Nitrogen dioxide concentrations

This report presents indicators of nitrogen dioxide concentrations at monitoring sites in New Zealand between 2020 and 2023. Concentrations are measured against the National Environmental Standard for Air Quality (NESAQ) and World Health Organisation (WHO) 2021 guidelines for nitrogen dioxide exposure.

Key facts

- One out of ten monitoring stations recorded levels of nitrogen dioxide (NO_2) that exceeded the national standard for hourly concentrations between 2020 and 2023.
- Almost all monitoring stations with at least three complete years exceeded the WHO recommendations for daily concentrations of NO_2 on multiple occasions between 2020 and 2023.
- Five monitoring stations recorded levels of NO_2 exceeding the WHO 2021 guideline for annual average concentrations (10 µg/m^3) between 2020 and 2023.

What is nitrogen dioxide?

Nitrogen dioxide (NO_2) is a corrosive gas that mixes with air. In New Zealand, most human-made forms of NO_2 come from motor vehicles – primarily (77%) from diesel-fuelled types.

Exposure to NO_2 can cause a range of health impacts in people, including increasing their susceptibility to infections and asthma. Health impacts from NO_2 include premature death, hospitalisations (for cardiovascular and respiratory diseases), and childhood asthma. In 2016, NO_2 was responsible for 61% of the social cost of air pollution in New Zealand, in terms of the direct cost to the health system as well as the loss of life, lost quality of life and lost productivity.

In 2016, NO_2 was responsible for:

2,025 premature deaths

8,531 hospitalisations for cardiovascular & respiratory disease

$9.4 billion social cost

Source: Kuschel, Metcalfe, Sridhar, Davy, Hastings, Mason et al 2022

Air quality standards and guidelines

NO_2 air quality standards and guidelines have been developed to provide some level of protection against health risks. One-hour average NO_2 concentrations are measured against a threshold value of 200 micrograms (µg) per cubic metre in the National Environmental Standards for Air Quality (NESAQ). This value is allowed to be exceeded nine times in a 12-month period.

Additionally, annual and daily average concentrations can be compared against the 2021 guidelines set by the WHO of 10µg/m^3 and 25 µg/m^3, respectively (Ministry for the Environment and Stats NZ 2021), though, unlike the NESAQ, these are not binding targets.

Nitrogen dioxide monitoring is limited

Between 2020 and 2023, ten monitoring stations were assessed to have data for at least three complete years (Figure 1). All of these were located in the North Island, with seven stations operated by Auckland Council and three by the Greater Wellington Regional Council. Also, as each station only monitors the air in its immediate area, each station is only representative of a small area around it and not of a whole town or city.

For instance, sites closer to roads or industrial sites are likely to record higher concentrations of pollutants than the local norm. Therefore, sites have been classified according to their location as being in residential areas, areas of high traffic, or background areas.

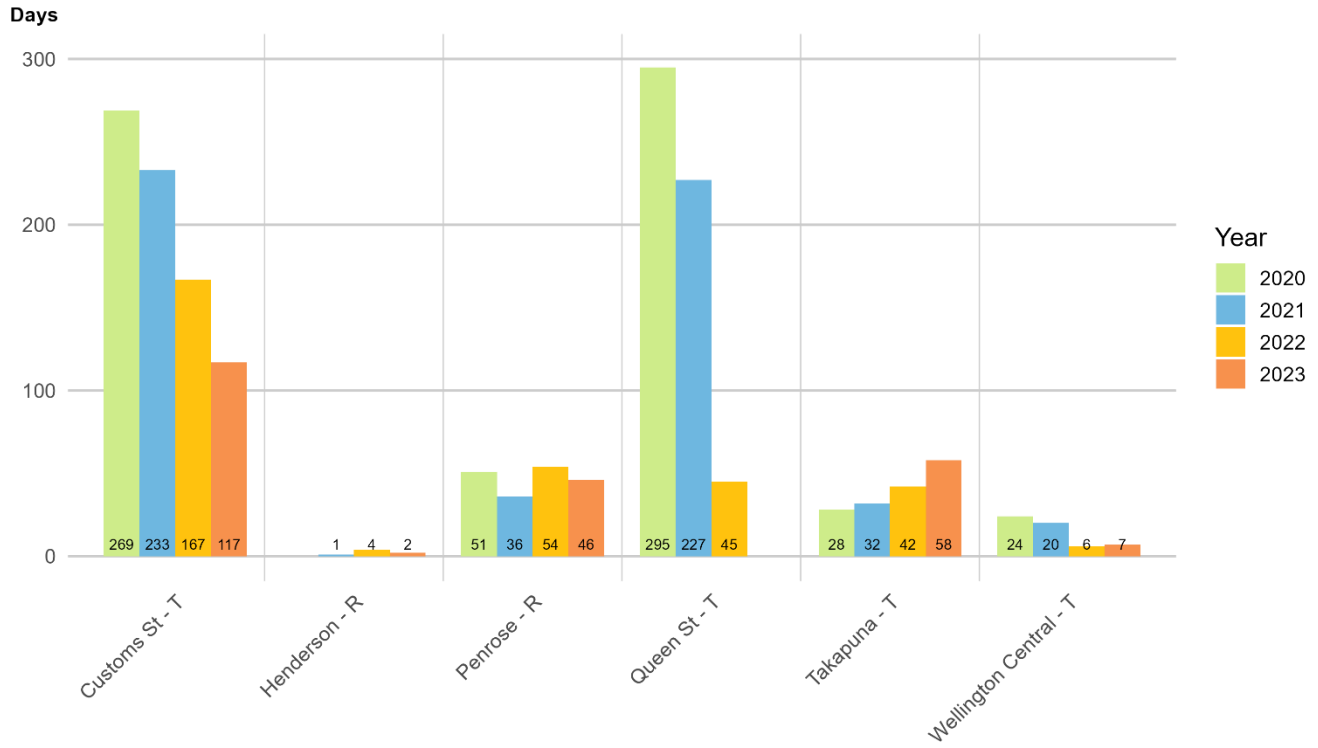
Figure 1: **Monitoring stations with records of NO_2 for at least three complete years between 2020 and 2023.**

Source: Statistics New Zealand 2024

Exceedances of the daily average WHO guideline for NO_2

Six out of ten monitoring stations exceeded the WHO daily average NO_2 guideline at least three times over the four-year period between 2020 and 2023 (Figure 2). Customs and Queen Street in Auckland CBD had the most exceedances of the daily guideline in that period, exceeding it on average 196 and 189 days per year, respectively. Henderson had the fewest, with an average of two days per year.

Figure 2: Number of exceedances of the daily average WHO guideline for NO_2



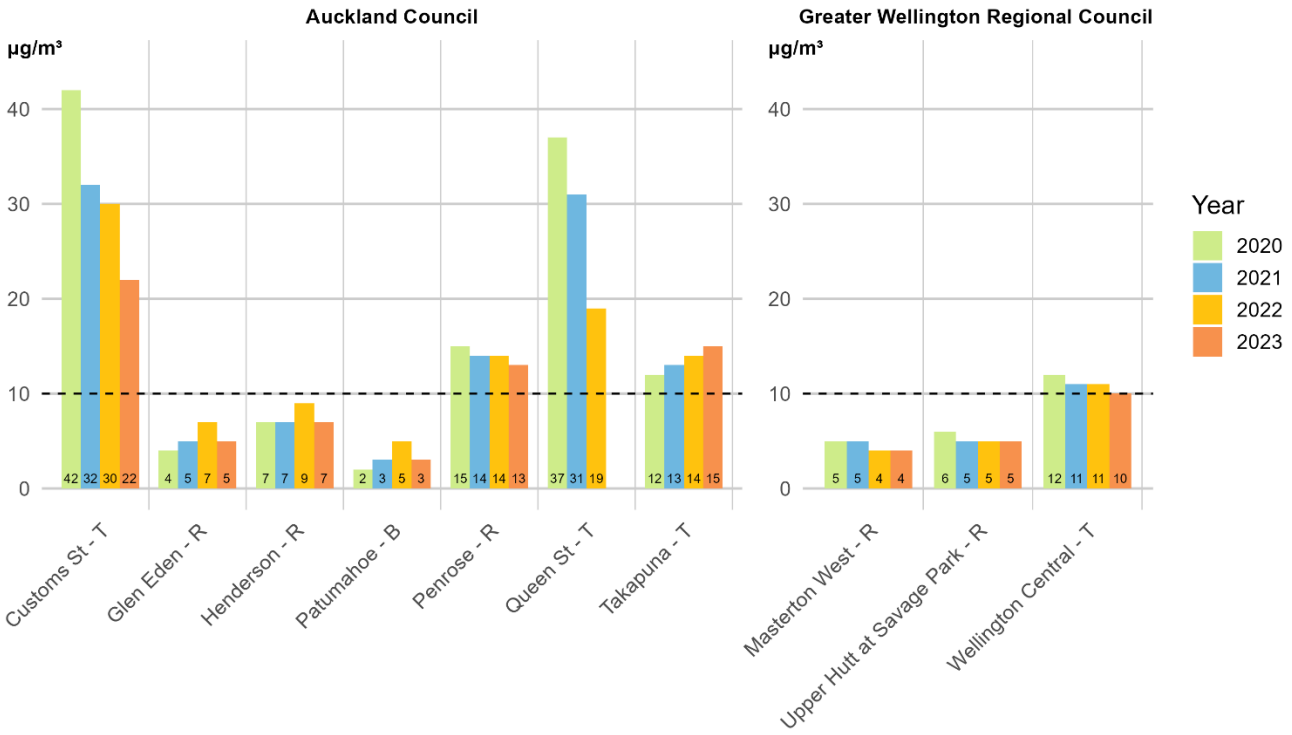
Notes: This graph shows the number of days when the NO_2 daily average concentration exceeded the WHO 2021 guideline of 25 µg/m^3. Blank columns represent no data for that year, i.e. data was unavailable or incomplete. Site classifications are indicated by T for traffic, R for residential, and B for background.
Source: Statistics New Zealand 2024

Exceedances of the annual average WHO guideline for NO2

The four monitoring stations in the Auckland region and one out of three in the Wellington region (the station in Wellington City itself) exceeded the WHO annual average guideline (10 µg/m^3) between 2020 and 2023 (Figure 3). Customs Street and Queen Street recorded the highest annual averages during this period (31.5 and 29 µg/m^3, respectively). Penrose and Takapuna in Auckland, and Wellington Central, recorded annual averages of 14, 13.5, and 11 µg/m^3, respectively.

In general, monitoring stations with a traffic focus (such as Customs Street, Queen Street, Takapuna, and Wellington Central) recorded higher annual average NO_2 concentrations than monitoring stations with a residential focus (such as Glen Eden, Henderson, Masterton, and Upper Hutt) or a background focus (Patumahoe). Only one residential-focused station in Auckland (Penrose) exceeded the WHO annual average value. This reflects the high contribution of motor vehicle emissions to NO_2 concentrations and highlights the localised nature of NO_2 emissions (Ministry for the Environment and Stats NZ, 2018).

Figure 3: Annual average NO_2 concentrations at monitoring stations,2020– 2023



Notes: The WHO 2021 guideline for NO_2 annual average concentrations is 10µg/m^3. Site classifications are indicated by T for traffic, R for residential, and B for background. Annual average threshold of 10µg/m^3 is shown in the dashed line.

Source: Statistics New Zealand 2024

One monitoring site exceeded the NESAQ hourly threshold

Between 2020 and 2023, exceedances of the NESAQ threshold were rare, with none occurring in 2021 and 2022. Only one station (Customs Street) out of ten exceeded the national one-hour average standard in 2020 (five times) and 2022 (94 times). The excessively high number of exceedances recorded in 2022 can be attributed to exhaust emissions from a mobile power generator that operated about 50 metres north of the monitoring location in June 2022 (Boamponsem, 2023).

Data for this indicator

Monitoring sites exceeding the national environmental standard (one-hour average) for nitrogen dioxide

One-hour average nitrogen dioxide concentration data comes from Statistics New Zealand (Statistics New Zealand 2024). Data is published by Statistics New Zealand 2024 and available via Nitrogen dioxide concentrations: Data to 2023 | Stats NZ. One-hour average nitrogen dioxide concentrations (in µg/m^3) are compared with the National Environmental Standard for Air Quality for nitrogen dioxide. The threshold is exceeded when concentrations are above 200µg/m^3. Nine exceedances in a 12-month period are allowed.

Monitoring sites exceeding the WHO average guidelines for nitrogen dioxide

EHINZ used the 24-hour and 12-month averages calculated and published by Statistics New Zealand from the above data source. Exceedances occur when concentrations exceed 25 µg/m³ for daily averages or 10 µg/m³ for annual averages

A complete year is defined as a year in which:

- Each season is at least 75% comprised of complete days, and
- **A complete day** is defined as one with at least 18 out of 24 hours of valid data recorded for the daily (24-hour) average.

A site is required to have a 75% completion rate for a given period of time for the data to be considered valid.

For additional information, see the Metadata sheet.

References

Kuschel G, Metcalfe J, Sridhar S, Davy P, Hastings K, Mason, K et al. 2022. *Health and air pollution in New Zealand 2016 (HAPINZ 3.0): Volume 1 –Findings and implications.* Report prepared by G Kuschel, J Metcalfe, S Sridhar, P Davy, K Hastings, K Mason, T Denne, J Berentson-Shaw, S Bell, S Hales, J Atkinson and A Woodward for Ministry for the Environment, Ministry of Health, Te Manatū Waka Ministry of Transport and Waka Kotahi NZ Transport Agency.

Ministry for the Environment and Statistics New Zealand. 2018. *Our air 2018. Data to 2017*. Wellington: Ministry for the Environment.World Health Organization (WHO). 2006. *Air quality guidelines. Global update 2005.* Geneva: World Health Organization.

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Boamponsem, L. (2023). *Auckland air quality – 2022 annual data report*. Auckland Council technical report, TR2023/8

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