

RAC Air Health Monitor

2025 concise report



The RAC Air Health Monitor network is a non-regulatory system combining a reference grade monitoring station with a dense array of calibrated indicative sensors to deliver high resolution, near real time air quality data for scientific analysis, public health awareness and community level planning. Comparisons to air quality standards are interpretive and should be considered indicative only. Findings are based on data collected by the RAC Air Health Monitor network between 2023 and 2025 and may not be representative of other periods.

For further information, reports and supporting resources, please visit **rac.com.au/airhealth**



Executive summary

The Royal Automobile Club of Western Australia (RAC), representing more than 1.3 million members, continues its commitment to supporting a safer, sustainable and connected future for Western Australia.

The RAC Air Health Monitor (AHM), launched in 2022, has now developed into one of the most comprehensive urban air quality monitoring networks in Australia, providing high resolution, near real time data to support informed decision making, public awareness and evidence-based policy.

Air pollution remains a significant public health and environmental issue, contributing to an estimated seven million premature deaths globally each year¹. In Australia, air pollution from vehicle emissions, particularly particulate matter (PM_{2.5}, tiny airborne particles or droplets that are 2.5 micrometres or less in width) and nitrogen dioxide (NO₂), is estimated to contribute to approximately 1,864 premature deaths annually, with estimates ranging up to 3,000 deaths.² PM_{2.5} and NO₂ are both closely associated with urban activity and transport emissions³. Exposure to these pollutants is linked to a wide range of adverse health outcomes, including respiratory and cardiovascular disease, with emerging evidence⁴ also highlighting impacts on neurological health. Importantly, health effects are observed even at concentrations below many national standards^{4,5}.

The burden of air pollution is not evenly distributed. Children, older adults and individuals with pre-existing health conditions are more vulnerable, and higher levels of exposure are often experienced in locations influenced by traffic and urban activity. This reinforces the importance of understanding not only overall air quality, but also how it varies across different environments and throughout daily life⁶.

Now in its third year of reporting, the 2025 Annual Report reflects a transition from baseline assessment to a more established evaluation of trends over time. With three consecutive years of consistent data from 2023 to 2025, the AHM provides a robust basis for understanding air quality patterns across Perth and Peel. This report presents findings for NO₂, PM_{2.5} and PM₁₀, and incorporates, for the first time within the annual reporting cycle, a full year of data from deployed Black Carbon Modules within the AHM network.

Air quality across the region remained generally stable in 2025, with gradual improvement observed in pollutants associated with human activity. NO₂ concentrations continued their downward trend, with a network-wide annual average of 9.67 parts per billion (ppb), representing a reduction of 5.66% compared with 2024 and nearly 16% since 2023. Despite this improvement, most monitoring locations remained above the World Health Organisation (WHO) annual guideline, with 94.86% of sites exceeding this level. In contrast, compliance with the National Environment Protection Measure (NEPM) standard was broadly maintained.

Traffic emissions remain the primary influence on nitrogen dioxide concentrations, particularly near major roads and highways, where annual averages reached 13.20 ppb. These locations also experienced higher short-term exposure, with approximately 43% of daily averages exceeding the WHO guideline. This confirms that roadside environments continue to represent areas of elevated and persistent exposure.

[1] World Health Organization. (2024). Ambient air pollution: Health impacts. <https://www.who.int/health-topics/air-pollution>

[2] Borchers-Arriagada, N., Chaston, T. B., Morgan, G. G., Knibbs, L. D., & Johnston, F. H. (2025). The mortality burden attributable to PM_{2.5} and NO₂ from all sources and traffic-related air pollution in Australia. *Environmental Research*, 285, 122519. <https://doi.org/10.1016/j.envres.2025.122519>

[3] Yang, J., Liu, C., Burnett, R. T., et al. (2025). Health burden attributable to long-term exposure to ambient PM_{2.5} and NO₂ at low concentrations: A global assessment. *Environmental Research*, 243, 117712. <https://doi.org/10.1016/j.envres.2025.117712>

[4] World Health Organization. (2024). Compendium on health and environment. <https://www.who.int/publications>

[5] World Health Organization. (2025). Ambient air pollution. <https://www.who.int/teams/environment-climate-change-and-health/air-quality-energy-and-health/ambient-air-pollution>

[6] World Health Organization. (2024). Compendium on health and environment. <https://www.who.int/publications>

Clear improvements were observed at school locations. The annual average NO₂ concentration declined to 766 ppb, representing a reduction of 16.9% from 2024 and approximately 26.7% since 2023. While daily exceedances were less frequent than across the wider network, concentrations at schools remain above WHO guideline levels, indicating that further reductions are still required to support long term health outcomes for children. PM_{2.5} concentrations also showed continued improvement. The 2025 annual average was 5.48 micrograms per cubic metre (µg/m³), a reduction of 6.8% from 2024 and more than 17% since 2023. A greater proportion of monitoring sites recorded lower annual concentrations, with nearly one quarter classified as “Good” under the RAC Air Quality Index. However, most locations remained above WHO guideline levels, reflecting the ongoing influence of diffuse urban and seasonal sources. While short term exceedances declined, episodic events linked to bushfires, prescribed burning and winter conditions continued to contribute to elevated concentrations.

In contrast, PM₁₀ concentrations (inhalable particulate matter with a diameter of 10 micrometres or less) remained broadly unchanged over the three-year period, with an annual average of 16.83 (µg/m³) in 2025. This stability reflects the influence of natural and mechanical sources such as windblown dust and surface disturbance, which are less responsive to changes in emissions. Although the frequency of exceedances has declined since 2023, PM₁₀ continues to represent a persistent background exposure across the region.

A significant development in 2025 was the incorporation of black carbon monitoring into the annual reporting framework. Black carbon is a component of PM_{2.5} and provides valuable insight into combustion-related sources of fine particle pollution. Results from the first full calendar year of monitoring indicate that approximately 80% of black carbon concentrations were associated with fossil fuel combustion, primarily vehicle emissions. Elevated pollution events were similarly dominated by these sources, reinforcing the influence of transport emissions and supporting a more detailed understanding of PM_{2.5} emission sources.

These findings have important implications for public health, economic productivity, equity and urban liveability. While overall compliance with national standards remains high, localised and short term exposure continues to occur, particularly in areas influenced by traffic. This highlights the need for a coordinated approach

to air quality management that addresses both emission sources and how, where and when people are exposed in their daily lives. In this context, air quality is closely linked to public health, equity and the liveability of urban environments.

These findings reinforce the importance of a statewide approach to air quality management. RAC continues to advocate for the WA Government to lead the development of an effective, contemporary Air Quality Management Plan (AQMP) for all of Western Australia. An updated AQMP presents an opportunity to incorporate contemporary evidence, consider WHO health-based guidelines alongside regulatory standards, strengthen statewide monitoring and reporting, and better address both emissions and community exposure.

Overall, the 2025 results demonstrate steady progress in reducing nitrogen dioxide and fine particulate matter across the region. However, the continued exceedance of WHO health-based guidelines indicates that further reductions in pollution and exposure are required. As the AHM enters a more established phase, RAC will continue to invest in monitoring, analysis and engagement to support informed policy development and improved air quality outcomes for Western Australia.



▲ RAC Air Health Monitor sensor and black carbon module with community signage

Timeline since project launch

RAC Air Health Monitor

2022

January

Roll-out of RAC AHM begins with installation of first batch of air quality sensors including the install of a reference grade station at RAC Head Office. During this process, sensor host partnerships began with government agency, local governments and private schools.



September

RAC AHM made public with announcement of initiative.



November

Launched at RAC President's Cocktail Event, attended by hundreds of government representatives, industry leaders and key stakeholders.

November - December

Public campaign launching the AHM.



2023

April

Showcased the AHM at the 76th Environmental Health Australia (EHA) WA State Conference.



July

Key feature in the inaugural RAC Imagine Program Futures Challenge.



October

RAC Air Health Stakeholder Series event held with special guests David Lu, Clarity CEO and Andrew Grieve, Senior Air Quality Analyst from Imperial College London (Breathe London).

June

Over 100,000 page views of the AHM.



July - November

Throughout the year, supported by Group CEO, presentations occurred to clubs in Australia and around the world.



November

> Featured in the 'FIA Accelerating a Just Transition: The Motor Sport and Mobility Perspective' White Paper highlighting the environmental initiatives of the FIA and its Members in the field of motor sport and mobility. Presented at COP 28.

> Winner - 2023 Clean Air Society of Australia & New Zealand (CASANZ) WA Branch Clear Air Achievement Award.



December

Finalist in the 2023 FIA President's Awards, Climate Action Award at the General Assembly meeting in Baku, Azerbaijan.

2024

February

Roll out of sensors on major roads and highways with support from Main Roads of Western Australia.



April

- > RAC Air Health video developed in collaboration with Kids Institute, City of Perth and Clarity Movement Co.
- > Additional RAC AQI independent review led by Professors from Curtin School of Population Health, to better align with international and local environmental standards.



June

- > Black carbon trial begins, one of the first of Clarity's global clients. Attendance as an Exhibitor at the 17th International Federation of Environmental Health (IFEH) World Congress.
- > RAC participated in a Clarity Global live webinar showcasing the RAC AHM to attendees from 28 different countries.



August

The AHM was recognised by the Clean Air Society of Australia and New Zealand (CASANZ), by winning the 2024 Innovation and Excellence Awards in the Industry Excellence category.

October - November

The 8 week AHM awareness campaign launched.

2025

February

Launch of RAC's Healthier air education program.

April

Exhibitor at the 78th Environmental Health Australia (EHA) WA State Conference.

July

AHM signage installed at 26 locations sensor locations across Perth with support from sensor hosts.



August - December

Showcased the AHM at community events and industry conferences including CASANZ Air Talks, RAC Member Tree Planting Day, RAC Hackathon, the WALGA Transport and Roads Forum, and the Volunteering WA Awards.



The three-year monitoring journey

The three-year results show a gradual improvement in air quality across the Perth and Peel region, driven by reductions in pollutants associated with combustion sources.

Both NO₂ and PM_{2.5} showed consistent downward trends between 2023 and 2025, while PM₁₀ concentrations remained relatively stable.

Annual AHM Network Comparison:

Data source	Year	NO ₂ (ppb)	PM _{2.5} (µg/m³)	PM ₁₀ (µg/m³)
AHM Network	2023	11.51	6.65	16.22
	2024	10.25 (-10.94%) ↓	5.88 (-11.58%) ↓	16.78 (+3.45%) ↑
	2025	9.67 (-5.66%) ↓	5.48 (-6.80%) ↓	16.83 (+0.30%) ↑
The 3-year variation (2023-2025)		-15.98%	-17.59%	+3.76%

- » Despite a **16% reduction** since 2023, average NO₂ levels remained **nearly double the WHO annual guideline**. Further reductions are needed.
- » **PM_{2.5} down 18%**
Improving fine particle air quality.
- » **PM₁₀ stable**
No significant changes since 2023.
- » **567% growth in EVs** since 2022 supporting long-term emissions reduction⁷.

Traffic emissions remain a persistent air quality challenge across Perth and Peel, with annual average NO₂ concentrations continuing to exceed the current WHO guideline. This highlights the opportunity for further improvement. The observed reduction in traffic-related emissions cannot be attributed to a single factor. However, the trend is consistent with the transition to a cleaner vehicle fleet, including increased electric vehicle uptake, newer vehicle technologies and improved fuel standards.

^[7] Department of Transport and Major Infrastructure. (2025). WA electric vehicle licencing data: December 2025 quarter. Government of Western Australia. https://transport.wa.gov.au/getmedia/a738aea6-0d9c-43d4-ae4e-cb7319877023/PROJ_P_WA_EV_analysis_summary_Dec_2025.pdf

RAC Air Health Monitor Introduction

This report analysed:

PM_{2.5}/PM₁₀ concentrations
and NO₂ measurements across:

214 sites*

Black carbon
monitoring across:

10 sites

Total coverage
area of Perth/Peel

9,730 km²

Tracking NO₂, PM_{2.5}, PM₁₀ and black carbon in real time**

*The number of locations monitored during a year may exceed the number monitored concurrently due to sensor relocations between sites.

**Black carbon is monitored in real time, but is not currently displayed on the AHM map.

60⁺

partners across
Perth and Peel

220k⁺

24-hour measurements
recorded in 2025 across
four pollutants

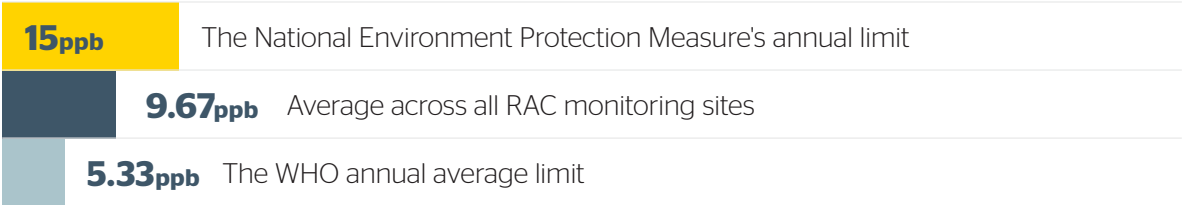
First full year of black carbon
monitoring data integrated
into the report, providing
new insights into traffic-
related emissions



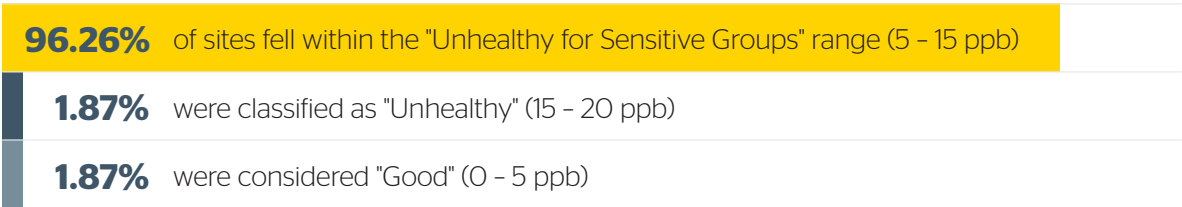
✓ Black carbon module
installed in Victoria Park

Traffic related emissions (NO₂)

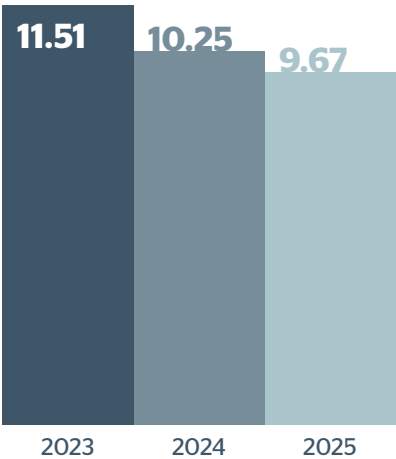
Annual average across all 214 monitoring sites vs The NEPM and WHO annual limit:



RAC Annual Air Quality Index Classification:



Annual average concentration (ppb)



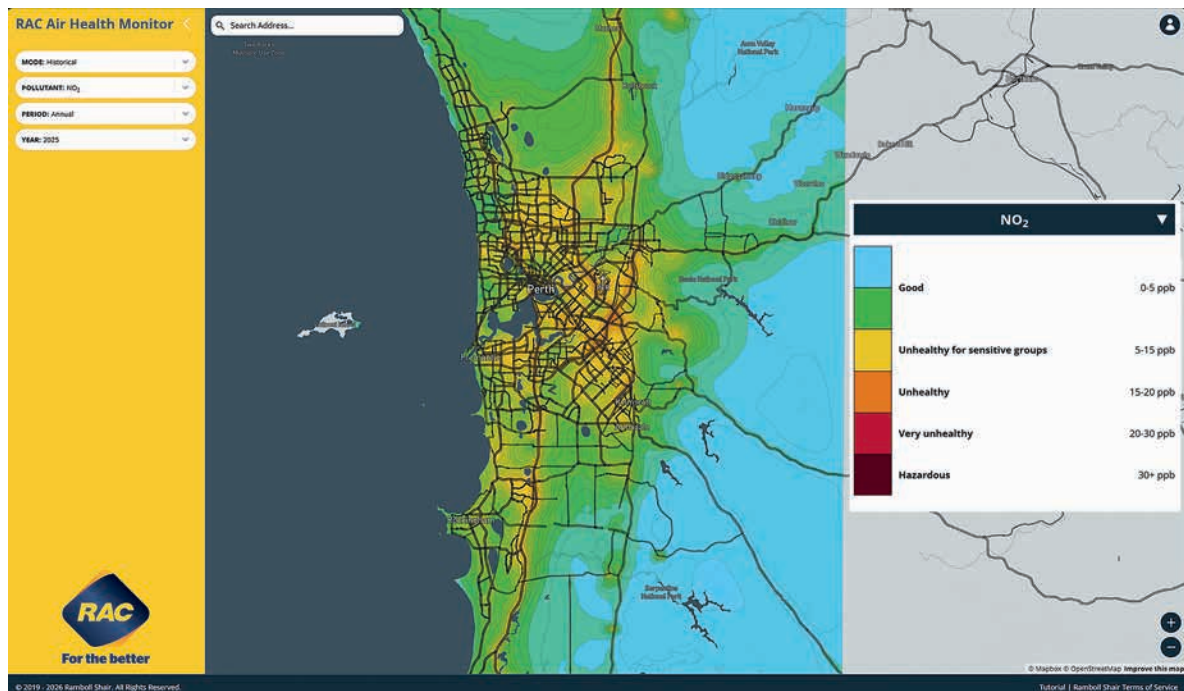
Freeway traffic alongside the Swan River >

1-hour average					
Category	Good	Unhealthy for sensitive groups	Unhealthy	Very unhealthy	Hazardous
Colour					
PM2.5 (µg/m3)	0-25	25-50	50-100	100-300	300+
PM10 (µg/m3)	0-50	50-100	100-200	200-600	600+
NO2 (ppb)	0-40	40-80	80-120	120-180	180+

24-hour average					
Category	Good	Unhealthy for sensitive groups	Unhealthy	Very unhealthy	Hazardous
Colour					
PM2.5 (µg/m3)	0-15	15-25	25-50	50-150	150+
PM10 (µg/m3)	0-25	25-50	50-100	100-300	300+
NO2 (ppb)	0-13	13-40	40-60	60-90	90+

Annual average					
Category	Good	Unhealthy for sensitive groups	Unhealthy	Very unhealthy	Hazardous
Colour					
PM2.5 (µg/m3)	0-5	5-8	8-15	15-45	45+
PM10 (µg/m3)	0-8	8-25	25-30	30-90	90+
NO2 (ppb)	0-5	5-15	15-20	20-30	30+

- ⬆ RAC Air Quality Index⁸
- ⬆ The AHM map displaying the 2025 annual average NO₂ concentrations across the Perth metropolitan area, using data from the network combined with a spatial model to estimate pollutant levels in areas without sensors⁸



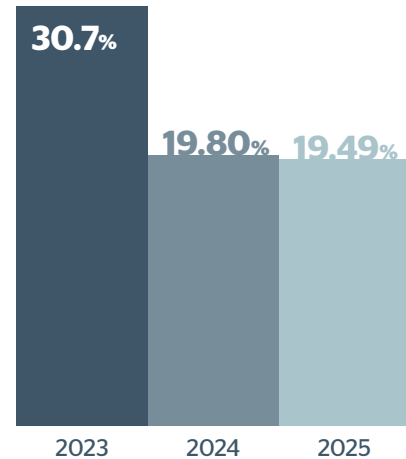
[8] RAC. (2025). About the RAC Air Health Monitor. RAC WA. <https://rac.com.au/about-rac/community-programs/air-health-monitor/about-air-health>

Daily & hourly patterns (NO₂)



Both hourly and daily guidelines reflect acute (short-term) exposure, with hourly limits capturing immediate peaks and daily limits capturing episodes across a full day. Annual guidelines, by contrast, indicate chronic (long-term) exposure.

Daily averages exceeded
WHO 24h limit (13.3ppb)



31%

Weekday NO₂ exceedances rate were more frequent on weekdays than weekends, highlighting the influence of road traffic emissions

100%

of hourly averages complied with the NEPM (80 ppb) standard, indicating that NO₂ concentrations are not primarily driven by extreme hourly spikes, but by sustained pollutant levels throughout the day

19.49%

of more than 74,000 24-hour averages were above the WHO daily guideline of 13.3 ppb. Every monitoring site recorded at least one day exceeding this limit, highlighting episodes of short-term pollution

▼ Perth commuter traffic along the freeway



Main roads and highways (NO₂)

Near-road environments consistently experience poorer air quality compared to urban background locations.

- » Annual average NO₂ concentrations across major traffic routes monitoring locations were **13.20 ppb** in 2025
- » 42.67% of daily measurements in this sensor group **exceeded the WHO 24-hour guideline**, 23.18 percentage points above the overall network average.
- » The **five highest annual average concentrations** among the main roads and highways locations were observed at sensors positioned near major traffic corridors and intersections:



▲ RAC AHM sensor and community signage installed along Albany Highway

Monitored Intersection	Tonkin Highway and Welshpool Road	Roe Highway and Great Eastern Highway Bypass	Leach Highway and Manning Road	East Parade and Graham Farmer Freeway PSP	Leach Highway and Kwinana Freeway
2023 NO ₂ Annual Concentration (ppb)	17.59	N/A*	12.81	12.70	12.21
2024 NO ₂ Annual Concentration (ppb)	15.94 (-9.38%) ↓	15.59	13.68 (+6.79%) ↑	13.59 (+7.01%) ↑	13.47 (+10.32%) ↑
2025 NO ₂ Annual Concentration (ppb)	16.25 (+1.95%) ↑	15.36 (-1.48%) ↓	14.22 (+3.95%) ↑	13.98 (+2.87%) ↑	13.87 (+2.97%) ↑
The three-year variation (2023-2025)	(-7.62%) ↓	N/A	(+11.01%) ↑	(+10.08%) ↑	(+13.60%) ↑
Traffic count (vehicles, weekday average)*	73,619 (Roe Hwy at Welshpool Rd bridge)	24,358 (GEH Bypass west of Roe Hwy)	34,813 (Manning Rd west of Leach Hwy)	45,319 (East Parade north of Summers St)	65,601 (Leach Hwy east of Kwinana Fwy)
Heavy vehicles*	19.3%	21.1%	6.4%	6.1%	7.8%
Main Roads Traffic Map Reference Year*	2021-2022	2023-2024	2024-2025	2025-2026	2021-2022

Main Roads Traffic Map* *Not monitored in 2023

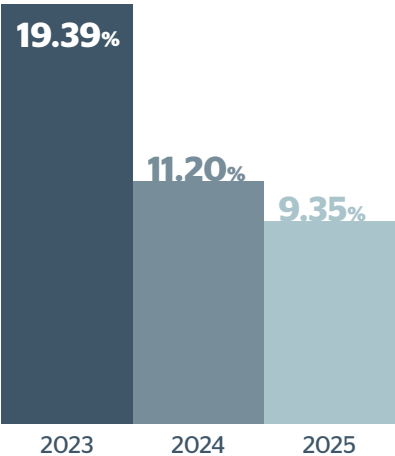
[9] Main Roads Western Australia. (2025). Trafficmap: Traffic volume data for Western Australia. Government of Western Australia. <https://trafficmap.mainroads.wagov.au/map>

Schools (NO₂)



- » Annual averages in schools **remain below the NEPM annual limit** of 15 ppb
- » Although substantial progress has been achieved, the average concentration at school sites in 2025 remained approximately **44% above the WHO annual recommendation**.
- » Approximately **21%** of Perth educational facilities are **located within 100 metres** of a busy road¹⁰.

Daily averages exceeded WHO 24h limit (13.3ppb)



2023 NO ₂ Annual Concentration (ppb)	2024 NO ₂ Annual Concentration (ppb)	2025 NO ₂ Annual Concentration (ppb)	The three-year variation (2023-2025)
10.46	9.22 (-11.86%) ↓	7.66 (-16.92%) ↓	-26.77% ↓

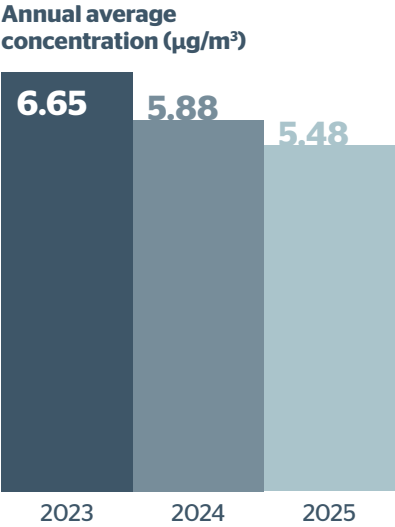
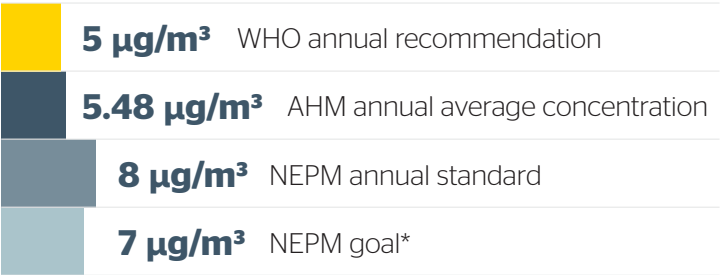


37
participating schools

◀ School students at a pedestrian crossing

[10] Climate Council. (2024). Airborne hazard: Climate change, air pollution and health in Australia. Climate Council of Australia. https://www.climatecouncil.org.au/wp-content/uploads/2024/11/Airborne-Hazard_ClimateCouncilReport.pdf

Fine particle pollution (PM_{2.5})



Main sources
Pollutant concentrations are influenced by both natural and human sources, including vehicle emissions, residential wood heating, commercial activities, and smoke from prescribed burns, planned burn-offs, and bushfires.

PM _{2.5} maximum concentration standard (24h)	Year	Number of daily exceedances during the year	Exceedance rate (%)	Percentage of sites recorded at least one daily exceedance
WHO (15 µg/m³)	2023	2,184	4.2%	88.52%
	2024	1,220	1.79%	97.63%
	2025	988	1.34%	94.39%
NEPM (25 µg/m³)	2023	448	0.86%	71.04%
	2024	327	0.48%	86.26%
	2025	125	0.22%	39.72%
NEPM goal (20 µg/m³)*	2025	325	0.44%	78.50%



Perth cityscape at sunset with smoke in the air

75.70%

of sites “Unhealthy for Sensitive Groups” based on the RAC Annual Air Quality Index classification

*Note: The current NEPM for ambient air quality includes PM_{2.5} goals of 20 µg/m³ (24-hour average) and 7 µg/m³ (annual average) from 1 January 2025¹. While these values are defined as goals rather than compliance standards, they provide an additional benchmark against which PM_{2.5} concentrations can be assessed.

^[11] National Environment Protection Council. (2021). National Environment Protection (Ambient Air Quality) Measure. Australian Government. <https://www.environment.gov.au/protection/nepc/nepms/ambient-air-quality>

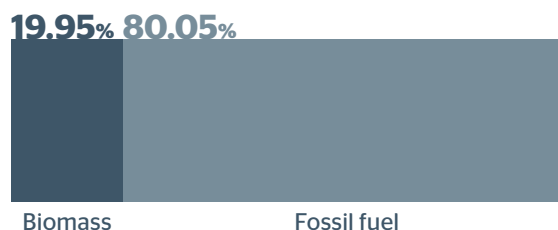
Black carbon

Black carbon, often referred to as “soot,” is a component of fine particulate matter (PM_{2.5}) resulting from the incomplete combustion of fossil fuel (i.e. sooty black material emitted from gas and diesel engines), biofuel and biomass^{12, 13}.

While Australia and the WHO do not currently set specific ambient air quality standards for black carbon, it is recognised as an important pollutant due to its links to combustion sources, adverse health effects and climate warming.

- » Fossil fuel black carbon concentrations were **35% higher on weekdays than weekends**, reflecting the influence of commuting and other weekday activities across the Perth and Peel region.
- » Lower weekend fossil fuel black carbon concentrations, similar to nitrogen dioxide patterns, mirror changes in travel behaviour across the week and demonstrate how **transport emissions contribute to measurable changes in urban air quality**.

Black carbon average source distribution

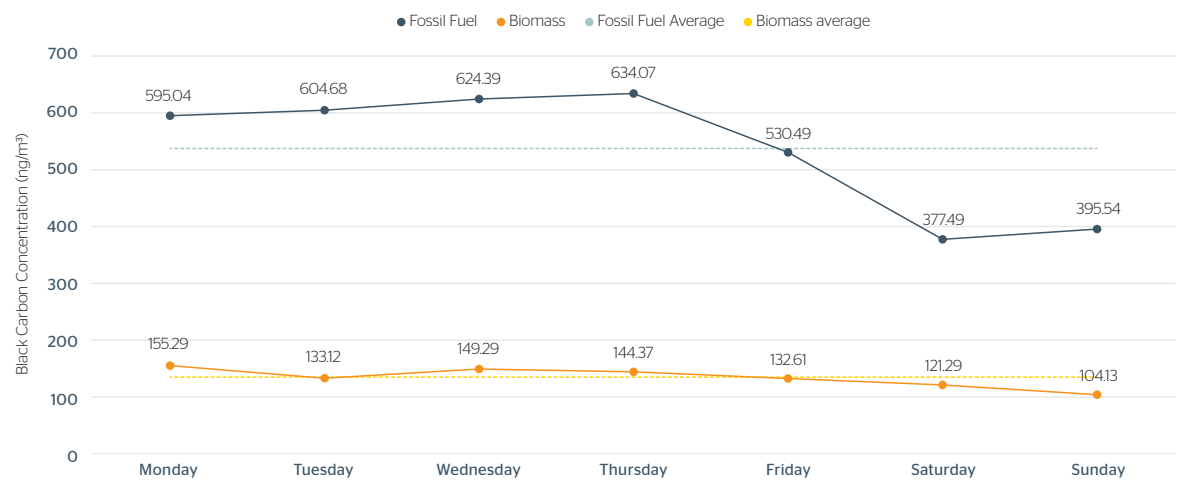


[12] Climate & Clean Air Coalition. (n.d). Black carbon. CCAC. <https://www.ccacoalition.org/short-lived-climate-pollutants/black-carbon>

[13] Carbon Containment Lab. (2022). Black Carbon: An introduction to a high-impact super pollutant. Yale University. <https://carboncontainmentlab.org/updates/posts/black-carbon-an-introduction-to-a-high-impact-super-pollutant>

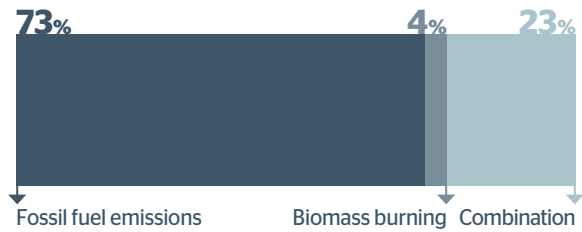


Black carbon average concentration by weekday



What drives black carbon peak events?

73% of black carbon peak events can be primarily attributed to fossil fuel emissions, predominantly from vehicular sources, while biomass burning contributes to around 4% of occurrences, and approximately 23% of events reflect a combination of both sources.



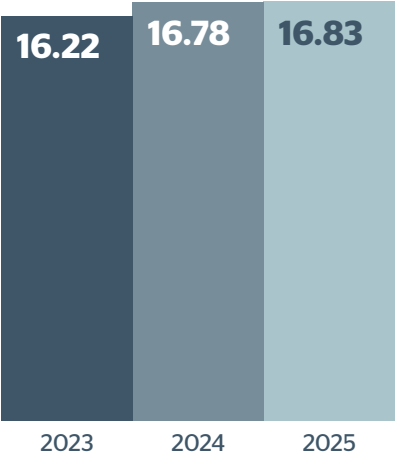
Coarse particle pollution (PM₁₀)

15 µg/m³	WHO annual recommendation
16.83 µg/m³	Annual average concentration
25 µg/m³	NEPM annual standard



Natural sources (e.g. dry soils, windblown dust, sea salt, and bushfire smoke) are the primary contributors, with smaller contributions from anthropogenic sources, including construction activities, disturbed land surfaces, unsealed road traffic, and smoke from prescribed burns and agricultural burn-offs. Seasonal patterns also influence PM₁₀ levels.

Annual average concentration (µg/m³)



PM ₁₀ maximum concentration standard (24h)	Year	Number of daily exceedances during the year	Exceedance rate (%)	Percentage of sites recorded at least one daily exceedance
WHO (45 µg/m³)	2023	395	0.76%	74.86%
	2024	315	0.46%	78.19%
	2025	288	0.39%	54.67%
NEPM (50 µg/m³)	2023	297	0.57%	65.03%
	2024	150	0.22%	40.78%
	2025	169	0.23%	37.38%



100%

of sites “Unhealthy for Sensitive Groups” Based on the RAC Annual Air Quality Index classification

Urban construction site

Policy implications and future actions

Looking ahead, the AHM will continue to support evidence based policy, advocacy and community engagement by tracking annual trends, identifying persistent exposure hotspots and improving understanding of transport-related air pollution. RAC will continue to report on annual trends and key insights to support education, campaigns, and awareness.

The AHM also provides a valuable decision support tool for government, local authorities and community stakeholders, helping identify where exposure occurs and where targeted interventions may be most effective.

Insights from the AHM will continue to strengthen RAC's advocacy by providing an evidence base to inform policy positions, budget submissions and engagement with government and industry

stakeholders. In this way, the AHM helps bridge the gap between data and action, ensuring policy responses are better aligned with how and where people experience air pollution in their daily lives.

The findings also reinforce the importance of a coordinated, statewide approach to air quality management. RAC continues to advocate for the WA Government to lead the development of an effective, contemporary air quality management plan for the State.

By continuing to invest in monitoring, partnerships and community engagement, RAC can help ensure that air quality remains a visible and actionable issue, supporting healthier communities and a safer, sustainable and connected Western Australia.

To find out more visit [**rac.com.au/publicpolicy**](https://rac.com.au/publicpolicy)



