

Monitoring Site

Collie

NEPM Standard

50 µg/m³

Averaging Period

24 hours

Concentration

51.0 µg/m³

Description of Event

Smoke Alert Advice was issued for the Perth Metropolitan region at 05:06 PM on 31 May 2017

“Smoke Alert for areas from Helena Valley to Perth in the metropolitan area

The Department of Parks and Wildlife has issued a smoke alert for the Perth Hills, Perth metropolitan area and southern suburbs.

The smoke is the result of a Parks and Wildlife prescribed burn at Beelu National Park in Helena Valley.

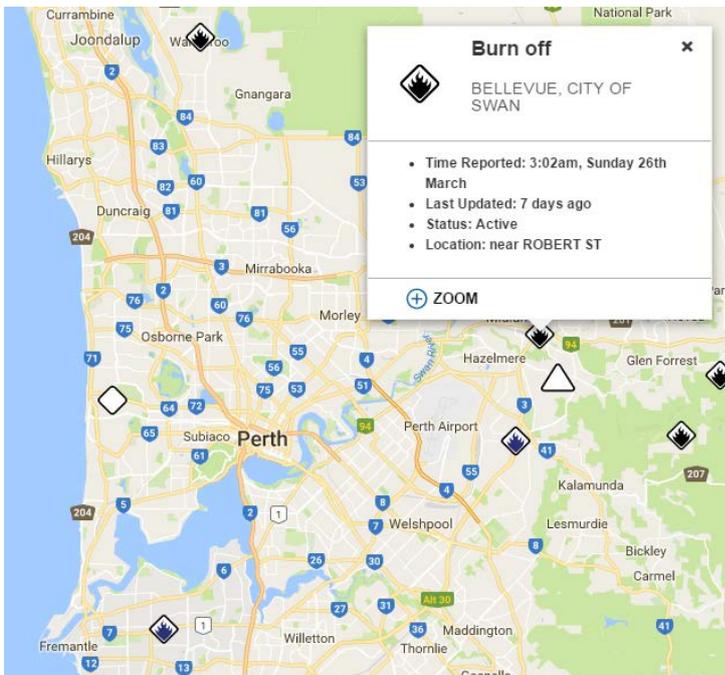
The smoke is expected to clear by late morning tomorrow.”

Exceptional Event

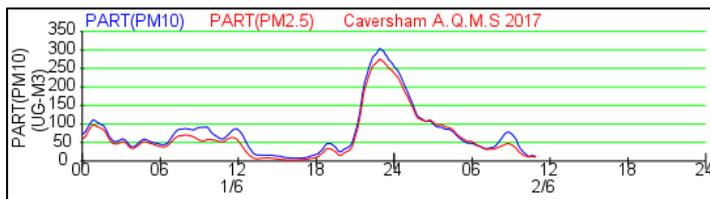
1 June 2017



<https://worldview.earthdata.nasa.gov> for this event (Aqua/MODIS)



Burnoff's (🔥) and fires (🔥) in progress (<https://www.emergency.wa.gov.au/>)



60 minute running averaged time series plot

Pollutant

PM₁₀ & PM_{2.5}

Monitoring Site

Caversham

NEPM Standard

PM₁₀ : 50 µg/m³

PM_{2.5} : 25 µg/m³

Averaging Period

24 hours

Concentration (µg/m³)

Location	PM ₁₀	PM _{2.5}
Caversham	79.2	65.9
Duncraig	30.6	24.7
South Lake	30.6	24.0
Bunbury	24.2	17.8
Collie	41.0	-

Description of Event

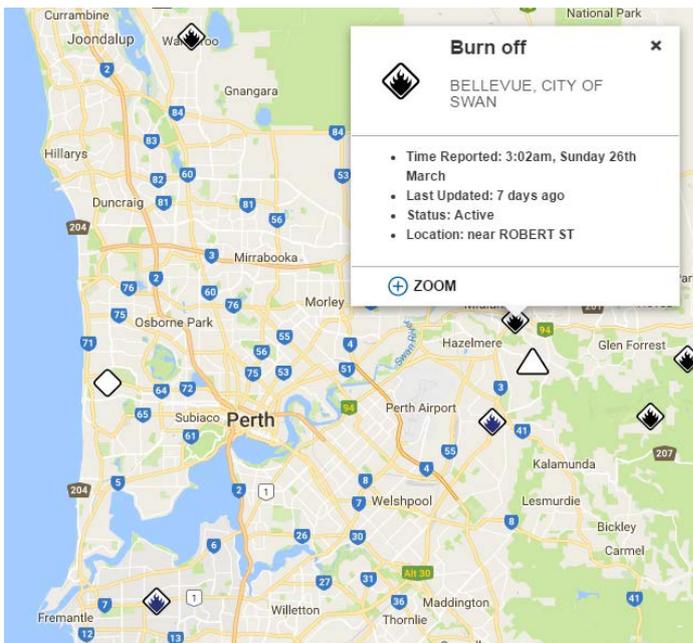
A number of burns were underway throughout the southwest but due to the localised effect at Caversham, the exceedence was most likely caused by a local burn-off at Bellevue in the City of Swan.

Assessable Event

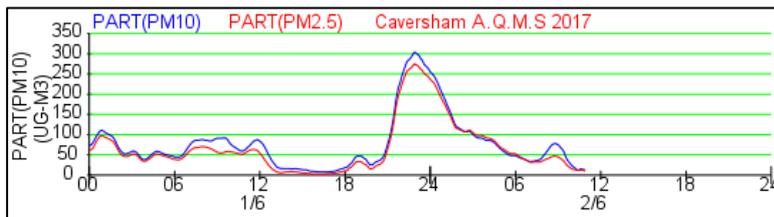
2 June 2017



<https://worldview.earthdata.nasa.gov> for this event (Aqua/MODIS)



Back trajectory over



60 minute running averaged time series plot

Pollutant

PM_{2.5}

Monitoring Site

Caversham

NEPM Standard

25 µg/m³

Averaging Period

24 hours

Concentration (µg/m³)

Location	PM ₁₀	PM _{2.5}
	0	5
Caversham	43.1	37.9
Duncraig	19.6	15.4
South Lake	24.7	20.5
Bunbury	19.6	12.9
Collie	35.4	-

Description of Event

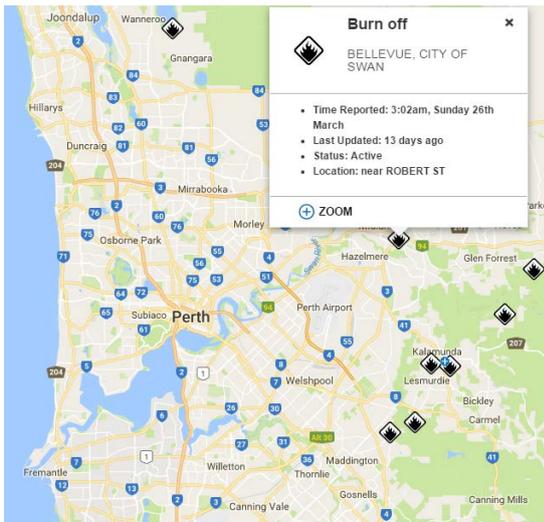
A number of burns were underway throughout the southwest but due to the localised effect at Caversham, the exceedence was most likely caused by a local burn-off at Bellevue in the City of Swan.

Assessable Event

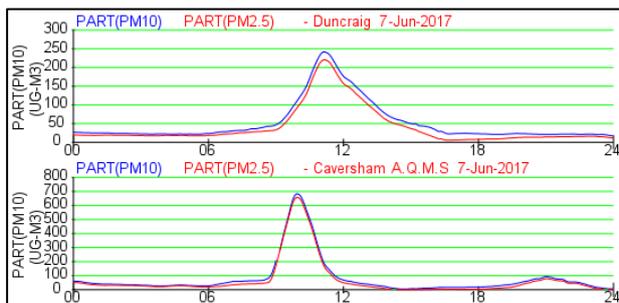
7 June 2017



<https://worldview.earthdata.nasa.gov> for this event (Terra/MODIS)



Burnoff's (🔥) and fires (🔥) in operation for 07/06/2017 (<https://www.emergency.wa.gov.au/>)



60 minute running averaged time series plot

Pollutant

PM₁₀ & PM_{2.5}

Monitoring Site

Caversham & Dun Craig

NEPM Standard

PM₁₀ : 50 µg/m³

PM_{2.5} : 25 µg/m³

Averaging Period

24 hours

Concentration (µg/m³)

Location	PM ₁₀	PM _{2.5}
	0	5
Caversham	79.1	65.2
Dun Craig	51.4	40.5
South Lake	29.4	19.9

Description of Event

A number of bushfires and controlled burns conducted by DPaW (listed below) and a number of burn offs in various locations contributed to the smoke haze. The exceedence was most likely caused by prescribed burns in the region.

PHS_108 (Flint 1) 35km ESE of Roleystone

PHS_061 Helena Valley 3km NE of Kalamunda

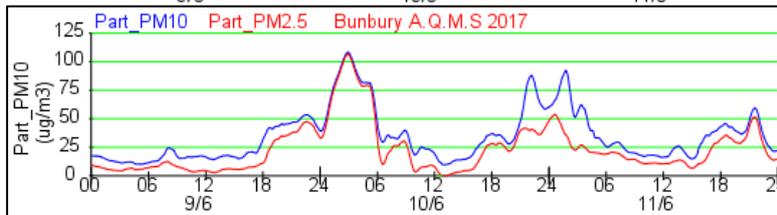
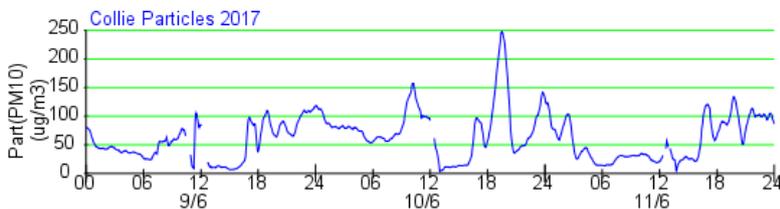
PHS_051 Willowdale Heaps Prescription 6km S of Dwellingup

Exceptional Event

9 - 11 June 2017



<https://worldview.earthdata.nasa.gov> for this event (Aqua/MODIS) (09/06/2017)



60 minute running averaged time series plot

Recent Burn Activities:

- PHS_095 Lupton 2 35km WSW of Brookton
- BWD_102 McGREGOR MILLBROOK 20km SE of Busselton
- SWC_069 HAMEL NURSERY
- WTN_056 Westralia
- PHS_061 Helena Valley 3km NE of Kalamunda
- BWD_050 CAMBRAY BARRABUP 12km NNW of Nannup
- PHS_095 Lupton 2 35km WSW of Brookton
- PHS_051 Willowdale Heaps Prescription 6km S of Dwellingup

Pollutant

PM₁₀ and PM_{2.5}

Monitoring Site

Collie (PM₁₀)

Bunbury (PM_{2.5})

NEPM Standard

PM₁₀ : 50 µg/m³

PM_{2.5} : 25 µg/m³

Averaging Period

24 hours

Concentration (µg/m³)

Collie:

Date	PM ₁₀
09/06/2017	57.6
10/06/2017	81.5
11/06/2017	55.4

Bunbury:

Date	PM _{2.5}
10/06/2017	33.9

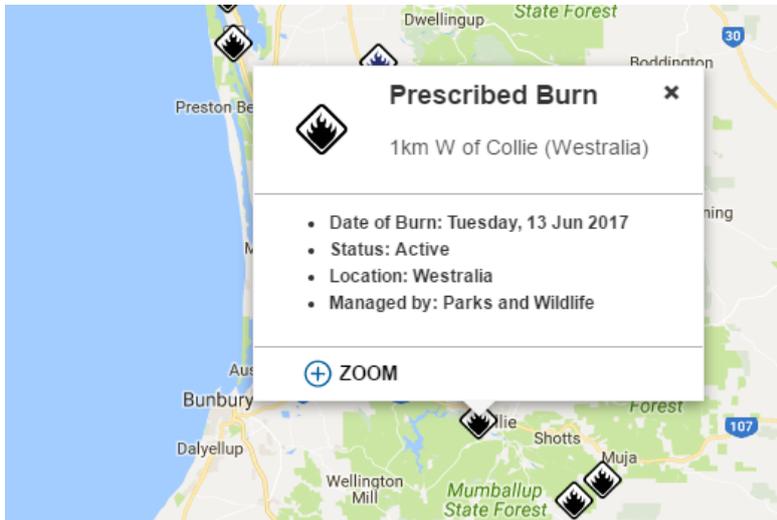
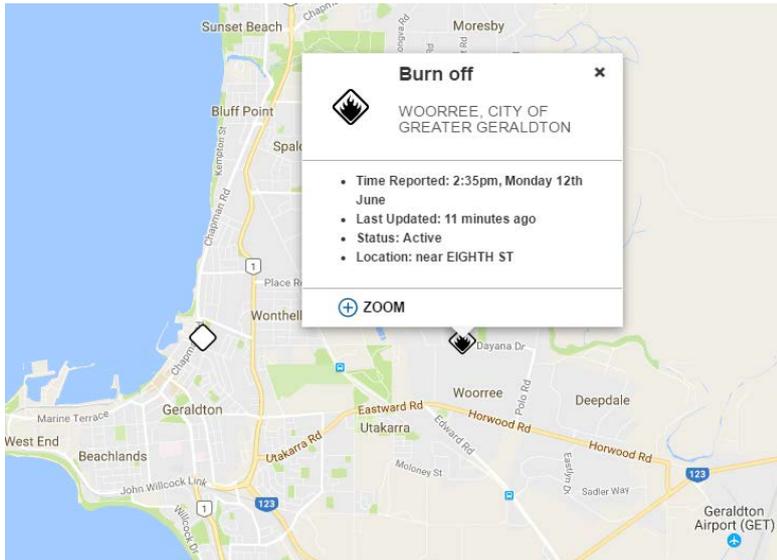
Description of Event

A number of controlled burns and general burn offs conducted in the southwest.

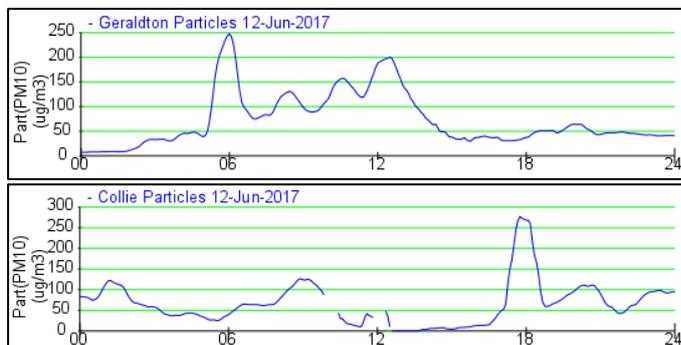
Also there was some possibility of overnight contribution from wood heater smoke.

Exceptional Event

12 June 2017



Burnoff's (🔥) and fires (🔥) in operation for 12/06/2017 at Geraldton (upper image) and Collie (lower image) (<https://www.emergency.wa.gov.au/>)



60 minute running averaged time series plot

Pollutant

PM₁₀

Monitoring Site

Geraldton & Collie

NEPM Standard

50 µg/m³

Averaging Period

24 hours

Concentration (µg/m³)

Location	PM ₁₀
Geraldton	73.5
Collie	68.2

Description of Event

Geraldton: Local burn-off/fire was reported in Geraldton close to the monitoring site.

Assessable Event

Collie: DPaW managed prescribed burn at or near Collie.

Exceptional Event

Following burns started 12/06/2017

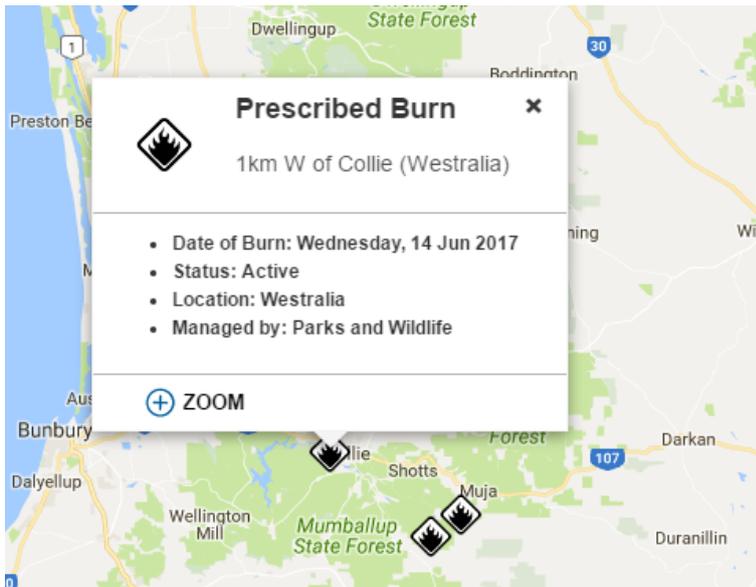
WTN_056 Westralia

BWD_067 BUTLER_127

BWD_102 McGREGOR MILLBROOK 20km SE of Busselton

Metropolitan Perth: PM₁₀ concentration for all metropolitan sites remained below 30 µg/m³.

13 June 2017



Burnoff's (🔥) and fires (🔥) in operation for 12/06/2017 at Geraldton (upper image) and Collie (lower image) (<https://www.emergency.wa.gov.au/>)



60 minute running averaged time series plot



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

Pollutant

PM₁₀

Monitoring Site

Collie

NEPM Standard

50 µg/m³

Averaging Period

24 hours

Concentration

54.7 µg/m³

Description of Event

DPaW managed prescribed burn at or near Collie coupled with low speed winds from a southerly aspect.

The following prescribed burns were commenced on 13/06/2017

WTN_040 Shotts 052 17km SE of Collie

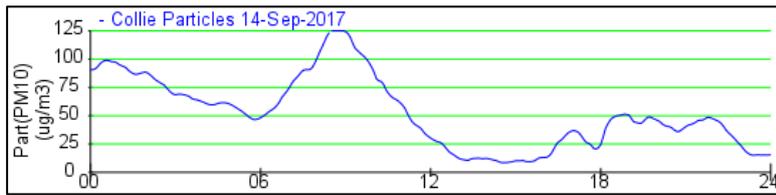
BWD_050 CAMBRAY BARRABUP 12km NNW of Nannup

BWD_102 McGREGOR MILLBROOK 20km SE of Busselton

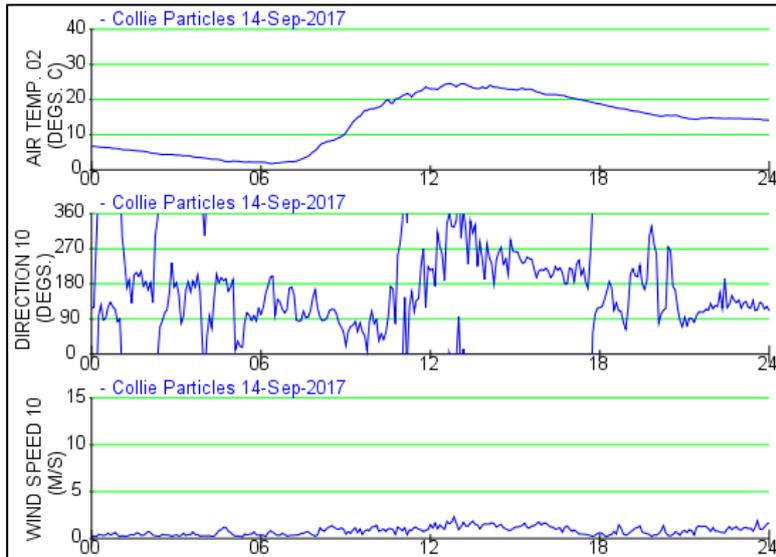
PHS_050 Huntly Heaps Prescription 15km S of Jarrahdale

Exceptional Event

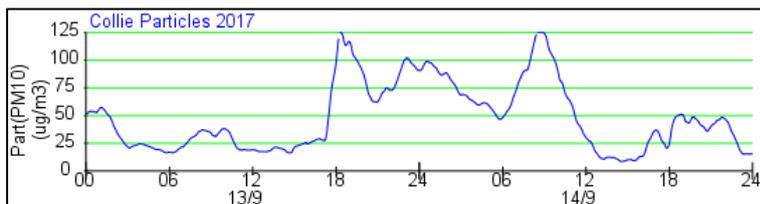
14 September 2017



60 minute running averaged time series plot showing peak occurring overnight



Five minute averaged time series plot of wind speed, direction and air temperature at Collie



60 minute running averaged time series plot showing the overnight profile typical of domestic wood heater smoke

Pollutant

PM₁₀

Monitoring Site

Collie

NEPM Standard

50 µg/m³

Averaging Period

24 hours

Concentration

51.2 µg/m³

Description of Event

Low temperatures combined with low wind speeds caused a build-up of smoke from domestic wood heaters.

The particle concentration peaks occurred overnight showing a typical domestic heater smoke profile.

A prescribed burn in the region was performed at WTN_076 Stockton Hardwood 7km SE of Collie on 14/09/2017, however as the smoke was a carryover from the previous day, it is likely early morning smoke was from wood heaters.

The concentration of PM₁₀ at Collie on 13/09/2017 was 45.2ug/m³

Assessable Event

15 September 2017



<https://worldview.earthdata.nasa.gov> for this event (Aqua/MODIS)

Pollutant

PM_{2.5}

Monitoring Site

Bunbury

NEPM Standard

25 µg/m³

Averaging Period

24 hours

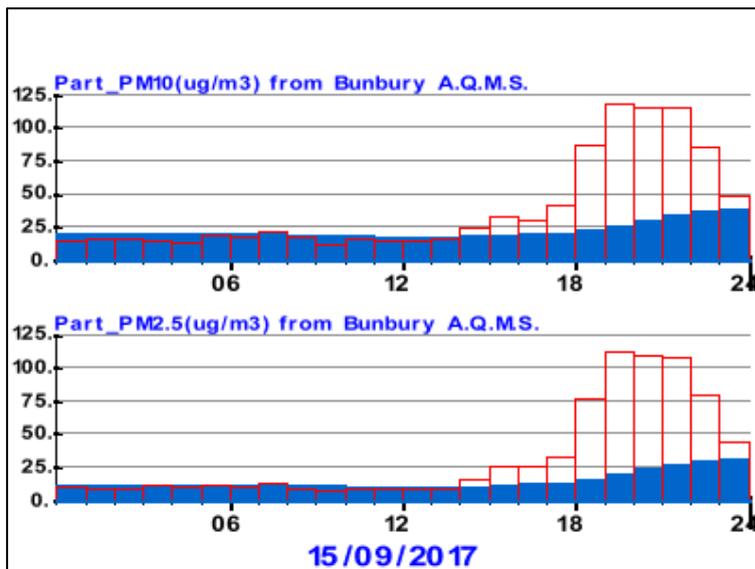
Concentration

31.4 µg/m³

Description of Event

The Department of Biodiversity, Conservation and Attractions (DBCA) conducting controlled burns at Collie (WTN_076 Stockton Hardwood 7km SE of Collie). Smoke impacted Bunbury with the easterlies.

Exceptional Event

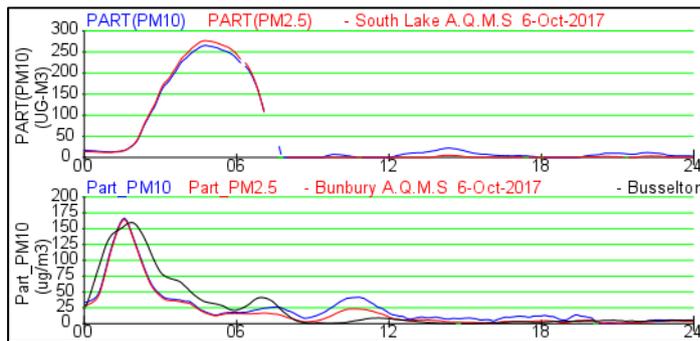


60 minute running averaged time series plot

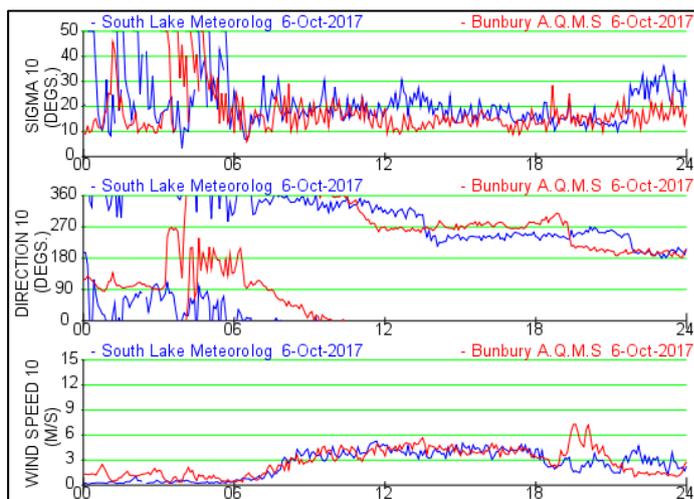
6 October 2017



<https://worldview.earthdata.nasa.gov> for this event (Aqua/MODIS)



60 minute running averaged time series plot



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

Pollutant

PM_{2.5}

Monitoring Site

South Lake

NEPM Standard

25 µg/m³

Averaging Period

24 hours

Concentration (µg/m³)

Location	PM _{2.5}	
	0	5
Caversham	12.2	5.9
Dun Craig	11.9	6.9
South Lake	49.6	46.6
Bunbury	24.0	19.1
Collie	25.2	-

Description of Event

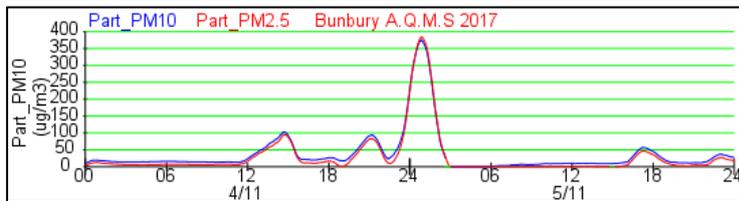
Smoke was caused by DBCA managed prescribed burn at PHS_040 Canning 5km E of Bedfordale.

Exceptional Event

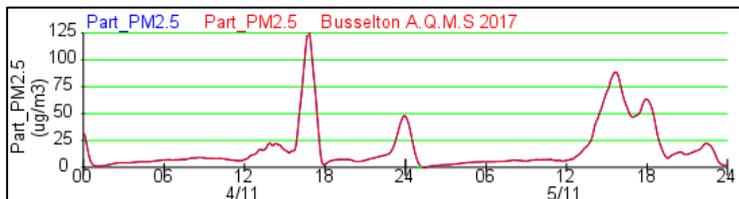
4 - 5 November 2017



<https://worldview.earthdata.nasa.gov> for this event (Aqua/MODIS)



60 minute running averaged time series plot for Bunbury



60 minute running averaged time series plot for Busselton

Note: While Busselton did not exceed the NEPM particle standard, the time series plot is shown for interest.

Pollutant

PM_{2.5}

Monitoring Site

Bunbury

NEPM Standard

25 µg/m³

Averaging Period

24 hours

Concentration

04/11/2017: 30.5 µg/m³

05/11/2015: 25.6 µg/m³

Description of Event

A number of prescribed burns were conducted in the south west.

04/11/2017

- PHS_093 Gordon 4 1km E of Byford
- PHS_097 Huntly 12km NNE of Dwellingup
- BWD_050 CAMBRAY BARRABUP 12km NNW of Nannup
- BWD_102 MCGREGOR MILLBROOK 20km SE of Busselton
- BWD_039 Nelson 134 7km SW of Bridgetown
- DON_060 Warrup 22km ENE of Manjimup
- SWC_033 Yalgorup NP 1 3km S of Dawesville

05/11/2017

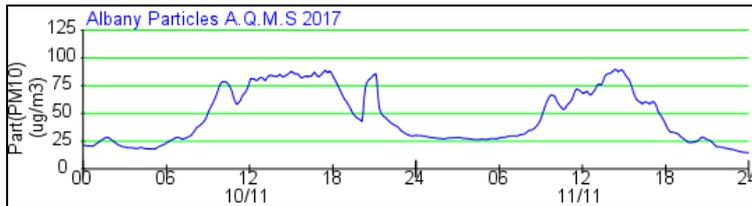
- WTN_070 Yabberup
- DON_064 Yornup 8km S of Bridgetown
- PHS_093 Gordon 4 1km E of Byford
- BWD_092 RYALL 10km NW of Kirup
- PHS_097 Huntly 12km NNE of Dwellingup
- PHS_047 Whittaker 1 5km SE of North Dandalup
- BWD_050 CAMBRAY BARRABUP 12km NNW of Nannup
- DON_060 Warrup 22km ENE of Manjimup

Exceptional Event

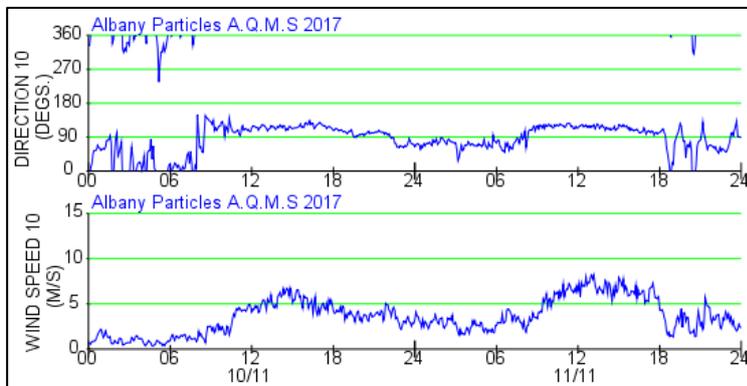
10 November 2017



<https://worldview.earthdata.nasa.gov> for this event (Terra/MODIS)



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

50.0 µg/m³

Averaging Period

24 hours

Concentration

52.3 µg/m³

Description of Event

Winds were from the east or ESE for most of the day so smoke was possibly a local fire event.

A prescribed burn was conducted 30km WNW of Albany on 09/11/2017 at ALB_053 Hunwick Rd Redmond State Forest 30km WNW of Albany

Satellite image shows no smoke, however it does capture a hot-spot (red dot) directly west of Albany.

Assessable Event

14 November 2017



<https://worldview.earthdata.nasa.gov> for this event (Terra/MODIS)

Pollutant

PM₁₀

Monitoring Site

Geraldton

NEPM Standard

50 µg/m³

Averaging Period

24 hours

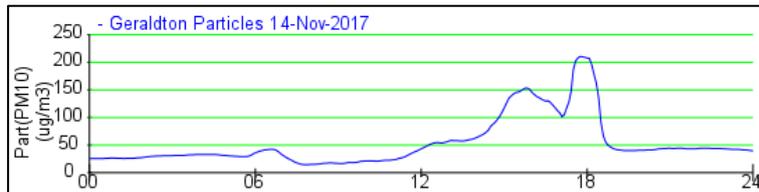
Concentration

53.7 µg/m³

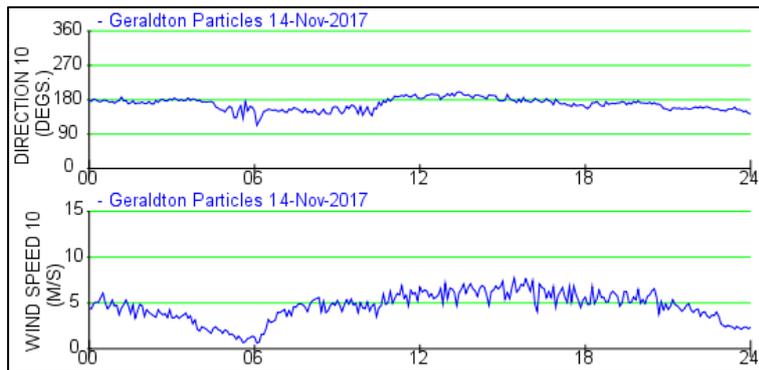
Description of Event

No prescribed burns were conducted in the region during this period. Satellite images picked up some hot-spots around 70km to the south east of the town site.

While these may have contributed to the exceedence, the short duration of the event together with the lack of wind direction change points to a local smoke/dust event.



60 minute running averaged time series plot



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

Assessable Event