

Air quality standards in Aotearoa – time for an update

Thirteen years after the Resource Management Act 1991, the Resource Management (National Environmental Standards for Air Quality) Regulations 2004 were promulgated to provide national direction for air quality management by setting a guaranteed minimum level of health protection for all New Zealanders.

During the nearly 20 years since the national air quality standards were introduced, there has been a significant improvement in particle pollution. Particles are characterised by their diameter which determines transport, deposition characteristics and ultimately health effects. For example, PM_{10} includes inhalable particles that are sufficiently small to penetrate to the thoracic region. Finer particulates, with diameter less than 2.5 micrometres ($PM_{2.5}$), have a high probability of deposition in smaller conducting airways and lung alveoli. The improvement in New Zealand's air quality is most evident by reviewing annual exposure to particulate matter less than 10 micrometres in diameter, or PM_{10} .

A 2022 study on *Health and Air Pollution in New Zealand 2016 (HAPINZ 3.0)* (Kuschel and others, Ministry for the Environment, Ministry of Health, Te Manatū Waka Ministry of Transport and Waka Kotahi NZ Transport Agency, 6 July 2022) reported the 2006 national population-weighted, annual average PM_{10} concentration was $15.3 \mu\text{g}/\text{m}^3$. By 2019, the study reports this had dropped to $12.8 \mu\text{g}/\text{m}^3$ – a reduction of 17 per cent. This dramatic improvement can be attributed to two elements of the 2004 national air quality standards:

- mandatory monitoring of ambient air quality; and,
- minimum requirements for new wood burners in people's homes to be clean and efficient.

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The first provided data to demonstrate the scale of the problem and enabled a slow, but steady reduction in emissions from New Zealand's priority pollution source – home heating. Coupled with significant local and central government investment to retrofit insulation in homes, and hard graft by regional councils and unitary authorities taking unpopular action on domestic fires, the national air quality standards have resulted in wintertime air pollution becoming a thing of the past in many small towns and cities across the motu.

However, the science has also shifted dramatically in this time, making the 2004 air quality standards outdated and no longer fit for purpose as an appropriate minimum level of health protection for New Zealanders. The following discussion explores some of the reasons why it's time to update the national air quality standards.

WHAT DOES THE NEW SCIENCE SAY?

In 2021, the World Health Organization (WHO) published updated Global Air Quality Guidelines in *WHO global air quality guidelines: Particulate matter ($PM_{2.5}$ and PM_{10})*,

ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide (WHO, 2021) with supporting systematic reviews of the updated guidelines in a special issue of *Environment International* (Paul Whaley and others (eds) "Update of the WHO global air quality guidelines: systematic reviews" (Environment International, 2021)). The systematic reviews present a substantial new body of evidence, since the Global Air Quality Guidelines of 2005 (*Air Quality Guidelines Global Update 2005: Particulate matter, ozone, nitrogen dioxide and sulfur dioxide* (WHO, 2005)), demonstrating the degree that air pollution affects all parts of the body, from the brain to a growing baby in a mother's

womb, at significantly lower concentrations than previously observed. The WHO 2021 guidelines take into account this latest body of evidence on the health impacts of different air pollutants, making them much more stringent than the WHO 2005 guidelines.

Table 1 below, presents the WHO 2021 guidelines for comparison with New Zealand's current air quality guidelines and standards. The table, and following review of the recent evidence, emphasises the importance of addressing chronic exposure (while continuing to address acute exposure) and applying air quality standards both indoors and outdoors.

Table 1. WHO 2021 and NZ Air Quality Guidelines and Standards

Pollutant	Time Average	WHO 2021 Air Quality Guidelines ($\mu\text{g}/\text{m}^3$)	NZ Air Quality Standards/ Guidelines ($\mu\text{g}/\text{m}^3$)
NO ₂	Annual	10	–
	24-hours	25	100 ^a
O ₃	Peak Season ^d	60	–
	8-hours	100	150 ^b
PM _{2.5}	Annual	5	–
	24-hours	15	25 ^c
PM ₁₀	Annual	15	20 ^a
	24-hours	45	50 ^b
SO ₂	24-hours	40	120 ^a
	1-hour	–	350 ^{b*} / 570 ^{b*}
CO	24-hours	4 mg/m ³	–

^a 2002 Ambient Air Quality Guideline ^b 2004 National Environmental Standard ^c 2002 Reporting guideline only ^{*} Lower limit has 9 exceedances permitted in any 12-month period and upper limit permits zero exceedances ^d Average of daily maximum 8-hour mean O₃ concentration in the six consecutive months with the highest six-month running-average O₃ concentration (usually summer).

Chronic Exposure is a Priority

Table 1 shows overall that New Zealand has very little protection for chronic (long-term) exposure to air pollution due to the lack of guidelines and standards for longer term measurement. This is at odds with findings that more people are adversely affected, more seriously, through chronic (long-term) exposure than through acute (short-term) exposure (WHO, 2021).

For example, Chen & Hoek in their 2020 review of long-term exposure to particulate matter and mortality (Jie Chen and Gerard Hoek "Long-term exposure to PM and all-cause and cause-specific mortality: A systematic review and meta-analysis" (2022) 143 *Environment International* 105974), report that that every 10 $\mu\text{g}/\text{m}^3$ increase in *annual* PM₁₀ is associated with a 4 per cent increase in all-cause mortality i.e., people die that would otherwise not have died at that time (this is also referred to as premature mortality).

In contrast, Orellano and others. in their 2020 review of short-term exposure and mortality (Pablo Orellano and others "Short-term exposure to particulate matter (PM10 and PM2.5), nitrogen dioxide (NO₂), and ozone (O₃) and all-cause and cause-specific mortality: Systematic review and meta-analysis" 142 *Environment International* 105876) found that every 10 µg/m³ increase in *daily* PM₁₀ was associated with a 0.4 per cent increase all-cause mortality. This means that elevated long-term particle pollution levels cause (an order of magnitude) higher mortality (deaths) and morbidity (illness) than elevated short-term particle pollution levels.

Similarly, Huangfu & Atkinson in a 2020 review found there is also evidence that the risks of long-term exposure to other pollutants such as nitrogen dioxide and ozone are greater than short-term exposure (Peijue Huangfu and Richard Atkinson "Long-term exposure to NO₂ and O₃ and all-cause and respiratory mortality: A systematic review and meta-analysis" (2022) 144 *Environment International* 105998). Chronic (long-term) exposure to air pollution is more serious than acute (short-term) exposure. Consequently, long-term air quality guidelines are more health protective than short-term guidelines.

Despite this, New Zealand does not have long-term air quality standards for any pollutants. The Ministry for the Environment published an annual guideline (not standard) for PM₁₀ of 20 µg/m³ in 2002 (Ministry for the Environment *Ambient Air Quality Guidelines: 2002 Update* (1 May 2002)). The WHO 2021 guideline and evidence identified above provide some compelling reasons for long-term standards for particulates (PM_{2.5} and PM₁₀) to provide greater health protection.

The evidence also supports introducing long-term standards for nitrogen dioxide and ozone. The *Health and Air Pollution in New Zealand 2016 Study (HAPINZ 3.0)* addressed for the first time, the health impacts of nitrogen dioxide in New Zealand. This study found that in 2016, more than 60 per cent (or 2,000) of the 3,300 deaths associated with human induced air pollution were associated with nitrogen dioxide (NO₂) pollution – largely from motor vehicles. New Zealanders are dying and getting sick from air pollution. The introduction of long-term air quality guidelines and/or national standards should be a priority.

It should be noted that short-term (acute) guidelines and/or standards are also needed to protect for additional/different health effects (e.g., asthma and hospital admissions during short high-level air pollution events). This provides another compelling reason to update the existing national air quality standards with new long-term, and updated short-term, criteria.

Indoor and Outdoor Application of Standards

WHO identifies that the 2021 guidelines apply to both indoor and outdoor environments. In practice, air quality professionals assume indoor air *is* outdoor air when preparing air quality assessments in New Zealand (and elsewhere). Epidemiology, on which the criteria are based, assumes the same. This is because in practice health effects at population level are statistically calculated from outside air quality measurements associated with the health effects people experience living and working (mostly inside) relative to the monitoring stations. However, in New Zealand, non-workplace related indoor air quality is not currently regulated. If this regulatory gap were to be filled, which agency should be driving reform?

Te Whatu Ora Health New Zealand (formerly the Ministry of Health) is the obvious choice, consistent with its purpose under the Health Act 1956 to improve, promote, and protect public health. Presumably, this applies everywhere (i.e., both indoors and outdoors). Health-based indoor and outdoor air quality guidelines from Te Whatu Ora could provide a science foundation for the Environment Ministry to implement/update some, or all, of the guidelines as ambient (i.e., outdoor) national environmental standards. This could in turn include interim targets and timeframes to meet the challenges in attaining significantly reduced pollutant concentration values that apply outdoors.

For indoor air, the health-based guidelines established by Te Whatu Ora could support other government agencies with a portfolio interest in indoor air quality, including: the Ministry of Business, Innovation and Employment (housing), Kainga Ora (state housing), Te Taupapa Kura Tainga – Ministry of Housing and Urban Development, Ministry of Education (school buildings) and Energy Efficiency and Conservation Authority (heating and energy).

SHOULD AOTEAROA MEET 2021 WHO GUIDELINES?

At the time of their introduction in 2004, the national air quality standards were world leading. It is time to make them fit for purpose again by updating them to align with the WHO 2021 guidelines. The science is clear, and the health benefits will be enormous.

CAN AOTEAROA MEET THE 2021 WHO GUIDELINES?

The concentration limits in the 2021 WHO guidelines are, with one exception, significantly reduced from the 2005 version. WHO has set concentration limits for pollutants at levels that are very, very low – close to background levels. Meeting these limits will require substantial reductions in emissions from homes, vehicles, and industry. The Director General of the WHO (*WHO Director-General remarks at the launch of the WHO Global Air Quality Guidelines, 22 September 2021*) has emphasised the society wide nature of efforts to tackle air pollutants as:

This is not a job for the health sector alone. It requires an all-of-government and all-of-society approach to improve the governance of air quality, the monitoring of air pollution risks, and the engagement of all economic sectors in reducing emissions. ... I urge all countries to put these guidelines to use, to save lives, support healthy communities, and help address the climate crisis.

The scale of the air pollution challenge does not mean we need to stop driving cars, shut down industry and stop burning wood to heat our homes. But we should be clear-eyed about the impacts of the way we're living. Air quality science has advanced to the point where we can make robust, quantified estimates of the impacts of discharges to air on mortality and morbidity. It is appropriate for these quantified risks to inform decision making in a transparent manner.

We are currently, however, in a policy and regulatory vacuum. Air quality practitioners are not required to prepare air quality assessments in accordance with the WHO 2021 guidelines. Decision makers, industry and the public will not necessarily know how much weight the WHO 2021 guidelines should be given in comparison to the existing, less stringent, New Zealand standards and guidelines. Agencies such as Waka Kotahi will be uncertain which

levels they should be aiming to achieve in major transport projects. Central and local government investing in home heating retrofit programmes will be similarly uncertain.

Before introduction of the national air quality standards in 2004, a non-unified nationwide regulatory approach resulted in re-establishing the appropriate assessment criteria for each air discharge or land use consent application, regional air plan or regional policy statement every time. It would be a shame to return to this situation 20 years later.

Interim targets proposed by WHO to meet the 2021 guidelines provide a means to transition the 2004 national air quality standards towards the more stringent WHO 2021 guidelines. It would be sensible to align any interim targets with New Zealand's climate change targets as a part of an integrated, all-of-government approach. This would save lives locally, and globally.

BUT AREN'T WE ALREADY UPDATING THE NATIONAL ENVIRONMENTAL STANDARDS FOR AIR QUALITY?

The lack of any standards (long- or short-term) for PM_{2.5} is not a new issue but rather one that was raised by the Parliamentary Commissioner for the Environment in 2015 (Parliamentary Commissioner for the Environment *The State of Air Quality in New Zealand: Commentary by the Parliamentary Commissioner for the Environment on the 2014 Air Domain Report* (05 March 2015)). In early 2020, the Ministry for the Environment proposed amendments to include inter alia, a new long-term standard for PM_{2.5} (Ministry for the Environment *Proposed Amendments to the National Environmental Standards for Air Quality: Particulate Matter and Mercury Emissions – Consultation document* (February 2020)). Despite public consultation closing in April 2020, no changes have yet been publicly announced. The advantage of this delay is that now the WHO 2021 Global Air Quality Guidelines have been published, they could, and should, be used to inform updating the national air quality standards. As a minimum, long-term air quality concentration limits should be urgently introduced in Aotearoa New Zealand as either guidelines or standards. Isn't it time that New Zealanders enjoyed their basic human right to breathe clean air (*The human right to a clean, healthy and sustainable environment* HRC RES 48/13 (8 October 2021))?