Environment and Climate Change Canada
Environnement et Changement climatique Canada

# POPULATION EXPOSURE TO OUTDOOR AIR POLLUTANTS

## CANADIAN ENVIRONMENTAL SUSTAINABILITY INDICATORS

Canada

**Suggested citation for this document:** Environment and Climate Change Canada (2023) Canadian Environmental Sustainability Indicators: Population exposure to outdoor air pollutants. Consulted on *Month day, year*.
Available at: www.canada.ca/en/environment-climate-change/services/environmental-indicators/population-exposure-outdoor-air-pollutants.html.

Cat. No.: En4-144/91-2023E-PDF
ISBN: 978-0-660-42117-9
Project code: EC21032



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# CANADIAN ENVIRONMENTAL SUSTAINABILITY INDICATORS

# POPULATION EXPOSURE TO OUTDOOR AIR POLLUTANTS

## March 2023

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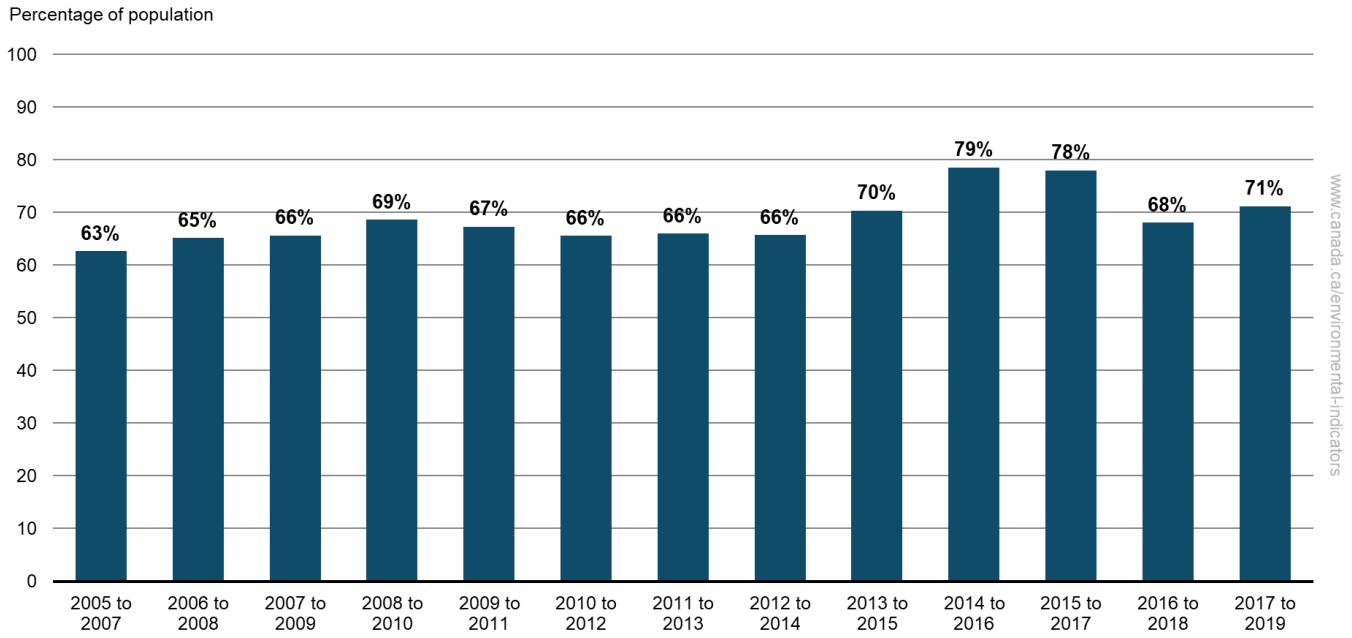
# Population exposure to outdoor air pollutants

Breathing in air pollutants can contribute to health issues such as asthma, cardiovascular diseases and premature mortality. The Canadian Ambient Air Quality Standards (CAAQS, the standards) are health and environmental-based outdoor air quality objectives for pollutant concentrations in the air.[1] The standards are intended to protect human health and the environment and to drive continuous improvement in air quality across Canada. This indicator tracks the percentage of the population living in areas of Canada where outdoor concentrations of air pollutants were less than or equal to the 2020 standards.[2]

## Key results

- In the most recent reporting period (2017 to 2019), 71% of Canadians lived in areas where outdoor concentrations of air pollutants were within the standards
    - This represents an improvement from 68% in the previous reporting period (2016 to 2018), mainly because air pollution concentrations in Mississauga did not exceed the standards in 2017 to 2019
    - It is also an improvement from 63% for the first reporting period (2005 to 2007)

**Figure 1. Percentage of Canadians living in areas where outdoor concentrations of air pollutants were less than or equal to the 2020 Canadian Ambient Air Quality Standards, Canada, 2005 to 2019**




Data for Figure 1

**Note:** With the exception of the annual standards for nitrogen dioxide and sulphur dioxide, the 2020 Canadian Ambient Air Quality Standards used in the indicator use 3-year average concentrations. For this reason the bar chart portrays percentage values over 3-year periods. The annual standards for nitrogen dioxide and sulphur dioxide use a single annual concentration for the 3-year reporting period. For example, for the 2017 to 2019 reporting period, the annual concentrations for 2019 were used for the annual standards for nitrogen dioxide and sulphur dioxide.

[1] Health effects can occur at levels below the 2020 CAAQS, so the Air Quality Management System includes the Air Zone Management Framework. It includes 4 colour-coded management levels which are associated with a suite of monitoring, reporting and management actions that become progressively more rigorous as air pollutant concentrations approach or exceed the CAAQS.

[2] The indicator uses the 2020 Canadian Ambient Air Quality Standards for comparative purposes only. Provinces and territories are responsible for reporting on achievement of the Canadian Ambient Air Quality Standards. For information on the Canadian Ambient Air Quality Standards, refer to the State of the Air website.

**Source:** Environment and Climate Change Canada (2022) Air Quality Research Division. Health Canada (2022) Air Quality Risk Assessment Division.

The indicator uses a total of 7 standards[3] related to 4 air pollutants (fine particulate matter [$PM_{2.5}$], ground-level ozone [$O_3$], nitrogen dioxide [$NO_2$] and sulphur dioxide [$SO_2$]). All 7 of these standards must be met for the population of a given area to be counted as less than or equal to the standards.

During the 2017 to 2019 reporting period, Ontario, Alberta and British Columbia had the most exceedances, while Quebec, New Brunswick and Saskatchewan had a smaller number of exceedances. Newfoundland and Labrador, Prince Edward Island, Nova Scotia, Manitoba, the Northwest Territories, Yukon and Nunavut had no exceedances.[4] For detailed information on geographical areas where exceedances were observed, please refer to Annex B.

Between the 2005 to 2007 and 2017 to 2019 reporting periods, the 8-hour standard for $O_3$ was exceeded most often. However, the proportion of the population living in areas exceeding this standard decreased from 34% in 2005 to 2007 to 17% in 2017 to 2019.[5]

From the 2013 to 2015 reporting period to the 2017 to 2019 reporting period, the proportion of the population living in areas exceeding the annual standard for $PM_{2.5}$ decreased from 13% to 2%. This improvement can be attributed to fewer large cities, having exceedances over the latter reporting periods; for example, no exceedances were recently reported in Montreal, Quebec City, or Hamilton. Conversely, in British Columbia, the number of communities exceeding the annual standard for $PM_{2.5}$ increased from 5 to 12 over this same period.

For the last 2 reporting periods (2016 to 2018 and 2017 to 2019), the proportion of the population living in areas exceeding the 24-hour standard for $PM_{2.5}$ was, respectively, 13% and 12%. This is an increase from the 3% observed over the 2015 to 2017 reporting period. This can be attributed to the influence of smoke from large wildfires in the western United States in 2018, and in British Columbia in 2017 and 2018 that affected air quality in large communities in Alberta (Calgary, Edmonton and Red Deer), Saskatchewan (Saskatoon) and British Columbia (Abbotsford and Kelowna).

Exceedances of the annual and 1-hour standards for $SO_2$ had minimal influence on the indicator. High concentrations of $SO_2$ tend to be limited to areas near the $SO_2$ sources which are typically located in communities with smaller populations. Despite its small influence on the indicator, $SO_2$ (specifically the 1-hour standard) remains a concern because of its health impacts on populations and the environment close to sulphur-emitting facilities.

Since the 2013 to 2015 reporting period, there have been no exceedances of the annual and 1-hour standards for $NO_2$.

[3] The indicator uses the following 2020 Canadian Ambient Air Quality Standards: a 24-hour standard and an annual standard for fine particulate matter, an 8-hour standard for ground-level ozone, a 1-hour standard and an annual standard for nitrogen dioxide and a 1-hour standard and an annual standard for sulphur dioxide.

[4] These results may be influenced by the number and placement of monitoring stations.

[5] Ground-level $O_3$ is not emitted directly into the air. It is a pollutant that forms in the air through chemical reactions mainly between nitrogen oxides ($NO_x$) and volatile organic compounds (VOCs) in the presence of sunlight.

# About the indicator

## What the indicator measures

This indicator tracks the proportion of the Canadian population living in areas where outdoor concentrations of air pollutants were less than or equal to the 2020 Canadian Air Ambient Quality Standards (CAAQS, the standards). The indicator uses the following 2020 standards (see Table 1 for more details).

- fine particulate matter ($PM_{2.5}$): 24-hour and annual
- ground-level ozone ($O_3$): 8-hour
- nitrogen dioxide ($NO_2$): 1-hour and annual
- sulphur dioxide ($SO_2$): 1-hour and annual

## Why this indicator is important

Canadians are exposed to air pollutants on a daily basis and this exposure can result in adverse health effects. Exposure to some air pollutants, even at low levels, has been linked to increased heart and respiratory problems, leading to increased hospitalization, emergency room visits and premature death. The Government of Canada estimates that each year 42 premature deaths per 100 000 Canadians can be linked to air pollution for a total of 15 300 premature deaths. The total economic valuation of the health impacts attributable to air pollution in Canada is $120 billion per year (based on 2016 currency).[6]

Ground-level $O_3$ and $PM_{2.5}$ are key components of smog and 2 of the most widespread air pollutants. Exposure to $O_3$ and $PM_{2.5}$, even at very low levels, has been associated with pulmonary, cardiovascular and respiratory health effects. Exposure to $O_3$ can cause throat irritation, coughing, shortness of breath and reduced lung function, and can also aggravate existing conditions, such as asthma or other chronic lung diseases. Exposure to $PM_{2.5}$ can lead to respiratory and cardiovascular effects, such as asthma attacks, chronic bronchitis, heart attacks as well as lung cancer.

Exposure to $SO_2$ and $NO_2$ can irritate the lungs, reduce lung function and increase susceptibility to allergens in people with asthma. Long-term exposure to $NO_2$ may contribute to allergies and asthma development. Fine particulate matter ($PM_{2.5}$), $O_3$ and $NO_2$ are known to have adverse health effects occurring even at low concentrations.

Besides their direct effects on human health, these pollutants also have adverse environmental impacts. $NO_2$ contributes to the formation of $O_3$ and $PM_{2.5}$, and has major impacts on acid deposition ("acid rain") and eutrophication (excessive nutrients in a body of water leading to algal blooms and low-oxygen that impact the aquatic system). Similarly, $SO_2$ is also a major contributor to acid deposition and contributes to secondary formation of $PM_{2.5}$. Fine particulate matter ($PM_{2.5}$) can damage vegetation and structures, and contributes to haze and reduced visibility. Ozone can also impact vegetation, decrease the productivity of some crops and may contribute to forest decline. It can also damage synthetic materials and textiles, cause cracks in rubber, accelerate fading of dyes and speed deterioration of some paints and coatings.

Improved air quality reduces heart attacks, hospital visits, allergy and child asthma attacks, and prevents lost school and work days. Cleaner air can also reduce damage to crops, forests, surface waters and infrastructure such as buildings and bridges.[7]

Consult the Air pollution: drivers and impacts web page for more information on the impacts of air pollution on human health, the economy and the environment.

## Related initiatives

This indicator tracks progress on the 2022 to 2026 Federal Sustainable Development Strategy, supporting the target: Increase the percentage of the population across Canada living in areas where air pollutant concentrations

[6] Health Canada (2021) Health Impacts of Air Pollution in Canada: Estimates of morbidity and premature mortality outcomes – 2021 Report. Retrieved on November 22, 2022.

[7] Canadian Council of Ministers of the Environment (2017) State of the Air. Retrieved on November 22, 2022.

are less than or equal to the Canadian Ambient Air Quality Standards from 60%[8] in 2005 to 85% in 2030. The most recent data available shows that, between the 2005 to 2007 and the 2017 to 2019 reporting periods, the percentage of Canadians living in areas where outdoor concentrations of air pollutants were less than or equal to the 2020 Canadian Ambient Air Quality Standards increased from 63% to 71%.

In addition, the indicator contributes to the Sustainable Development Goals of the 2030 Agenda for Sustainable Development. It is linked to Goal 11, Sustainable Cities and Communities and Target 11.6, "By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management."

### Related indicators

The Air health trends indicator provides an overview of the public health impacts attributable to outdoor air pollution in Canada.

The Air quality indicators track ambient concentrations of $PM_{2.5}$, $O_3$, $SO_2$, $NO_2$ and VOCs at the national and regional level and at local monitoring stations.

The Human exposure to harmful substances indicators track the concentrations of 4 substances (mercury, lead, cadmium and bisphenol A) in Canadians.

The Air pollutant emissions indicators track emissions from human activities of 6 key air pollutants: sulphur oxides ($SO_X$), nitrogen oxides ($NO_X$), volatile organic compounds (VOC), ammonia ($NH_3$), carbon monoxide (CO) and fine particulate matter ($PM_{2.5}$). Black carbon, which is a component of $PM_{2.5}$, is also reported. For each air pollutant, data are provided at the national, provincial/territorial and facility level and by major sources.

## Data sources and methods

### Data sources

The indicator is calculated from air pollutant concentration data and population statistics.

The air pollutant concentration data are taken from Environment and Climate Change Canada's Canada-wide Air Quality Database The population data were retrieved from Statistics Canada's demographic statistics.

#### More information

**Air pollution concentration data**

The Canada-wide Air Quality Database contains data collected through the National Air Pollution Surveillance Program which is a collaboration between Environment and Climate Change Canada, provincial, territorial and regional government networks. The indicator considers data from stations selected by provinces and territories for reporting on CAAQS achievement under the Air Quality Management System.

**Population data**

The 2005, 2007 to 2010 population estimates were received from Statistics Canada. These estimates are based on the 2011 Standard Geographical Classification. The following datasets were timestamped, May 26, 2014.

- Table 1 Annual population estimates by sex, July 1 2005, Census Subdivisions, Canada
- Table 1 Annual population estimates by sex, July 1 2007, Census Subdivisions, Canada
- Table 1 Annual population estimates by sex, July 1 2008, Census Subdivisions, Canada
- Table 1 Annual population estimates by sex, July 1 2009, Census Subdivisions, Canada
- Table 1 Annual population estimates by sex, July 1 2010, Census Subdivisions, Canada

[8] The 2005 baseline of 60% presented in the 2022 to 2026 Federal Sustainable Development Strategy is informed by the estimated value for the 2005 to 2007 reporting period from the indicator's previous version. Consequently to methodology changes, the results for all reporting periods have been recalculated in this indicator and show slight differences with the values released previously. The 2022 to 2026 Federal Sustainable Development Strategy will update its target baseline based on the latest estimates available.

The 2006 Census of population data were from the Statistics Canada Census Datasets website. The dataset was timestamped, May 29, 2008.

The 2011 Census of population data were from the Statistics Canada Census Datasets website. The dataset was timestamped, August 21, 2014.

The 2012 to 2015 population estimates were received from Statistics Canada. These estimates are based on the 2011 Standard Geographical Classification. The following datasets were timestamped, March 10, 2016.

- Table 1 Annual population estimates by sex, July 1 2012, Census Subdivisions, Canada
- Table 1 Annual population estimates by sex, July 1 2013, Census Subdivisions, Canada
- Table 1 Annual population estimates by sex, July 1 2014, Census Subdivisions, Canada
- Table 1 Annual population estimates by sex, July 1 2015, Census Subdivisions, Canada

The 2016 Census of population data were from the Statistics Canada Census Datasets website. The dataset was timestamped, August 28, 2017.

The 2017 to 2019 population estimates were received from Statistics Canada. These estimates are based on the 2016 Standard Geographical Classification. The following datasets were timestamped, February 13, 2020.

- Table 1 Annual population estimates by sex, July 1 2017, Census Subdivisions, Canada
- Table 1 Annual population estimates by sex, July 1 2018, Census Subdivisions, Canada
- Table 1 Annual population estimates by sex, July 1 2019, Census Subdivisions, Canada

**Canadian Ambient Air Quality Standards**

In October 2012, the ministers of the Environment of all provinces and territories, except Quebec,[9] agreed to begin implementing the Air Quality Management System. This system provides a comprehensive, cross-Canada framework for collaborative action to further protect human health and the environment through continuous improvement of air quality. Under the system, the Canadian Ambient Air Quality Standards (CAAQS, the standards) are drivers for air quality improvement across the country. The CAAQS are health and environmental-based air quality objectives for pollutant concentrations in outdoor air. Together with the management levels,[10] the CAAQS act as a benchmark to support continuous improvement of air quality. The standards are not "pollute-up-to levels" and the Air Quality Management System encourages governments to take action to improve air quality, considering that some pollutants can affect human health even at concentrations below the standards.

Under the Canadian Environmental Protection Act, 1999, the 2020 CAAQS were established:

- for fine particulate matter and ozone in May 2013
- for sulphur dioxide in October 2017
- for nitrogen dioxide in December 2017

The 2020 CAAQS replaced the 2015 CAAQS for fine particulate matter and ozone. More stringent CAAQS for ozone, nitrogen dioxide and sulphur dioxide have been established for 2025. For consistency, the indicator will continue to use the 2020 CAAQS numerical values. For more information on the 2015 and 2025 numerical values, refer to the Canadian Ambient Air Quality Standards.

[9] Although Quebec supports the general objectives of the Air Quality Management System, it will not implement the system since it includes federal industrial emission requirements that duplicate Quebec's regulations. However, Quebec is collaborating with jurisdictions on developing other elements of the system, notably air zones and airsheds.

[10] Management levels refer to the air zone management framework. More information can be found in the Canadian Council of Ministers of the Environment's Guidance document on air zone management (PDF; 225 kB).

**Table 1. Canadian Ambient Air Quality Standards for 2020**

| Pollutant | Averaging time | 2020 Standard (numerical value) | Statistical form |
|---|---|---|---|
| Fine particulate matter | 24-hour (calendar day) | 27 µg/m$^3$ | The 3-year average of the annual 98th percentile of the daily 24-hour average concentrations |
| Fine particulate matter | Annual (calendar year) | 8.8 µg/m$^3$ | The 3-year average of the annual average of the daily 24-hour average concentrations |
| Ozone | 8-hour | 62 ppb | The 3-year average of the annual 4th-highest of the daily maximum 8-hour average concentrations |
| Nitrogen dioxide | 1-hour | 60 ppb | The 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations |
| Nitrogen dioxide | Annual (calendar year) | 17.0 ppb | The arithmetic average over a single calendar year of all 1-hour average concentrations |
| Sulphur dioxide | 1-hour | 70 ppb | The 3-year average of the annual 99th percentile of the daily maximum 1-hour average concentrations |
| Sulphur dioxide | Annual (calendar year) | 5.0 ppb | The arithmetic average over a single calendar year of all 1-hour average concentrations |

**Note:** Units: µg/m$^3$ = micrograms per cubic metre, ppb = parts per billion.

## Methods

The indicator is calculated by comparing the spatially averaged pollutant concentration for each geographical area with the respective 2020 Canadian Ambient Air Quality Standards (CAAQS, the standards). The total population of all geographical areas where the average concentrations for all pollutants are less than or equal to the respective standards are compared to the national population.

### More information

#### Data completeness criteria

Concentration values at monitoring stations are considered to be "valid" and are used in the calculation of the indicator if they meet the related data completeness criteria specified in Table 2.

**Table 2. Monitoring station data completeness criteria used in the calculation of the indicator**

| Pollutant | Averaging time | Data completeness and calculation criteria |
|---|---|---|
| Fine particulate matter | 24-hour (calendar day) | • A daily 24-hour average concentration was considered valid if at least 75% (18 hours) of the 1-hour concentrations were available on a given day<br>• A 98th percentile of the daily average concentration was considered valid if at least 75% of the daily average concentrations were available for the year and at least 60% of the daily average concentrations were available in each quarter[A] of a calendar year<br>• For the 3-year average, at least 2 of the 3 years were needed |

| Pollutant | Averaging time | Data completeness and calculation criteria |
|---|---|---|
| Fine particulate matter | Annual (calendar year) | • A daily 24-hour average concentration was considered valid if at least 75% (18 hours) of the 1-hour concentrations were available on a given day<br>• An annual average concentration was considered valid if at least 75% of the daily average concentrations were available for the year and at least 60% of the daily average concentrations were available in each quarter[A] of a calendar year<br>• For the 3-year average, at least 2 of the 3 years were needed |
| Ozone | 8-hour | • Rolling (or moving) 8-hour average concentrations were calculated for each hour of the day from the 1-hour average concentrations, resulting in up to 24 8-hour average concentrations per day<br>• To be valid a rolling 8-hour average concentration must have at least 6 1-hour average concentrations<br>• A daily maximum 8-hour average concentration was considered valid if at least 75% (18) of the 8-hour rolling average concentrations were available in the day<br>• The annual 4th-highest daily maximum 8-hour average concentration was considered valid if at least 75% of all daily maximum 8-hour average concentrations were available for the year and at least 60% in each quarter were available<br>• For the 3-year average, at least 2 of the 3 years were needed |
| Nitrogen dioxide | 1-hour | • The daily maximum 1-hour average concentration was considered valid if at least 75% (18) of the hourly concentrations were available on a given day<br>• The 98th percentile of the daily maximum 1-hour average concentrations was considered valid if at least 75% of the daily maximum 1-hour average concentrations for the year were available and at least 60% in each quarter were available<br>• For the 3-year average, at least 2 of the 3 years were needed |
| Nitrogen dioxide | Annual (calendar year) | • An annual average concentration was considered valid if at least 75% of all the 1 hour average concentrations were available for the year and at least 60% were available in each quarter |
| Sulphur dioxide | 1-hour | • The daily maximum 1-hour average concentration was considered valid if at least 75% (18 hours) of the hourly concentrations were available on a given day<br>• The annual 99th percentile of the daily maximum 1-hour average concentrations was considered valid if at least 75% of all the daily maximum 1-hour average concentrations for the year were available and at least 60% in each quarter were available<br>• For the 3-year average, at least 2 of the 3 years were needed |
| Sulphur dioxide | Annual (calendar year) | • An annual average concentration was considered valid if at least 75% of all the 1-hour average concentrations were available for the year and at least 60% were available in each quarter |

**Note:** [A] The calendar quarters are as follows: quarter 1 from January 1 to March 31; quarter 2 from April 1 to June 30; quarter 3 from July 1 to September 30 and quarter 4 from October 1 to December 31.

For a geographical area having only 1 monitoring station, the data completeness criteria of Table 2 are applied. For a geographical area having more than 1 monitoring station, the data completeness criteria of Table 2 are applied to the overall data available for all monitoring stations within the geographical area. In such a case, the averaged concentration of all monitoring stations is reported for that particular geographical area even though each of the monitoring stations could have incomplete data.

**Geographical areas**

Each air quality monitoring station is assigned to a geographical area. For fine particulate matter, ground-level ozone, nitrogen dioxide and sulphur dioxide (annual concentrations only), these areas are either a Statistics Canada's census metropolitan area, census division or census subdivision. For each year from 2005 to 2019, population counts are allocated to each geographical area with at least 1 monitoring station.

Because high sulphur dioxide concentrations tend to be localized around point sources, the geographical area for the annual and 1-hour standard for sulphur dioxide was set to a 2 kilometre (km) radius around the station. Only population data within the 2 km boundary of the monitoring station were used. In this case, Statistics Canada's dissemination block data were used to calculate the population within the 2 km boundary of a station.

Refer to Annex C for a list of geographic areas used to calculate the indicator.

**Air pollutant concentrations by geographical area**

For each air pollutant and averaging time, the following steps were used to assign a concentration value to each geographical area.

1. A concentration value was first calculated for each monitoring station in the area using the data completeness and calculation criteria outlined in Table 2
2. The arithmetic average was calculated from the concentration values of all monitoring stations in the geographical area

For example, Winnipeg has 2 monitoring stations that meet the data completeness criteria for fine particulate matter. The annual average concentration of fine particulate matter for Winnipeg is calculated by using the following steps.

1. The daily 24-hour average concentration for each monitoring station was calculated
    - if at least 75% (18 hours) of the 1-hour concentrations for the station were available on a given day (from Table 2)
2. An average daily 24-hour concentration using all monitoring stations within Winnipeg was calculated
3. An annual average concentration for Winnipeg was then calculated
    - if at least 75% of the daily average concentrations were available for the year and at least 60% of the daily average concentrations were available in each quarter of a calendar year (from Table 2)

**Comparison with the standards and total population at or below the standards**

The concentration value for each pollutant was then compared to the respective standard to determine if the population in the geographical area was exposed to pollutant levels less than or equal to the corresponding standard. This comparison was done for each pollutant and for each standard:

- If the concentration value for the area was less than or equal to the respective standard for all 7 CAAQS, the population count was recorded for the geographical area
- If at least 1 standard was exceeded, the population for the geographical area was set to 0

The population from all geographical areas with average concentrations less than or equal to all CAAQS were then added together. The sum was then divided by the total Canadian population and multiplied by 100 to produce the percentage of the population that lives in an area where air pollutant concentrations were less than or equal to the standards. The general formula is as follows:

100 * (sum of the population at or below all CAAQS ÷ total population of Canada)

Where the population at or below all CAAQS = the population of Canadians living in geographical areas where ambient concentrations of fine particulate matter, ozone, nitrogen dioxide and sulphur dioxide are all less than or equal to their respective standard.

## Recent changes

The annual standard for sulphur dioxide was included for all reporting periods, whereas in the previous iteration this standard was considered only for the 2015 to 2017 and the 2016 to 2018 reporting periods. Similar to the 1-hour standard for sulphur dioxide, only population data within the 2 km boundary of the monitoring station were used for the annual standard, whereas in the previous iteration all of the population data pertaining to the geographical area was used.

A data completeness criteria for the ozone concentration calculation was changed. Daily maximum 8-hour average concentrations were considered over the full year, instead of the period from April 1 to September 30 as in the last iteration.

Only stations that are selected by provinces and territories for reporting on CAAQS achievement under the Air Quality Management System are used in the calculation, whereas all stations reporting to Canada-wide Air Quality Database were used in the last iteration.

Due to the methodology changes listed above, the results for all reporting periods have been recalculated and show slight differences with the values released previously.

## Caveats and limitations

From 2005 to 2019, approximately 62% of the population lived in areas covered by selected air quality monitoring stations that meet the data completeness criteria. Refer to Annex C for a list of geographical areas used in the indicator. The indicator assumes that the remainder of the population lives in areas where outdoor concentrations of ozone, fine particulate matter, sulphur dioxide and nitrogen dioxide are less than or equal to their 2020 standards.[11] Populations in northern regions of the country have less coverage, as monitoring stations tend to be situated near urban areas with a higher population density.

### More information

This indicator is used to report the percentage of the Canadian population living in areas where outdoor concentrations of air pollutants were less than or equal to the 2020 Canadian Ambient Air Quality Standards (CAAQS, the standards). The indicator is not used for formally reporting the achievement status of the standards. Under the Air Quality Management System, reporting on achievement of the standards is a provincial and territorial responsibility.

The method used to calculate the indicator differ from that used to report on the achievement status of the CAAQS. In particular, for the indicator, the average concentration from CAAQS monitoring stations in the geographical area is used to compare against the standard. However, for the purposes of reporting on CAAQS achievement and management levels, provinces and territories can remove air pollution from transboundary flows and exceptional events. As a result, this indicator may result in higher concentrations than reported by provinces and territories.

Populations not covered by monitoring stations were assumed to be below the standards. While this results in some uncertainty regarding the estimated population below the standards, a sensitivity analysis indicated that this assumption does not result in a large error. Ongoing research and analysis is being conducted on methods that will consider the entire population.

Some data collected at monitoring stations cannot be used in calculating the indicator because the data do not meet the data completeness criteria. The removal of this data can influence the number of geographical areas used per reporting period. Refer to Annex C for a list of geographical areas used in the indicator.

[11] While this assumption holds for most of the pollutants used in the analysis of the indicator, ground-level ozone concentrations are generally higher outside urban cores. For example, a region such as Southwestern Ontario, it is likely that the entire region would be above the Canadian Ambient Air Quality Standard for ozone.

The indicator uses the actual concentrations measured at monitoring stations. Some of these concentrations may have been influenced by pollutant sources in other countries and by smoke from wildfires both within and outside Canada.

# Resources

## References


Canadian Council of Ministers of the Environment (2012) Guidance document on achievement determination for Canadian Ambient Air Quality Standards for fine particulate matter and ozone (PDF; 264 kB). Retrieved on November 22, 2022.

Canadian Council of Ministers of the Environment (2014) Air Quality Management System. Retrieved on November 22, 2022.

Canadian Council of Ministers of the Environment (2017) State of the air. Retrieved on November 22, 2022.

Canadian Council of Ministers of the Environment (2019) Guidance document on air zone management (PDF; 225 kB). Retrieved on November 22, 2022.

Canadian Council of Ministers of the Environment (2020) Guidance document on achievement determination for Canadian Ambient Air Quality Standards for nitrogen dioxide (PDF; 616 kB). Retrieved on November 22, 2022.

Canadian Council of Ministers of the Environment (2020) Guidance document on achievement determination for Canadian Ambient Air Quality Standards for sulphur dioxide (PDF; 586 kB). Retrieved on November 22, 2022.

Environment and Climate Change Canada (2022) National Air Pollution Surveillance Program. Retrieved on November 22, 2022.

Government of Canada (2021) Health effects of air pollution. Retrieved on November 22, 2022.


## Related information

Air pollution: drivers and impacts

Canadian Smog Science Assessment Highlights and Key Messages

Smog: causes and effects

# Annexes

## Annex A. Data table for the figure presented in this document

- Table A.1. Data for In the most recent reporting period (2017 to 2019), 71% of Canadians lived in areas where outdoor concentrations of air pollutants were within the standards
    - This represents an improvement from 68% in the previous reporting period (2016 to 2018), mainly because air pollution concentrations in Mississauga did not exceed the standards in 2017 to 2019
    - It is also an improvement from 63% for the first reporting period (2005 to 2007)

**Figure 1. Percentage of Canadians living in areas where outdoor concentrations of air pollutants were less than or equal to the 2020 Canadian Ambient Air Quality Standards, Canada, 2005 to**

| Period | Proportion of the population where air pollutants were at or below the standards (percentage) |
|---|---|
| 2005 to 2007 | 63 |
| 2006 to 2008 | 65 |
| 2007 to 2009 | 66 |
| 2008 to 2010 | 69 |
| 2009 to 2011 | 67 |
| 2010 to 2012 | 66 |
| 2011 to 2013 | 66 |
| 2012 to 2014 | 66 |
| 2013 to 2015 | 70 |
| 2014 to 2016 | 79 |
| 2015 to 2017 | 78 |
| 2016 to 2018 | 68 |
| 2017 to 2019 | 71 |

**Note:** With the exception of the annual standard for nitrogen dioxide and sulphur dioxide, the 2020 Canadian Ambient Air Quality Standards used in the indicator use 3-year average concentrations. For this reason the table portrays percentage values over 3-year periods. The annual standards for nitrogen dioxide and sulphur dioxide use a single annual concentration for the 3-year reporting period. For example, for the 2017 to 2019 reporting period, the annual concentrations for 2019 were used for the annual standards for nitrogen dioxide and sulphur dioxide.
**Source:** Environment and Climate Change Canada (2022) Air Quality Research Division. Health Canada (2022) Air Quality Risk Assessment Division.

# Annex B. Geographical areas with exceedances from the standards for the 2017-2019 reporting period

**Table B.2. Geographical areas with exceedances from the standards for the 2017-2019 reporting period**

| Province or territory | Community | Standard exceeded |
|---|---|---|
| New Brunswick | Edmunston | 1-hour standard for $SO_2$ |
| Quebec | Rouyn-Noranda | 1-hour standard for $SO_2$ |
| Quebec | Saguenay | 1-hour standard for $SO_2$<br>annual standard for $SO_2$ |
| Ontario | Kingston | 8-hour standard for $O_3$ |
| Ontario | Peterborough | 8-hour standard for $O_3$ |
| Ontario | Oshawa | 8-hour standard for $O_3$ |
| Ontario | Newmarket | 8-hour standard for $O_3$ |
| Ontario | Toronto | 8-hour standard for $O_3$ |
| Ontario | Brampton | 8-hour standard for $O_3$ |
| Ontario | Guelph | 8-hour standard for $O_3$ |
| Ontario | Oakville | 8-hour standard for $O_3$ |
| Ontario | Burlington | 8-hour standard for $O_3$ |
| Ontario | Hamilton | 8-hour standard for $O_3$<br>1-hour standard for $SO_2$ |
| Ontario | Brantford | 8-hour standard for $O_3$ |
| Ontario | Kitchener | 8-hour standard for $O_3$ |
| Ontario | Central Elgin | 8-hour standard for $O_3$ |
| Ontario | Windsor | 8-hour standard for $O_3$ |
| Ontario | Sarnia | 8-hour standard for $O_3$ |
| Ontario | London | 8-hour standard for $O_3$ |
| Manitoba | Flin Flon | 24-hour standard for $PM_{2.5}$ |
| Manitoba | Thompson | 1-hour standard for $SO_2$ |
| Saskatchewan | Estevan | 1-hour standard for $SO_2$ |
| Saskatchewan | Swift Current | 24-hour standard for $PM_{2.5}$ |
| Saskatchewan | Saskatoon | annual standard for $PM_{2.5}$<br>24-hour standard for $PM_{2.5}$ |
| Alberta | Medicine Hat | 24-hour standard for $PM_{2.5}$<br>8-hour standard for $O_3$ |
| Alberta | Lethbridge | 24-hour standard for $PM_{2.5}$ |
| Alberta | Calgary | 24-hour standard for $PM_{2.5}$ |
| Alberta | Red Deer | 24-hour standard for $PM_{2.5}$ |
| Alberta | Lamont County | 24-hour standard for $PM_{2.5}$ |
| Alberta | Drayton Valley | 24-hour standard for $PM_{2.5}$ |
| Alberta | Edmonton | 24-hour standard for $PM_{2.5}$ |
| Alberta | St. Paul County No. 19 | 24-hour standard for $PM_{2.5}$ |

| Province or territory | Community | Standard exceeded |
|---|---|---|
| Alberta | Lac Ste. Anne County | 24-hour standard for $PM_{2.5}$ |
| Alberta | Hinton | 24-hour standard for $PM_{2.5}$<br>annual standard for $PM_{2.5}$ |
| Alberta | Edson | 24-hour standard for $PM_{2.5}$ |
| Alberta | Grande Prairie County No. 1 | 24-hour standard for $PM_{2.5}$ |
| Alberta | Grande Prairie | 24-hour standard for $PM_{2.5}$ |
| British Columbia | Castlegar | 24-hour standard for $PM_{2.5}$<br>annual standard for $PM_{2.5}$ |
| British Columbia | Grand Forks | 24-hour standard for $PM_{2.5}$<br>annual standard for $PM_{2.5}$ |
| British Columbia | Hope | 24-hour standard for $PM_{2.5}$<br>8-hour standard for $O_3$ |
| British Columbia | Chilliwack | 24-hour standard for $PM_{2.5}$ |
| British Columbia | Abbotsford | 24-hour standard for $PM_{2.5}$ |
| British Columbia | Kent | 24-hour standard for $PM_{2.5}$ |
| British Columbia | North Cowichan | 1-hour standard for $SO_2$ |
| British Columbia | Port Alberni | 24-hour standard for $PM_{2.5}$<br>annual standard for $PM_{2.5}$ |
| British Columbia | Courtenay | 24-hour standard for $PM_{2.5}$<br>annual standard for $PM_{2.5}$ |
| British Columbia | Sunshine Coast F | 24-hour standard for $PM_{2.5}$ |
| British Columbia | Squamish | 24-hour standard for $PM_{2.5}$ |
| British Columbia | Whistler | 24-hour standard for $PM_{2.5}$ |
| British Columbia | Kamloops | 24-hour standard for $PM_{2.5}$<br>annual standard for $PM_{2.5}$ |
| British Columbia | Kelowna | 24-hour standard for $PM_{2.5}$<br>annual standard for $PM_{2.5}$ |
| British Columbia | Vernon | 24-hour standard for $PM_{2.5}$<br>annual standard for $PM_{2.5}$ |
| British Columbia | Golden | 24-hour standard for $PM_{2.5}$<br>annual standard for $PM_{2.5}$ |
| British Columbia | Williams Lake | 24-hour standard for $PM_{2.5}$<br>annual standard for $PM_{2.5}$ |
| British Columbia | Quesnel | 24-hour standard for $PM_{2.5}$<br>annual standard for $PM_{2.5}$ |
| British Columbia | Vanderhoof | 24-hour standard for $PM_{2.5}$<br>annual standard for $PM_{2.5}$ |
| British Columbia | Burns Lake | 24-hour standard for $PM_{2.5}$<br>annual standard for $PM_{2.5}$ |
| British Columbia | Houston | 24-hour standard for $PM_{2.5}$ |
| British Columbia | Smithers | 24-hour standard for $PM_{2.5}$ |
| British Columbia | Fort St. John | 24-hour standard for $PM_{2.5}$ |

**Note:** With the exception of the annual standard for nitrogen dioxide and sulphur dioxide, the 2020 Canadian Ambient Air Quality Standards used in the indicator use 3-year average concentrations. For this reason the table portrays percentage values over 3-year periods. The annual standards for nitrogen dioxide and sulphur dioxide use a single annual concentration for the 3-year reporting period. For example, for the 2017 to 2019 reporting period, the annual concentrations for 2019 were used for the annual standards for nitrogen dioxide and sulphur dioxide.
**Source:** Environment and Climate Change Canada (2022) Air Quality Research Division. Health Canada (2022) Air Quality Risk Assessment Division.

## Annex C. Geographical areas used to calculate the indicator

**Table C.3. Geographical areas used to calculate the indicator**

| Census subdivision, census metropolitan area or census division | Province or territory | Community | Reporting periods used |
|---|---|---|---|
| 1 | Newfoundland and Labrador | St. John's | 2005-2007 to 2017-2019 |
| 1002005 | Newfoundland and Labrador | Burin | 2011-2013 to 2017-2019 |
| 1005018 | Newfoundland and Labrador | Corner Brook | 2005-2007 to 2017-2019 |
| 1006017 | Newfoundland and Labrador | Grand Falls-Windsor | 2005-2007 to 2017-2019 |
| 1009022 | Newfoundland and Labrador | Port au Choix | 2011-2013 to 2017-2019 |
| 1010032 | Newfoundland and Labrador | Labrador City | 2013-2015 to 2017-2019 |
| 1102075 | Prince Edward Island | Charlottetown | 2013-2015 to 2017-2019 |
| 1207001 | Nova Scotia | Kings, Subd. A | 2005-2007 to 2017-2019 |
| 1207012 | Nova Scotia | Kentville | 2005-2007 to 2012-2014 |
| 1209034 | Nova Scotia | Halifax | 2005-2007 to 2017-2019 |
| 1212004 | Nova Scotia | Pictou | 2005-2007 to 2017-2019 |
| 1215002 | Nova Scotia | Port Hawkesbury | 2009-2011 to 2017-2019 |
| 1217030 | Nova Scotia | Cape Breton | 2005-2007 to 2017-2019 |
| 1301006, 310 | New Brunswick | Saint John | 2005-2007 to 2017-2019 |
| 1302026 | New Brunswick | Saint Andrews | 2005-2007 to 2017-2019 |
| 1307022 | New Brunswick | Moncton | 2005-2007 to 2017-2019 |
| 1310032 | New Brunswick | Fredericton | 2005-2007 to 2017-2019 |
| 1313027 | New Brunswick | Edmunston | 2016-2018 to 2017-2019 |
| 1315011 | New Brunswick | Bathurst | 2005-2007 to 2017-2019 |
| 2413045 | Quebec | Auclair | 2005-2007 to 2017-2019 |
| 2418040 | Quebec | Notre-Dame-du-Rosaire | 2005-2007 to 2017-2019 |
| 2420005 | Quebec | Saint-Francois-de-l'Île-d'Orléans | 2005-2007 to 2016-2018 |
| 2423027, 2423 | Quebec | Québec | 2005-2007 to 2017-2019 |
| 2425213 | Quebec | Levis | 2005-2007 to 2017-2019 |
| 2429020 | Quebec | Saint-Hilaire-de-Dorset | 2005-2007 to 2017-2019 |
| 2434058 | Quebec | Deschambault-Grondines | 2005-2007 to 2017-2019 |
| 2437067 | Quebec | Trois-Rivières | 2005-2007 to 2017-2019 |
| 2439025 | Quebec | Tingwick | 2005-2007 to 2017-2019 |
| 2441027 | Quebec | La Patrie | 2005-2007 to 2017-2019 |
| 2443027 | Quebec | Sherbrooke | 2005-2007 to 2017-2019 |
| 2450090 | Quebec | Saint-Zéphirin-de-Courval | 2005-2007 to 2017-2019 |

| Census subdivision, census metropolitan area or census division | Province or territory | Community | Reporting periods used |
|---|---|---|---|
| 2451080 | Quebec | Charette | 2005-2007 to 2017-2019 |
| 2454090 | Quebec | Saint-Simon | 2005-2007 to 2017-2019 |
| 2456083 | Quebec | Saint-Jean-sur-Richelieu | 2005-2007 to 2017-2019 |
| 2458007 | Quebec | Brossard | 2005-2007 to 2017-2019 |
| 2458227 | Quebec | Longueuil | 2005-2007 to 2017-2019 |
| 2464008 | Quebec | Terrebonne | 2015-2017 to 2017-2019 |
| 2465005 | Quebec | Laval | 2005-2007 to 2017-2019 |
| 2466023, 2466 | Quebec | Montréal | 2005-2007 to 2017-2019 |
| 2469070 | Quebec | Saint-Anicet | 2005-2007 to 2017-2019 |
| 2478047 | Quebec | Saint-Faustin–Lac-Carré | 2005-2007 to 2017-2019 |
| 2479097 | Quebec | Ferme-Neuve | 2005-2007 to 2017-2019 |
| 2481017 | Quebec | Gatineau | 2005-2007 to 2017-2019 |
| 2482035 | Quebec | La Pêche | 2005-2007 to 2017-2019 |
| 2486042 | Quebec | Rouyn-Noranda | 2005-2007 to 2017-2019 |
| 2489040 | Quebec | Senneterre | 2005-2007 to 2017-2019 |
| 2490027 | Quebec | Lac-Édouard | 2005-2007 to 2017-2019 |
| 2491050 | Quebec | La Doré | 2005-2007 to 2017-2019 |
| 2494068 | Quebec | Saguenay | 2005-2007 to 2017-2019 |
| 3506008 | Ontario | Ottawa | 2005-2007 to 2017-2019 |
| 3510010 | Ontario | Kingston | 2005-2007 to 2017-2019 |
| 3515014 | Ontario | Peterborough | 2005-2007 to 2017-2019 |
| 3518013 | Ontario | Oshawa | 2005-2007 to 2017-2019 |
| 3519048 | Ontario | Newmarket | 2005-2007 to 2017-2019 |
| 3520005 | Ontario | Toronto | 2005-2007 to 2017-2019 |
| 3521005 | Ontario | Mississauga | 2005-2007 to 2017-2019 |
| 3521010 | Ontario | Brampton | 2005-2007 to 2017-2019 |
| 3523008 | Ontario | Guelph | 2005-2007 to 2017-2019 |
| 3524001 | Ontario | Oakville | 2005-2007 to 2017-2019 |
| 3524002 | Ontario | Burlington | 2005-2007 to 2017-2019 |
| 3525005 | Ontario | Hamilton | 2005-2007 to 2017-2019 |
| 3526053 | Ontario | St. Catharines | 2005-2007 to 2017-2019 |
| 3529006 | Ontario | Brantford | 2005-2007 to 2017-2019 |
| 3530013 | Ontario | Kitchener | 2005-2007 to 2017-2019 |
| 3534020 | Ontario | Central Elgin | 2005-2007 to 2017-2019 |
| 3537039 | Ontario | Windsor | 2005-2007 to 2017-2019 |

| Census subdivision, census metropolitan area or census division | Province or territory | Community | Reporting periods used |
|---|---|---|---|
| 3538030 | Ontario | Sarnia | 2005-2007 to 2017-2019 |
| 3539036 | Ontario | London | 2005-2007 to 2017-2019 |
| 3543042 | Ontario | Barrie | 2005-2007 to 2017-2019 |
| 3553005 | Ontario | Greater Sudbury | 2005-2007 to 2017-2019 |
| 3557061 | Ontario | Sault Ste. Marie | 2005-2007 to 2017-2019 |
| 3558004 | Ontario | Thunder Bay | 2005-2007 to 2017-2019 |
| 4607062 | Manitoba | Brandon | 2005-2007 to 2017-2019 |
| 4621064 | Manitoba | Flin Flon (Part) | 2005-2007 to 2017-2019 |
| 4622026 | Manitoba | Thompson | 2010-2012 to 2017-2019 |
| 602 | Manitoba | Winnipeg | 2005-2007 to 2017-2019 |
| 4706027 | Saskatchewan | Regina | 2005-2007 to 2017-2019 |
| 4708004 | Saskatchewan | Swift Current | 2008-2010 to 2017-2019 |
| 4711066 | Saskatchewan | Saskatoon | 2005-2007 to 2017-2019 |
| 4715066 | Saskatchewan | Prince Albert | 2005-2007 to 2017-2019 |
| 4801006 | Alberta | Medicine Hat | 2005-2007 to 2017-2019 |
| 4802012 | Alberta | Lethbridge | 2005-2007 to 2017-2019 |
| 825 | Alberta | Calgary | 2005-2007 to 2017-2019 |
| 4808011 | Alberta | Red Deer | 2005-2007 to 2017-2019 |
| 4810058 | Alberta | Lamont County | 2005-2007 to 2017-2019 |
| 4811031 | Alberta | Drayton Valley | 2005-2007 to 2017-2019 |
| 4811032 | Alberta | Brazeau County | 2005-2007 to 2017-2019 |
| 4811061, 835 | Alberta | Edmonton | 2005-2007 to 2017-2019 |
| 4812002 | Alberta | Cold Lake | 2005-2007 to 2017-2019 |
| 4812014 | Alberta | St. Paul County No. 19 | 2009-2011 to 2017-2019 |
| 4813001 | Alberta | Lac Ste. Anne County | 2005-2007 to 2017-2019 |
| 4814003 | Alberta | Yellowhead County | 2005-2007 to 2017-2019 |
| 4814019 | Alberta | Hinton | 2009-2011 to 2017-2019 |
| 4814024 | Alberta | Edson | 2005-2007 to 2017-2019 |
| 860 | Alberta | Wood Buffalo | 2005-2007 to 2017-2019 |
| 4819006 | Alberta | Grande Prairie County No. 1 | 2005-2007 to 2017-2019 |
| 4819012 | Alberta | Grande Prairie | 2005-2007 to 2017-2019 |
| 5903045 | British Columbia | Castlegar | 2011-2013 to 2017-2019 |
| 5905032 | British Columbia | Grand Forks | 2006-2008, 2007-2009, 2013-2015 to 2017-2019 |
| 5909009 | British Columbia | Hope | 2005-2007 to 2017-2019 |

| Census subdivision, census metropolitan area or census division | Province or territory | Community | Reporting periods used |
|---|---|---|---|
| 5909020 | British Columbia | Chilliwack | 2005-2007 to 2017-2019 |
| 932 | British Columbia | Abbotsford | 2005-2007 to 2017-2019 |
| 933 | British Columbia | Vancouver | 2005-2007 to 2017-2019 |
| 5909032 | British Columbia | Kent | 2013-2015 to 2017-2019 |
| 935 | British Columbia | Victoria | 2005-2007 to 2017-2019 |
| 5919008 | British Columbia | North Cowichan | 2008-2010 to 2017-2019 |
| 5919012 | British Columbia | Duncan | 2009-2011 to 2017-2019 |
| 5921007 | British Columbia | Nanaimo | 2005-2007 to 2017-2019 |
| 5923008 | British Columbia | Port Alberni | 2010-2012 to 2017-2019 |
| 5924034 | British Columbia | Campbell River | 2005-2007 to 2017-2019 |
| 5926010 | British Columbia | Courtenay | 2011-2013 to 2017-2019 |
| 5927008 | British Columbia | Powell River | 2005-2007 to 2015-2017 |
| 5929028 | British Columbia | Sunshine Coast F | 2005-2007 to 2017-2019 |
| 5931006 | British Columbia | Squamish | 2015-2017 to 2017-2019 |
| 5931020 | British Columbia | Whistler | 2005-2007 to 2017-2019 |
| 5933042 | British Columbia | Kamloops | 2005-2007 to 2017-2019 |
| 5935010 | British Columbia | Kelowna | 2005-2007 to 2017-2019 |
| 5937014 | British Columbia | Vernon | 2005-2007 to 2017-2019 |
| 5939007 | British Columbia | Golden | 2005-2007 to 2017-2019 |
| 5941009 | British Columbia | Williams Lake | 2005-2007 to 2017-2019 |
| 5941013 | British Columbia | Quesnel | 2005-2007 to 2017-2019 |
| 5949005 | British Columbia | Kitimat | 2005-2007 to 2017-2019 |
| 5949011 | British Columbia | Terrace | 2013-2015 to 2017-2019 |
| 5951007 | British Columbia | Vanderhoof | 2009-2011 to 2017-2019 |
| 5951022 | British Columbia | Burns Lake | 2005-2007 to 2017-2019 |
| 5951034 | British Columbia | Houston | 2006-2008 to 2010-2012 and 2012-2014 to 2017-2019 |
| 5951043 | British Columbia | Smithers | 2005-2007 to 2017-2019 |
| 5953023 | British Columbia | Prince George | 2005-2007 to 2017-2019 |
| 5955034 | British Columbia | Fort St. John | 2014-2016 to 2017-2019 |
| 6001009 | Yukon | Whitehorse | 2005-2007 to 2017-2019 |
| 6101017 | Northwest Territories | Inuvik | 2005-2007 to 2017-2019 |
| 6102007 | Northwest Territories | Norman Wells | 2005-2007 to 2017-2019 |
| 6105001 | Northwest Territories | Fort Smith | 2013-2015 to 2017-2019 |
| 6106023 | Northwest Territories | Yellowknife | 2005-2007 to 2017-2019 |

| Census subdivision, census metropolitan area or census division | Province or territory | Community | Reporting periods used |
|---|---|---|---|
| 6204003 | Nunavut | Iqaluit | 2013-2015 to 2017-2019 |

Additional information can be obtained at:

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