state of the air 2019

BC LUNG ASSOCIATION CELEBRATING THE CLEAN AIR MONTH OF JUNE

foreword

This year's State of the Air Report is once again packed with articles on some of the most important issues affecting air quality in BC.

Volatile Organic Compounds (VOCs) are a broad class of air pollutants, with thousands of different species. In this Report, we demystify VOCs: their sources, characteristics, and human health and air quality impacts. We also look at initiatives to curb VOC emissions from motor vehicles, the petroleum sector, and everyday commercial and consumer products.

We have a follow-up article on small air quality sensors, which continue to create a huge interest due to their low cost and ease of use. Though not without limitations, these sensors enable "citizen science" activities, and can support government monitoring, reporting, and forecasting efforts, especially during adverse air quality events like wildfires.

The wildfires of 2018 proved to be even worse than the previous year's, burning a much larger area and raising particulate matter ($PM_{2.5}$) concentrations across BC for most of August. Metro Vancouver was under air quality advisories for 18 days, while some areas in the central and southern interior and southeastern BC were under Smoky Skies Bulletins for over 40 days.

Fittingly, the 16th Annual BC Lung Association Air Quality & Health Workshop focused on the growing threat of wildfire smoke to air quality and public health. Leading authorities gathered to discuss the impacts of - and the efficacy of programs designed to address - wildfire smoke. This year's Clean Air Champion, Glen Okrainetz, was also recognized at the event.

Before retiring from government service, Glen served in various capacities and helped develop the BC Air Action Plan, which spawned several air quality programs in our province, including the Provincial Wood Stove Exchange Program. We have feature stories on both Glen and our workshop in this report.

In closing, I wish to thank all the individuals and agencies who shared their time, energy, and expertise to make this year's Report happen. Until the next edition!

CHRISTOPHER LAM
President and CEO, BC Lung Association

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Demystifying VOCs

What are VOCs?

Volatile Organic Compounds (VOCs) are a broad class of air pollutants that (1) contain at least one carbon atom and (2) readily evaporate under normal atmospheric pressure. There are thousands of different VOCs that vary by chemical composition, structure, and behaviour. Most air quality programs focus on the most abundant compounds, which typically have 2-12 carbon atoms.

Where do VOCs come from?

Both natural sources and human activities contribute to the VOCs found in the air. In rural or forested areas, natural sources contribute more VOCs to outdoor air than human activities. In urban areas, emissions from vehicles and the chemical products sectors account for a greater proportion of outdoor VOCs (Figure 1). Indoor sources of VOCs include building materials, consumer products, and cigarette smoke. **Typically, VOC concentrations are higher indoors than outdoor.**[1]

How are VOCs measured in BC?

VOCs are sampled in BC as part of the National Air Pollution Surveillance (NAPS) Program. Gas samples are collected in specially prepared canisters over a 24-hour period every 6 or 12 days by provincial or Metro Vancouver staff. The filled canisters are then shipped to a federal laboratory in Ottawa for analysis by Environment and Climate Change Canada, where up to 175 different VOC species can be detected. VOCs are currently sampled at several sites in Metro Vancouver as well as in Abbotsford, Chilliwack, Prince George, and Saturna Island. To view historical VOC data, see: http://maps-cartes.ec.gc.ca/rnspa-naps/data.aspx?lang=en.

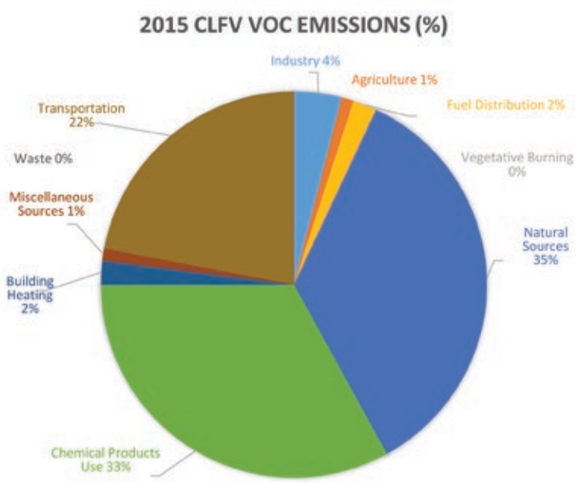


Figure 1: VOC emissions in the Canadian Lower Fraser Valley (CLFV), 2015. Total VOC emissions: 65,408 tonnes. Retrieved from: http://www.metrovancouver.org/services/air-quality/AirQualityPublications/2015LowerFraserValleyAirEmissionsInventory.pdf

Why are VOCs a concern?

Some types of VOCs have direct effects on human health and some types contribute to smog formation that in turn may affect human health and the environment. Additionally, some VOCs are associated with a pungent odour that may range from pleasant-smelling to offensive. The health effects of VOCs depend on the specific VOC and the level and duration of exposure. Short-term exposure to moderate levels of many VOCs may cause acute irritation of the eyes, nose and throat, and headaches. Short-term exposure to higher levels may cause more severe effects, such as nausea or loss of consciousness. Long-term exposure to VOCs in the workplace may cause neurological effects, liver damage, and cancer. For example, the International Agency for Research on Cancer (IARC) has identified benzene and formaldehyde as human carcinogens.[2] For more information, see: https://toxtown.nlm.nih.gov/chemicals-and-contaminants/volatile-organic-compounds-vocs.

1 For more information on VOCs and indoor air quality, see: https://www.healthlinkbc.ca/healthlinkbc-files/air-quality-VOCs
2 https://www.iarc.fr

Are VOC odours a health concern?

VOC-related odours range from pleasant (e.g. the scent of pine trees) to offensive (e.g. the smell of composting materials). Some people are very sensitive to odours, and find the smell distressing. Although concentrations of VOCs at these odour thresholds are generally not harmful to health, stress is a known risk factor for cardiovascular diseases.

How do VOCs contribute to smog & haze?

VOCs can be very reactive in sunlight, contributing to reactions that result in the formation of fine particulate matter ($PM_{2.5}$) and ground-level ozone. These pollutants have both direct and indirect effects on human health and the environment. The blue haze commonly associated with forests (e.g. the Blue Ridge Mountains) is due to the formation of $PM_{2.5}$ resulting from reactions involving naturally occurring VOCs in the presence of sunlight.[3] Particles of this size are especially efficient at scattering blue light.[4]

What do we know about the types of VOCs emitted by industry in BC?

Under the Canadian Environmental Protection Act of 1999, all industries are required to submit annual emission reports to the National Pollutant Release Inventory (NPRI). Based on data from the 2017 NPRI, a total of 18,120 tonnes of VOCs were released from over 200 industrial facilities in BC.[5]

The largest VOC emissions were associated with oriented strandboard (OSB) production, pulp and paper, and upstream oil and gas.

What is being done to manage VOC emissions?

Transportation is the largest single source of VOCs in BC. New vehicle emissions standards are being phased in by the federal government and will be fully implemented by 2025. These new standards are 80% more stringent than the previous standards. In addition, new national requirements for VOC emissions from the oil and gas sector are expected to significantly reduce VOC emissions between 2017 and 2035.[6]

Finally, the federal government is working to reduce the VOCs emitted by use of solvents in consumer and commercial products such as household cleaning agents, personal care products, paints, and printing inks.[7]

3 Went F.W. (1960) Blue hazes in the atmosphere. Nature 187: 641.
4 Ferman M.A., Wolff G.T. and N.A. Kelly (1981) The nature and sources of haze in the Shenandoah Valley/Blue Ridge Mountains Area. JAPCA 31: 10. pp. 1074-1082. Retrieved from: https://www.tandfonline.com/doi/abs/10.1080/00022470.1981.10465329
5 For more information, see: https://www.canada.ca/en/services/environment/pollution-waste-management/national-pollutant-release-inventory.html
6 For more information, see: https://www.canada.ca/en/news/archive/2015/07/cleaner-vehicles-fuels-canadians-final-tier-3-vehicle-fuel-standards.html
7 For more information, see: https://www.canada.ca/en/environment-climate-change/services/managing-pollution/sources-industry/volatile-organic-compounds-consumer-commercial.html

Big Interest in Small Sensors

The proliferation of small, low-cost, air quality sensors has made collection of air quality data accessible to almost anyone. These sensors have some advantages over standard air monitoring equipment used by government agencies: low-cost sensors are easy to use and readily available to the public. As such, these sensors can support "citizen science" projects, in which the public deploy sensors to understand their local air quality. A large network of these sensors can also increase the spatial resolution and coverage of air quality data. However, low-cost sensors also have limitations: their reliability and accuracy can vary, as there are no performance criteria to meet in order to be sold. Furthermore, unlike reference instruments which are audited and calibrated regularly, many small sensors cannot be calibrated and their performance will degrade, in some cases, in one to two years.

Several government agencies and academic organizations in BC have been exploring the use and performance of these sensors.

Metro Vancouver

Metro Vancouver's "Air Aware" project aims to learn about the strengths and limitations of low-cost sensors, how they might play a role in Metro Vancouver's air monitoring network, and how and why the public are using them.

Metro Vancouver selected several different low-cost sensors and co-located them at their air monitoring stations for approximately two months alongside reference instruments. When the low-cost sensor data was compared to data collected by reference instruments, preliminary analysis showed that sensor performance and operability varied widely.

An important part of Air Aware involves working with the public to help understand differences between low-cost sensors and the reference instruments at Metro Vancouver's air monitoring stations. Metro Vancouver chose sensors that performed well, were easy to set up, and had a user-friendly interface, and are lending them to volunteers during the spring and summer of 2019. This will provide insight about a user's experience with air quality sensors and data, and will help Metro Vancouver understand how to best respond to their air quality needs and questions.

Metro Vancouver will use the results from the co-location and feedback from volunteers to create resources that will include information on strengths and limitations of low-cost sensors, guidance on choosing and setting up a sensor suitable for the user's needs, and challenges that a user might encounter when using low-cost air sensors.

University of Northern BC

The PurpleAir PAII is a low-cost fine particulate matter ($PM_{2.5}$) monitor. Thousands have been installed world-wide, with over 150 across BC. Researchers at the University of Northern British Columbia (UNBC) in Prince George tested six of these sensors and found that readings correlated very well with government instruments. The average correlation – a measure of how well the sensor responds to changes in $PM_{2.5}$ levels – was 0.97 (1.00 is perfect), for 24-hour averages from the six sensors over 450 days. The average difference between the low-cost sensor and 'gold standard' instruments was 9.3 µg/m³, but when sensor $PM_{2.5}$ readings are corrected by UNBC researchers to better match the 'gold standard', the average error is reduced to 2.5 µg/m³.

A map of all 'gold standard' $PM_{2.5}$ readings in BC alongside calibrated sensor readings is available at weather.unbc.ca/aqmap. Anyone wishing to have their PurpleAir monitor reading corrected and included on this map can contact UNBC through the web page.

Environment and Climate Change Canada (ECCC)

ECCC is currently testing low-cost air quality sensors from several manufacturers to assess their performance and limitations over a broad range of meteorological and air quality conditions. The most extensive evaluation thus far has been of the PurpleAir. Testing has been underway for nearly one year and an initial assessment of its accuracy in reporting $PM_{2.5}$ concentrations and the AQHI, including during wildfire smoke events, has been completed. Next, ECCC is planning to deploy a large number of PurpleAir units in the Prince George area in the summer of 2019, as a pilot study to assess their effectiveness for enhancing wildfire smoke reporting and forecasting. Other activities include developing a rapidly deployable small sensor measurement platform, which could enhance monitoring during high impact air quality events.

Above: Self-contained tripod deployed SW of Edmonton containing PurpleAir sensors, Aeroqual AQY, 2B OEM-106L and Vaisala WXT with solar/battery power.

In addition, a national working group has been formed to share information and coordinate efforts related to understanding low-cost air quality sensors. The working group consists of representatives of federal departments, provincial and territorial governments, regional air quality agencies and organizations, and university groups.

Updates to the Provincial Air Quality Health Index (AQHI) for Biomass Smoke

The Air Quality Health Index (AQHI) is a tool designed to help people understand what air quality means to their health. It was developed by the federal government, based on the observed relationship between health effects and concentrations of nitrogen dioxide (NO_2), ground-level ozone (O_3), and fine particulate matter ($PM_{2.5}$) in Canadian cities. Of these pollutants, $PM_{2.5}$ has the smallest effect on the overall AQHI equation. In contrast, $PM_{2.5}$ is the most prominent pollutant in the biomass smoke emitted by wildfires, residential wood stoves, wood-fired boilers, and open burning. These are all important sources of air pollution in British Columbia (BC), and they were not being captured very well in the three-pollutant AQHI.

In May 2018 the AQHI for BC was updated to better reflect the effects of biomass smoke on air quality and health across the province. Each hour, two different values are calculated:

1. A three-pollutant index based on the 3-hour running averages of O_3, NO_2, and $PM_{2.5}$ as described https://www.tandfonline.com/doi/abs/10.3155/1047-3289.58.3.435.

2. A one-pollutant index based on the 1-hour average of $PM_{2.5}$ alone (Figure 2).

The higher of these two values is taken as the AQHI for that hour, then reported on provincial and national websites and through the national AQHI and WeatherCAN smartphone apps (both available for Android and iOS). This update to the BC AQHI was based on the observed relationship between $PM_{2.5}$ and respiratory health effects during smoky periods.

Current 1-hour $PM_{2.5}$ (µg/m³)	Index Value	AQHI Risk Category	Health Message for People at Higher Risk	Health Message for General Population
0 – 10	1	Low	**Enjoy** your usual outdoor activities.	**Ideal** air quality for outdoor activities.
11 – 20	2			
21 – 30	3			
31 – 40	4	Moderate	**Consider** reducing or rescheduling strenuous activities outdoors if you are experience symptoms.	**No need to modify** your usual outdoor activities unless you experience symptoms.
41 – 50	5			
51 – 60	6			
61 – 70	7	High	**Reduce or reschedule** strenuous activity outdoors.	**Consider** reducing or rescheduling strenuous activities outdoors if you experience symptoms.
71 – 80	8			
81 – 90	9			
91 – 100	10			
101+	10+	Very High	**Avoid** strenuous activities outdoors.	**Reduce or reschedule** strenuous activity outdoors, especially if you experience symptoms.

Figure 2: Values of the updated British Columbia Air Quality Health Index (AQHI) for different 1-hour average concentrations of fine particulate matter ($PM_{2.5}$). When the index value based on $PM_{2.5}$ alone is higher than the index value for the 3-pollutant AQHI model, the higher value will be reported.

The updated AQHI has now been running for an entire year. It performed well during the unprecedented 2018 wildfire smoke season, and during many winter woodsmoke episodes in coastal and mountain communities (Figure 3). From July through September of 2018 the one-pollutant index based on $PM_{2.5}$ alone was higher than the three-pollutant index for 33% of recorded hours across the province. From November 2018 through February 2019 the same was true for 40% of recorded hours in communities known to be most affected by residential woodsmoke. These results confirm the need for an updated AQHI to better protect the health of the BC population.

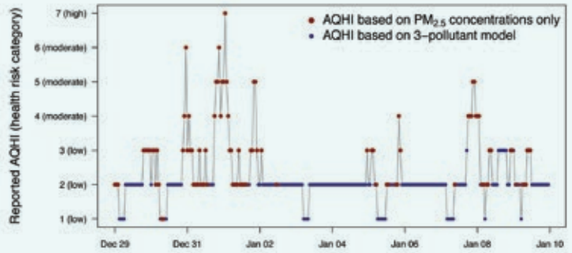


Figure 3: The reported Air Quality Health Index (AQHI) values for a community affected by residential woodsmoke in late 2018 and early 2019.

POLLUTION LEVELS
How Does BC Measure Up?

The summer of 2018 was the worst wildfire season on record in BC. A total of 2,092 wildfires burned over 1.35 million hectares of land, surpassing the record of 1.22 million hectares set the previous year. On August 8, 2018 there were 460 wildfires burning in the province. Wildfires are a large source of smoke. Smoky Skies Bulletins – used to warn the public of rapidly changing air quality conditions due to wildfire smoke – were issued for at least a few days in most areas of the province. Hardest hit were the Central and Southern Interior and the Kootenays in southeastern BC, with some forecast areas under a Smoky Skies Bulletin for at least 40 days last summer. Within Metro Vancouver, wildfire smoke transported from outside the region triggered 18 days of air quality advisories.

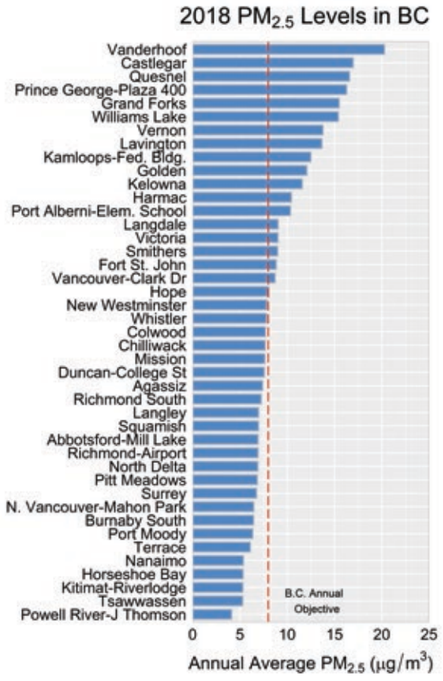
In the following sections, air quality data collected in 2018 are summarized and compared against provincial or national objectives. Data from all routine monitoring sites are summarized in the Technical Appendix.

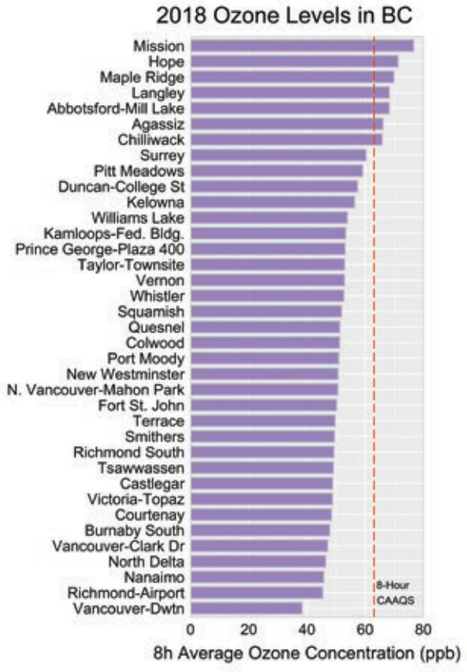
$PM_{2.5}$ Fine Particulate Matter

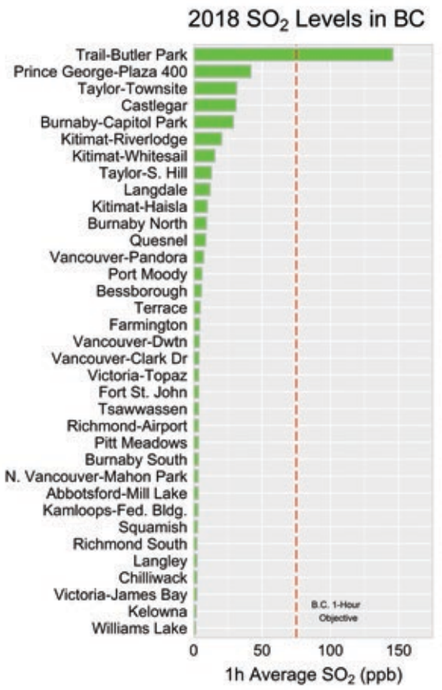
Fine particulate matter ($PM_{2.5}$) refers to microscopic particles that are 2.5 micrometres or smaller in diameter. Major sources in BC include residential wood combustion, prescribed burning, marine vessels, heavy-duty diesel vehicles, the pulp and paper sector and the mining sector. Inhaled $PM_{2.5}$ can travel deep into the lungs and cause irritation and inflammation. In places with higher baseline concentrations of $PM_{2.5}$, this inflammation further causes higher rates of chronic disease, including heart disease.

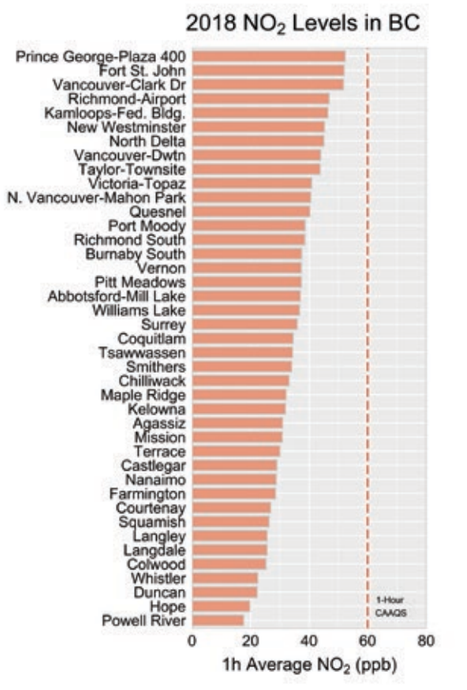
In 2018, $PM_{2.5}$ was monitored continuously in more than 60 sites across the province for at least a portion of the year. Annual average concentrations ranged from 4.1 µg/m³ in Powell River to 20.3 µg/m³ in Vanderhoof. A total of 19 sites exceeded the provincial annual objective of 8 µg/m³. Furthermore, a staggering 46 of 51 sites with sufficient data exceeded the provincial 24-hour objective of 25 µg/m³ due to wildfire smoke (data summarized in Technical Appendix). In more normal years, the highest $PM_{2.5}$ levels occur in the winter, during periods of stagnant weather conditions.[1] The elevated $PM_{2.5}$ levels observed in 2018 reflect the extreme conditions that much of the province experienced over parts of the summer. The “Trends” section on page 8 provides a comparison of $PM_{2.5}$ in 2018 with the past nine years.

1 Based on the annual 98th percentile of daily average









SO_2 Sulphur Dioxide

Sulphur dioxide (SO_2) is a colourless gas with a pungent odour at higher concentrations. Major sources of SO_2 include the upstream oil and gas sector, metal smelting facilities, the pulp and paper sector and marine vessels. Short-term exposures to SO_2 can aggravate asthma and increase respiratory symptoms.

In 2018, SO_2 was monitored at 45 sites, excluding mobile and industrial fenceline sites. One-hour SO_2 levels ranged from 1 ppb in Williams Lake to 146 ppb at Trail-Butler Park.[2] The majority of monitoring sites recorded 1-hour levels less than 10 ppb. Trail-area sites were the only locations to observe exceedances of the provincial objective of 75 ppb in 2018.

O_3 Ground-level Ozone

Ground-level ozone (O_3) is a reactive gas that forms in the atmosphere from reactions involving nitrogen oxides (NOx) and hydrocarbons in the presence of sunlight. A major source of both NOx and hydrocarbons in BC is the transportation sector, including motor vehicles. Short-term exposures can cause breathing difficulties, an aggravation of asthma symptoms and other lung diseases, and premature death. There is growing evidence that long-term exposures may be associated with the development of respiratory effects, especially in the young and the elderly.

In 2018, O_3 was monitored at 46 monitoring sites. Eight-hour concentrations ranged from 38 ppb in Downtown Vancouver to 77 ppb in Mission.[3] A total of seven monitoring sites exceeded the level of the national standard of 63 ppb.[4] These included five sites in the Fraser Valley Regional District (FVRD) (Mission, Hope, Abbotsford, Agassiz and Chilliwack) and two sites in Metro Vancouver (Maple Ridge and Langley). Similar to 2017, it is anticipated that the high O_3 levels in the FVRD were a function of sunny, warm conditions and periodic wildfire smoke.

NO_2 Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a reddish-brown gas that is associated with emissions from high-temperature combustion. NO_2 is mostly formed in the atmosphere from reactions involving nitrogen oxide (NO) and ground-level ozone. The largest sources of NO in BC include the transportation sector and industry. Short-term exposures to NO_2 are linked to respiratory illness, and there is growing evidence of effects from long-term exposure, including cardiovascular mortality, cancer and reproductive effects.

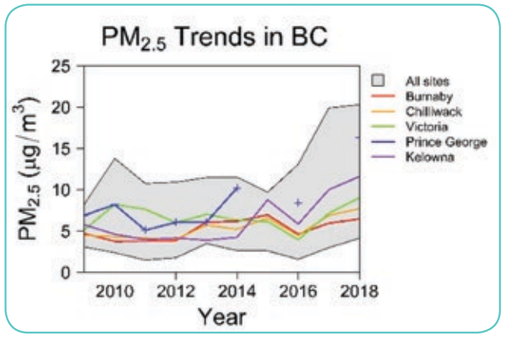
In 2018, NO_2 levels were monitored at more than 50 sites. One-hour concentrations ranged from 18 ppb in Powell River to 52 ppb at Prince George, Fort St. John and Vancouver-Clark Drive.[5] All sites were below the provincial objective of 100 ppb and the national standard of 60 ppb over one year.[6] Although the peak 1-hour concentrations of NO_2 were similar in Prince George, Fort St. John and Vancouver, on average, NO_2 concentrations were highest in Vancouver (19.2 ppb) and other sites in Metro Vancouver located in proximity to major transportation routes. In contrast, annual NO_2 levels in Prince George (10.4 ppb) and Fort St. John (7.0 ppb) were significantly lower. See the Technical Appendix for annual concentrations at other BC sites.

2 Based on the annual 97.5th percentile of daily one-hour maximum concentrations. The provincial objective of 75 ppb is based on similar statistical form as presented, but averaged over three years. Elevated SO_2 levels were also recorded at Trail-Warfield; however, this data is under review and not included in this report.
3 Based on the annual 4th highest daily 8-hour maximum concentration over one year.
4 Achievement of the national standard is based on a similar statistical form as presented, but averaged over three years.
5 Based on annual 98th percentile of daily one-hour maximum concentration.
6 The Canadian Ambient Air Quality Standard (CAAQS) of 60 ppb is based on a three-year average.

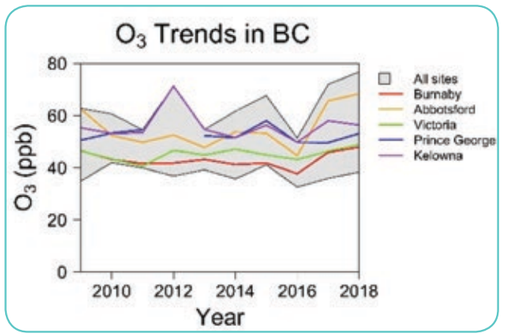
TRENDS
Air Pollution Through the Years

We look at trends in air pollution to assess the effectiveness of actions to improve air quality and to determine the need for additional work. The following figures provide 10-year trends in annual concentrations in the most heavily populated areas of the province, and the minimum and maximum concentrations across all BC sites.

$PM_{2.5}$ levels (shown as annual average) have been increasingly influenced by wildfire smoke over the past decade. In 2014 and 2015, wildfire impacts on $PM_{2.5}$ levels were observed in parts of the province (e.g. Prince George and Kelowna). In 2017 and 2018 especially, wildfire smoke was widespread. Several sites, including Prince George, Kelowna, Chilliwack and Victoria, observed their highest average concentrations over the past decade in 2018.

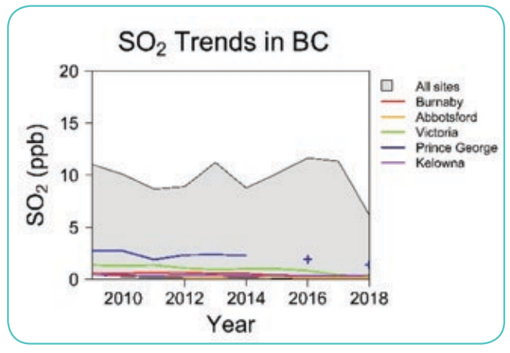


Ozone levels (shown as 4th highest daily 8-hour maxima) are also known to be influenced by wildfire smoke. Siberian wildfire smoke in 2012 and BC wildfires in 2015, 2017 and 2018 are believed to have contributed to higher ozone levels in these years.[6,7]

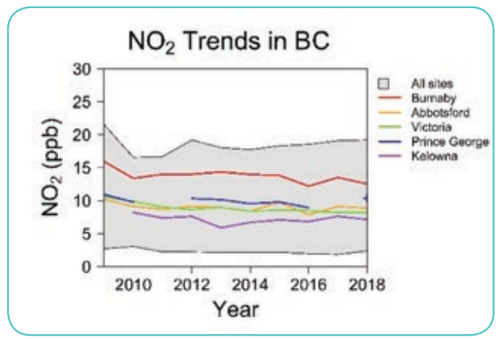


6 Teakles, A.D., So, R., Ainslie, B. et al. (2017) Impacts of the July 2012 Siberian fire plume on air quality in the Pacific Northwest. Atmos. Chem. Phys. 17, pp. 2593-2611.
7 Influence of 2015 and 2017 wildfire smoke on ozone levels in the Lower Fraser Valley are discussed further in: Lower Fraser Valley Air Zone Report (2015-2017) at: https://www2.gov.bc.ca/gov/content/environment/air-land-water/air/reports/latest-air-zone-reports.

SO_2 levels (shown as annual average) in urban areas remain low – less than 3 ppb throughout the last decade. This reflects efforts to reduce sulphur content in motor vehicle and marine fuels and a reduction of emissions from the petroleum refining and cement industries.



NO_2 levels (shown as annual average) have generally declined in urban areas over the past decade, largely due to more stringent vehicle emission standards and other local actions. There is evidence that trends have bottomed out or have begun to increase. The introduction of new vehicle emission standards, beginning in 2017, is expected to result in improved air quality over the next decade as the new technology penetrates the vehicle fleet.



Glen Okrainetz– 2019 Clean Air Champion

The BC Lung Association's Air Quality/Health Steering Committee annually awards the title of "Clean Air Champion" to a deserving recipient who has made a significant contribution to the field of air quality. The contribution may have been in any aspect of air quality, including basic science, epidemiology, public health, advocacy, education, and innovations. Nominees may be an individual or an organization, including public interest groups, academics, local governments, private companies and others.

This year's recipient of the award is Mr. Glen Okrainetz.

In recognition of his numerous contributions over the past decade to protect air quality in BC, Glen Okrainetz is recognized as this year's Clean Air Champion. "Glen has been a tireless supporter of air quality in the province and has led the BC Lung Air Quality/Health Steering Committee for 15 years. He is well-respected among his colleagues and this report would not have been possible without his support," says Dr. Menn Biagtan, VP, Health Initiatives and Programs of the BC Lung Association.

Until his retirement in December 2018, Glen was the Director of the Clean Air, Integrated Pest Management and Industry Section of the Ministry of Environment and Climate Change Strategy. He worked on a wide range of issues that spanned local and regional activities (e.g. AirCare review, support of airshed planning efforts), provincial activities (e.g. BC Scrap-It Program), national efforts (e.g. Air Quality Management System, Canadian Ambient Air Quality Standards) and international collaborations (e.g. International Airshed Strategy).

Glen was instrumental in the development of the BC Air Action Plan in response to the government's commitment that British Columbia would have the best air quality, bar none. The Air Action Plan, over time, yielded a number of important programs to improve air quality in BC that included:

- The Provincial Wood Stove Exchange program to promote the shift to cleaner forms of residential heating;
- Tighter emission standards for wood-burning appliances;
- Strategies to reduce emissions from pile burning and new tools to improve our ability to forecast smoke impacts;
- Incentives to encourage the transition to cleaner vehicles;
- Promotion of anti-idling efforts and the clean-up of diesel emissions from school buses;
- Collaboration with the Fraser Basin Council to green commercial and public sector vehicle fleets;
- Work with the federal government, ports and the shipping industry to support green ports and marine vessels

"Glen was the chair of the BC Lung Association Air Quality/Health Steering Committee. He brought to the table his leadership skills, his ability to 'connect the dots,' his support for collaborative solutions, and boundless humour," says Michael Brauer, Professor, School of Population and Public Health UBC.

"Some people who have seen us interact probably think I am enjoying Glen's retirement as much as he is. But I have a tremendous respect and admiration for the work he did on ensuring clean, healthy air throughout BC, and working with local airsheds such as Metro Vancouver. Thanks Glen!" says Roger Quan, Director of Air Quality and Climate Change, Metro Vancouver.

Although Glen has retired from his work with the Ministry, he remains active in the environmental field. Glen continues to sit on the Board of Directors of the Scrap-It Program, and to ride his bicycle around the streets of Victoria.

2018 Even Worse than 2017 for Wildfire Smoke

After the unprecedented 2017 wildfire season, no one expected that the 2018 season would be even worse for wildfires and smoke in BC. Although the 2018 wildfires were not as disruptive or destructive as those in 2017, the area they burned was even larger and their air quality impacts were more extreme. Concentrations of fine particulate matter ($PM_{2.5}$) were elevated across the province for most of August (Figure 4), with the highest measurements in the central and southern interior where the fires were most intense. Even still, weather conditions transported heavy smoke to coastal areas, and Metro Vancouver was under air quality advisory for a record 22 days, of which 18 days were related to wildfire smoke.

Exposure to wildfire smoke has been associated with a wide range of acute health effects, especially for people with respiratory conditions such as asthma and chronic obstructive pulmonary disease (COPD). Evidence also suggests that people with heart conditions are at higher risk. Given that wildfire seasons are getting longer and more intense across North America, Europe, and Australia, there will be many new research on the short- and long-term health effects of wildfire smoke in the coming years. We cannot predict what the 2019 wildfire season will bring for BC, but we should now approach every summer prepared for another record-setting year. The best way to reduce any health risks from wildfire smoke is to reduce your smoke exposure by (1) keeping the indoors as smoke-free as possible and (2) limiting exercise outdoors when it is smoky. New fact sheets from the BC Centre for Disease Control (BCCDC) can help you to prepare and protect yourself: http://www.bccdc.ca/health-professionals/professional-resources/wildfire-smoke-response-planning

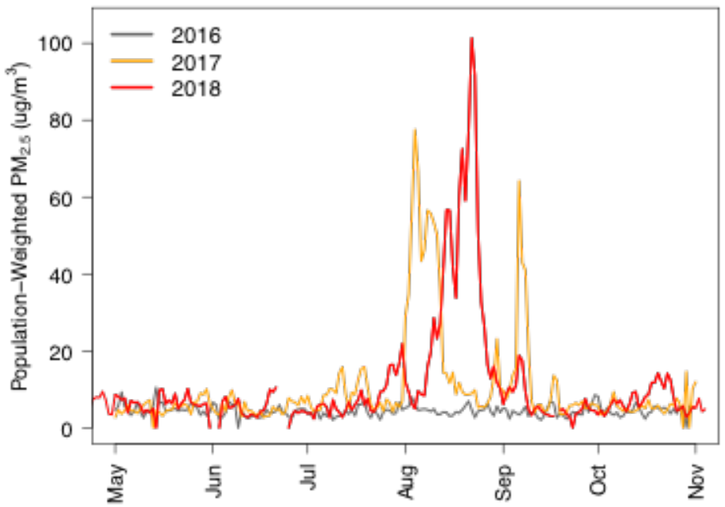


Figure 4: The daily population-weighted average of fine particulate matter ($PM_{2.5}$) concentrations across BC in the mild wildfire season of 2016 and the extreme wildfire seasons of 2017 and 2018. The population-weighted average takes the estimated exposure for every person in the province, and then averages all 4.9 million values. Some locations (e.g. Prince George) experienced much higher concentrations than those shown here, while others (e.g. Terrace) were lower.

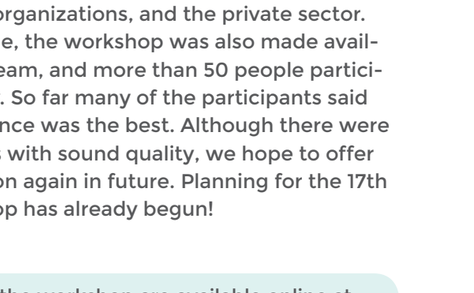
Highlights from the Air Quality and Health Workshop

On February 6, 2019 the BC Lung Association held its 16th annual Air Quality and Health Workshop at the Pinnacle Hotel in Vancouver. The topic was Wildfire Smoke: A Growing Threat to Air Quality and Public Health, which drew considerable interest after the extreme 2017 and 2018 wildfire seasons. The objectives of the workshop were to: (1) describe the complex wildfire smoke mixture; (2) review what is already known about the health effects of wildfire smoke based on historic events; (3) summarize the expected impacts of climate change on wildfire and smoke over the coming decades; (4) discuss the effectiveness of individual and community interventions for wildfire smoke protection; and (5) identify critical gaps in the current toxicological, epidemiological, and intervention evidence.

Dr. Sarah Henderson from the BC Centre for Disease Control (BCCDC) gave an overview of wildfire smoke and health in BC and elsewhere over the past 20 years and some insight into the next 20 years. Dr. Michael Flannigan from the University of Alberta followed with a talk about the changing wildfire regime in western Canada, and the spectre of even longer and more extreme seasons in BC and Alberta.

Dr. Ian Gilmour from the Environmental Protection Agency (EPA) described the constituents of smoke, which is an extremely complex mixture of organic and inorganic gases and particles. He then went on to present exciting work from his lab on the toxicology of wildfire smoke, especially the effects of smoke from different fuels and different fire temperatures. The overall findings were that smoke had significant respiratory and cardiovascular effects in animals. Dr. Colleen Reid from the University of Colorado then reviewed what is known about the health effects of wildfire smoke in humans. While there is clear and growing evidence of acute respiratory and cardiovascular effects, more research is needed on infants exposed *in utero*, other acute outcomes such as mental health impacts, and the long-term effects of extreme and repeated exposures.

The afternoon started with Dr. Bonne Ford from Colorado State University discussing all the different tools that are available for assessing exposure to wildfire smoke, including low-cost sensors. This was followed by Angela Yao from the BCCDC, who described different tools for public health surveillance, including assessment of population susceptibility to current and future smoke events. Sarah Coefield, an air quality specialist with the Missoula County Health Department, shared her experience thru her work in public health. As a front-line public health professional, Sarah managed periods of extreme and prolonged smoke exposure in a rural area, and she shared many lessons learned.



Dr. Robert Brook from the University of Michigan discussed the health protection offered by portable air cleaners and face masks, including some new evidence from studies conducted in highly polluted cities. Dr. John Balmes from the Berkeley School of Public Health then discussed his own experiences during recent wildfire seasons in California, and the limited evidence for community-based interventions to protect people from smoke exposures. Prior to the final talk, Roger Quan from Metro Vancouver spoke in recognition of the extensive contributions of Glen Okrainetz, who retired from the BC Ministry of Environment and Climate Change Strategy in December 2018. Finally, Glen took the stage to reiterate the importance of wildfire smoke as an air quality and public health issue in the changing climate.

The workshop was attended by more than 200 participants from government agencies, universities, non-governmental organizations, and the private sector. For the first time, the workshop was also made available via live stream, and more than 50 people participated remotely. So far many of the participants said that tis conference was the best. Although there were some problems with sound quality, we hope to offer the online option again in future. Planning for the 17th annual workshop has already begun!

All slides from the workshop are available online at https://bc.lung.ca/health-professionals/air-quality-health-workshop

Updates from Partner Agencies

Ministry of Environment and Climate Change Strategy

Regulatory Updates

The Ministry of Environment and Climate Change Strategy (ENV) is finalizing proposed revisions to the Open Burning Smoke Control Regulation. Information on the proposed changes can be found at https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/legislation-regulation/environmental-protection-regulatory-review/open-burning-smoke-control-regulation. If the proposal is adopted before summer, new burning rules will be in effect for the fall burning season.

Provincial Wood Stove Exchange Program

The province increased its funding of the Provincial Wood Stove Exchange Program from $200,000 in 2017 to $300,000 in 2018. This funding will support wood stove exchange programs in 15 BC communities, and will include incentives of $250 for changing to a cleaner-burning wood stove, and $400 for changing to a qualifying electric heat pump, gas or propane stove, or pellet-fuelled stove. Individual communities may provide additional incentives to residents, over and above those provided by the province. For more information on the Provincial Wood Stove Exchange Program, see: https://www2.gov.bc.ca/gov/content/environment/air-land-water/air/air-pollution/smoke-burning/exchange.

Air Quality Monitoring Network

In 2018, ENV installed a new and fully-equipped air quality monitoring station at the Muriel Baxter School in Cranbrook. ENV also supported work by Dr. Peter Jackson of the University of Northern BC to compare the performance of low-cost $PM_{2.5}$ sensors with government reference instruments. For more information on this work, see page 4.

The Province and the Prince Rupert Port Authority have agreed to share information collected by the Port Authority in the Fairview area. This has given the Province access to data from a coastal site in an area of the Province where little air quality data is available. In turn, the Prince Rupert Port Authority's data is freely available on all regular Ministry reporting channels and the site is operationally audited by an external party.

On January 1, 2018, ENV began a pilot program in Kitimat to issue public alerts when sulphur dioxide (SO_2) levels exceed predefined thresholds. When triggered, alerts are automatically posted to ENV's website and sent out to the AQ-advisories.ca website operated by the Bulkley Valley Lakes District Air Management Society, for immediate forwarding to a subscription list. The pilot continues to run at this time. For more information on the pilot, see: https://www2.gov.bc.ca/gov/content/environment/air-land-water/air/air-quality/measuring/kitimat-so2-alert-pilot-project.

AQHI Update

The AQHI is a tool developed by Canadian health researchers to communicate short-term health risks to the public. Originally based on data from the largest Canadian cities, the AQHI has been shown to periodically under-report health risks during smoky conditions. In 2018, ENV has directly supported the work by the BCCDC to develop an AQHI-Plus to better characterize health risks due to wildfire smoke (for more info, see: page 5).

metrovancouver
SERVICES AND SOLUTIONS FOR A LIVABLE REGION

Air Quality and Climate Change Planning

Metro Vancouver is beginning development of its next regional air quality and greenhouse gas management plan, the *Clean Air Plan*. The plan will identify opportunities for emissions reductions to protect human health and the environment, minimize the region's contribution to climate change and improve visual air quality.

Metro Vancouver is also implementing *Climate 2050*, a new regional climate action strategy, to support transitioning our region to a resilient and low carbon future, and increasing the health, well-being and prosperity of Metro Vancouver residents. The first component of the strategy – the *Climate 2050 Strategic Framework* – was approved by the Board in 2018.

The *Clean Air Plan* will be developed in 2019-2020 and will be the key air quality and greenhouse gas planning document for Metro Vancouver. Integrated with *Climate 2050*, it will set the direction for air quality and greenhouse gas management in the region for the next five to ten years.

Regional Air Quality Objectives

Metro Vancouver is initiating consultation to update regional air quality objectives for nitrogen dioxide and ozone, following adoption of new Canadian Ambient Air Quality Standards. The new regional objectives are intended to provide greater human health and environmental protection, and enable air quality management activities and emission reductions in the region.

Reducing Vehicle Emissions

Metro Vancouver has been working to increase the uptake of electric vehicles (EVs) in the region, to support regional emission reductions goals. Programs such as Emotive: The Electric Vehicle Experience (www.emotivebc.ca), EVCondo.ca, and EVWorkplace.ca engage with residents, strata corporations and businesses to lower the barriers to owning and charging an EV.

In 2018, Metro Vancouver celebrated its busiest season ever for Emotive, a community outreach campaign founded by Metro Vancouver, the cities of Surrey and Vancouver, Fraser Basin Council and the Province of BC, which aims to raise awareness of plug-in electric vehicles in BC In Metro Vancouver, Emotive was at 45 community events in 2018, and the 2019 schedule includes 50 events.

Regulatory Updates

Metro Vancouver is taking measures to address residential wood smoke, which is responsible for more than a quarter of $PM_{2.5}$ emissions in the region and can cause respiratory and cardiac health effects. Following consultation with residents, businesses, and health agencies, a new bylaw is being developed, which, if adopted, would complement a variety of educational and incentive programs currently in place to reduce wood smoke from indoor wood-burning stoves and fireplaces across the region. The new bylaw is expected to include a phased approach to regulate the emissions, with seasonal restrictions, registration requirements, and limits on the operation of older, more polluting wood-burning devices.

Metro Vancouver is seeking ways to reduce odour emissions across the region, following increasing public complaints about odours from a variety of sources, which could include compost and food processing facilities. Odorous air contaminants have the potential to cause effects ranging from nuisance when present at low levels to health effects when frequently present at elevated levels. Metro Vancouver will be engaging with local communities, businesses, and municipalities over the summer and fall to share information about enhancing odour management in the region.

Diesel engine exhaust is a leading air quality threat to human health in Metro Vancouver, containing a complex mixture of air contaminants. Non-road engines, such as loaders, tractors and other equipment, are a primary source of diesel emissions. To reduce emissions from older, higher emitting non-road diesel engines, Metro Vancouver has implemented its Non-Road Diesel Engine Bylaw. Since 2015, the Bylaw has prohibited registration of Tier 0 engines, the oldest, highest-emitting engines. Beginning in 2020, similar measures for Tier 1 engines will apply in the region. An outreach campaign will be launched in June about the Tier 1 engine registration deadline and prohibition against introducing previously unregistered Tier 1 engines into the region.

For updates on consultation activities, visit www.metrovancouver.org/services/air-quality/consultation.

Air Quality Monitoring and Preparing for Wildfires

Metro Vancouver is enhancing the way it responds to air quality impacts from wildfires, following unprecedented levels of smoke during the past four years and anticipated changes in the frequency, duration and severity of

(Cont'd on p.14)

(Cont'd from p.13 - Updates: From Partner Agencies)

wildfires in the future as a result of climate change.

Metro Vancouver operates a network of 31 air quality monitoring stations from Horseshoe Bay to Hope and issues air quality advisories whenever air quality is expected to reach unhealthy levels. During the summers of 2015, 2017 and 2018, Metro Vancouver experienced significantly increased wildfire smoke impacts. The 14-day advisory in August 2018 was the longest continuous advisory period in the history of Metro Vancouver's air quality program.

Since late 2017, Metro Vancouver has been working with local health authorities, BC Centre for Disease Control, Health Canada, the BC Ministry of Environment and Climate Change Strategy, and the Fraser Valley Regional District to develop more effective information for residents on wildfire smoke health impacts and interventions for reducing them. Opportunities for early outreach and messaging before air quality degrades to levels that warrant an advisory are also being investigated.

Caring for the Air

Metro Vancouver's annual Caring for the Air Report has more air quality and climate change stories at www.metrovancouver.org/air.

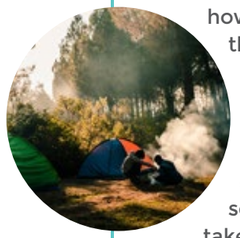
Fraser Valley Regional District (FVRD)

Wildfire Smoke Communications

In the summer time, FVRD residents are often exposed to hazardous smoke, both from local wildfires and from burning forests far away. These episodes have become longer and more frequent in recent years. Our part of the airshed is prone to accumulating higher levels of toxic air pollutants from smoke than the rest of the region and it is important that our residents know how to protect themselves and their families. The FVRD collaborates with the regional health agencies and neighbouring jurisdictions to develop meaningful and timely messages about how smoke affects air quality and health and how to prepare and protect oneself from those effects.

"Love Our Air" for Schools

FVRD outreach efforts have been greatly enhanced through the 2017 launch of a well-received school program called *"Love our Air"*, a portfolio of lessons and custom workshops designed for Grades 5 and 10 Science classrooms. The program focuses on developing students' respect for the environment and understanding how to reduce pollution through their everyday actions. Students learn to identify types of air pollutants, their sources and impacts, as well as possible actions and solutions that they can take as individuals, or with their community. The program has been offered in every part of the region, including small communities. It will continue in the 2019/2020 school year.



Electric Vehicles

The FVRD continues to partner with Emotive: The Electric Vehicle Experience campaign in the region. This campaign brings electric vehicles to events throughout the region to show residents how great electric vehicles are to drive. An Emotive booth was set up at key events in the region, such as the Abbotsford Airshow and the Agassiz Fall Fair and Corn Festival.

Radon Awareness

New radon data indicates that some areas in the FVRD have radon levels that are of concern. Long-term exposure to indoor radon buildup results in an increased risk of developing lung cancer. Due to the potential health concerns associated with it, the FVRD is working with health agencies to support their initiatives on improving radon awareness throughout the region and protect residents from potentially unsafe exposure.

Environment and Climate Change Canada
Environnement et Changement climatique

Environment and Climate Change Canada (ECCC) has a mandate to provide Canadians with a clean, safe and sustainable environment. With respect to air quality, this is achieved through its Air Pollution and Weather and Environmental Observations, Forecasts and Warnings programs and mechanisms such as the Air Quality Management System and the Canada-US Air Quality Accord. In British Columbia, the regional ECCC office has shifted its focus in recent years towards science activities in support of air quality prediction and services.

Small Sensors in Support of Air Quality Monitoring and Prediction

ECCC is currently investigating small low-cost sensors to assess their potential for communicating risk of exposure to air pollution, improving air quality forecasting and enhancing community engagement with respect to air quality issues. Several initiatives are underway and are described in further detail on page 4.

Air Quality Modelling and Wildfire Smoke Forecasting

ECCC is currently working on an evaluation study of its smoke forecast model FireWork (www.weather.gc.ca/firework) in order to improve its ability to forecast $PM_{2.5}$ concentrations during wildfire smoke events. The study is using ground- and satellite-based observations to examine how different model configurations and different fire emission models can be used to give Canadians better guidance on wildfire impacts in their communities. Part of the study included a survey on how the FireWork model guidance is used by air quality meteorologists, air quality scientists and public health workers and how they would like the model to be improved. The survey results will help guide model development as well as improve the suite of forecast products delivered to the various user communities. In addition, a pilot project is underway to study how the upgrades to ECCC's weather radar network can be used to detect wildfire plumes. The radar upgrades should allow for better discrimination between clouds, rain and smoke particles and could ultimately be used to improve air quality forecasts.

Health Canada Santé Canada

The International Society of Exposure Science and the International Society for Environmental Epidemiology returned to Canada in 2018 for a joint annual meeting for the first time since the 2002 meeting in Vancouver. Health Canada staff were major contributors to the organization of the 2018 meeting in Ottawa and 25 Health Canada attendees presented their research on air quality and toxic chemicals to the conference. A highlight of the conference was a symposium honouring the career of Health Canada research scientist Dr. Richard Burnett, who has done much to shape Canadian and global knowledge of the health impacts of air pollution. At the conference, Dr. Burnett presented a new Global Exposure Mortality Model which used data from 41 cohort studies in 16 countries to develop new predictions of the relationship between ambient air $PM_{2.5}$ concentrations and mortality.

Health Canada air quality research published in 2018 reported on investigations of air pollution exposure and impacts on vulnerable populations including prenatal exposure, diabetics and older Canadians. Research ranged from large scale epidemiological studies like the Canadian Census and Environmental Health Cohort (CanCHEC), to small panel studies. Papers were published on the impact of traffic, steel mills and refineries. New projects have begun on aeroallergens, ultrafine particles, and biomass burning.

Work continues in support of the Canadian Ambient Air Quality Standards with a risk assessment on ozone nearing completion and a new review of $PM_{2.5}$ beginning. A risk assessment of traffic related air pollution is also underway. A guidance document on *Ventilation and the Indoor Environment* was recently published as well as several fact sheets on a variety of subjects related to indoor and outdoor.

Recently, Health Canada supported and contributed its research results to the Canadian Partnership for Children's Health and the Environment's Healthy Schools Day on April 4, 2019, which was focused on reducing the impacts of diesel school buses.

Health Canada provided financial support to the BC Centre for Disease Control (BCCDC) to develop a series of one-page fact sheets on wildfire smoke, air quality and health. These documents were developed for all organizations in BC that need to provide information to the public on wildfire smoke and health. They are intended to provide a consistent set of messages based on the most up-to-date evidence. As part of this work, BCCDC is also completing an updated evidence review on the use of masks during smoke events and a new evidence review on the impact of exposure to wildfire smoke on infants and babies *in utero*. Some of the one-pager documents are available on-line on the BCCDC website and the remaining documents will be posted soon.

Visit/Contact

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1-800-665-5864 (in BC but outside the Lower Mainland)

BC MINISTRY OF ENVIRONMENT AND CLIMATE CHANGE STRATEGY
www.gov.bc.ca/bcairquality
Environmental Standards Branch
525 Superior Street
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HEALTH CANADA ENVIRONMENTAL HEALTH PROGRAM-BC REGION
www.hc-sc.gc.ca/ewh-semt/air/index-eng.php
Federal Building Sinclair Centre
420-757 Hastings St. W
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BC CENTRE FOR DISEASE CONTROL
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655 West 12th Ave
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ENVIRONMENT AND CLIMATE CHANGE CANADA
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1-800-528-0661

BC MINISTRY OF HEALTH
http://www2.gov.bc.ca/gov/content/governments/organizational-structure/ministries-organizations/ministries/health
Health Protection Branch
1515 Blanshard Street, RBB 4-2
Victoria, BC V8W 3C8
(250) 952-1911

NORTHERN HEALTH AUTHORITY
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Suite 600, 299 Victoria St.
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ISLAND HEALTH AUTHORITY
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1952 Bay Street
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(250) 370- 8699

VANCOUVER COASTAL HEALTH AUTHORITY
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Vancouver, BC V5Z 4C2
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1-866-884-0888

FRASER HEALTH AUTHORITY
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1-877- 935-5699

INTERIOR HEALTH AUTHORITY
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220 – 1815 Kirschner Rd.
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We welcome your feedback via this link: https://form.jotform.com/lungassociation/SOTA

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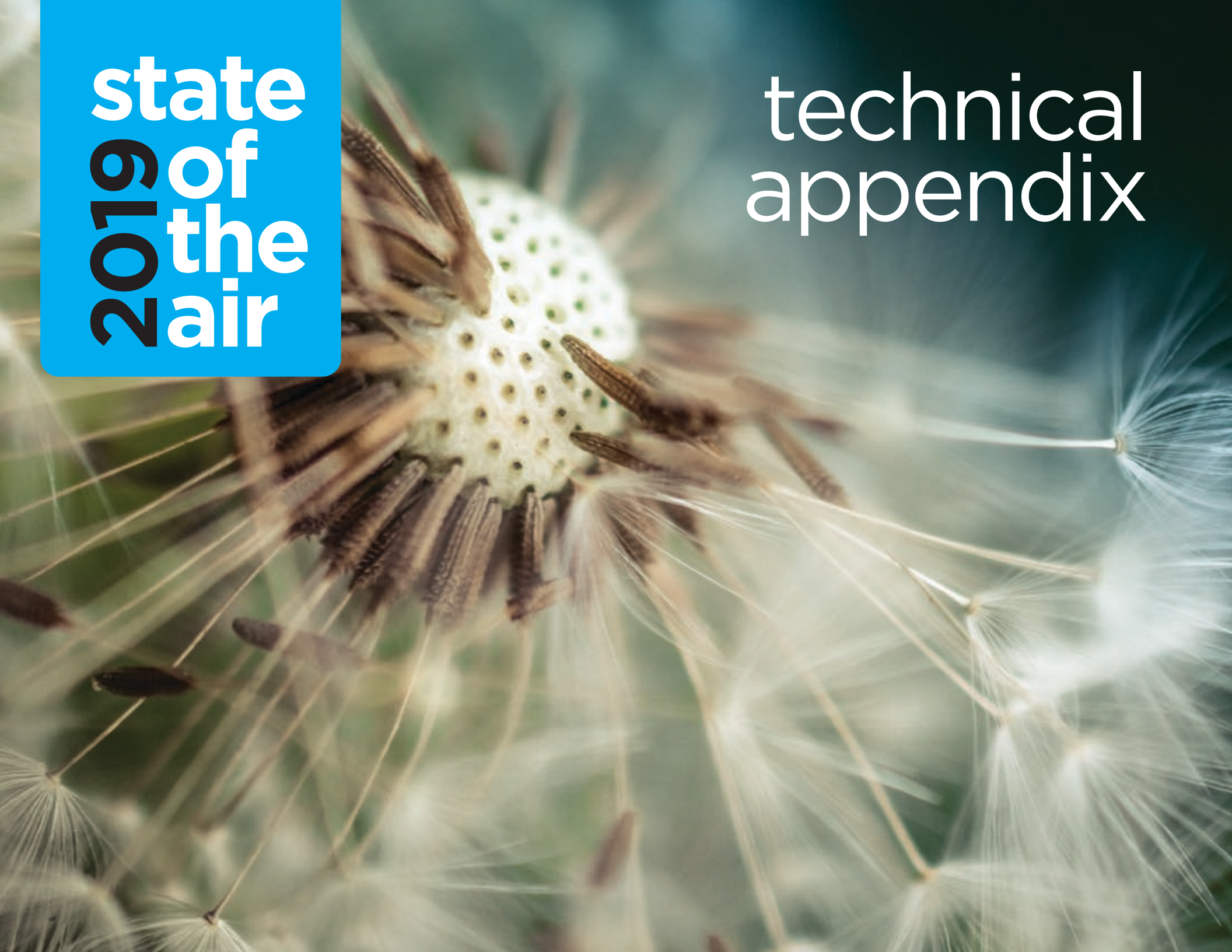
2019 state of the air

technical appendix



2019 BC Lung State of the Air Report -- Technical Appendix

Data Source:

BC Ministry of Environment and Metro Vancouver

Units:

All data presented in ppb except $PM_{2.5,}$ which is presented in micrograms per cubic metre

Monitoring sites:

Monitoring is often conducted to address various objectives that may include measuring concentrations representative of: community exposure, industrial impacts, background concentrations, etc.

For the State of Air Report, monitoring sites immediately adjacent to industrial facilities were not included unless these sites were also near areas of high population density.

Data completeness:

Data completeness criteria have been relaxed relative to previous reports to enable reporting of data from more stations.

In this report, a valid day has data for at least 18 hours (75%).

A valid year has data for at least 60% of days in each quarter and 75% of of hours over an entire year, with the following exceptions.

For peak (4th highest) 8-hour ozone levels, a valid 8-hour period has data for at least 6 hours, a valid day has data for at least 18 hours, and a valid year has at least 75% of days in the second and third quarters (April 1 to September 30).

For peak (1-hour) SO_2 and NO_2 levels, a valid daily maximum includes those days where less than 18 hours are available in a day but the maximum concentration exceeds the objective level.

Annual mean $PM_{2.5}$ levels are based on the annual mean of daily $PM_{2.5}$ concentrations.

Where data completeness requirements are not met, only number of hours per year, maximum value and number of exceedances are shown.

Collocated monitors:

Where more than one $PM_{2.5}$ monitor is operating at a single site, data are shown for the monitor currently considered the primary reporting monitor and/or the monitor reporting a complete year of data.

A common example is the collocation of new FEM instruments alongside the TEOM instruments. This is done primarily for testing purposes, to ensure satisfactory FEM performance prior to establishing the FEM instrument as the primary reporting monitor and decommissioning the older TEOM instrument.

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2018 Nitrogen Dioxide Levels

Site	Year	No. Valid Hrs	Annual Avg	Percentiles (1h)					Max 1h	Annual 98th Percentile of D1HM*	No. Days			% of Valid Days Per Quarter			
				25th	50th	75th	98th	99th			>100 ppb	>60 ppb	>42 ppb	Q1	Q2	Q3	Q4
Abbotsford-Airport	2018	8578	7.5	3	6	11	22	24	36	31	0	0	0	100	99	99	98
Abbotsford-Mill Lake	2018	8614	8.9	4	7	12	25	28	50	37	0	0	1	100	99	100	99
Agassiz	2018	8678	8.1	4	6	11	23	26	50	31	0	0	2	100	100	100	100
Burnaby-Kensington	2018	8720	11.4	7	10	15	29	32	53	39	0	0	3	100	100	100	100
Burnaby-Mtn	2018	8712	7.4	4	6	10	24	28	50	36	0	0	3	99	100	99	100
Burnaby South	2018	8683	12.5	7	11	17	30	33	48	37	0	0	2	100	98	100	100
Castlegar	2018	8287	6.4	3	5	9	19	21	47	29	0	0	2	100	93	100	100
Chilliwack	2018	8621	8.3	4	7	11	23	26	43	33	0	0	1	100	98	99	99
Colwood	2018	8233	4.7	1	3	7	18	21	31	25	0	0	0	100	100	92	99
Coquitlam	2018	8717	9.4	5	8	13	26	28	48	35	0	0	3	100	100	100	100
Courtenay	2018	8236	3.9	2	3	5	15	18	49	27	0	0	3	100	100	98	95
Cranbrook	2018	3040	.	.	.	.	.	.	32	.	0	0	0	0	0	43	100
Duncan-Cairnsmore	2018	314	.	.	.	.	.	.	19	.	0	0	0	14	0	0	0
Duncan-College St	2018	7822	4.3	2	3	6	14	16	27	22	0	0	0	79	100	99	95
Farmington	2018	8275	3.6	1	2	5	16	20	47	29	0	0	1	98	93	100	98
Fort St. John	2018	8074	7	2	4	8	34	41	79	52	0	3	27	100	98	86	99
Hope	2018	8684	4.3	2	3	6	13	15	28	20	0	0	0	99	100	100	99
Kamloops Aberdeen	2018	427	.	.	.	.	.	.	32	.	0	0	0	20	0	0	0
Kamloops-Fed. Bldg.	2018	8348	11.8	6	9	16	36	41	54	46	0	0	17	98	100	99	100
Kelowna	2018	8372	7.2	3	5	10	23	25	37	32	0	0	0	100	100	100	99
Langdale	2018	8207	4.3	2	3	6	14	16	52	26	0	0	1	100	100	95	96
Langley	2018	8616	5.7	2	4	8	18	21	32	26	0	0	0	100	99	100	98
Maple Ridge	2018	8713	7.8	4	6	11	22	25	40	32	0	0	0	100	97	100	100
Mission	2018	8688	7	3	5	9	23	25	37	31	0	0	0	98	100	100	100
Nanaimo	2018	8321	6.1	2	5	9	19	21	42	29	0	0	1	100	98	100	99
New Westminster	2018	8634	16.5	10	16	22	35	38	69	45	0	1	13	100	96	100	100
North Delta	2018	8688	12.9	6	11	18	34	36	50	45	0	0	9	98	99	100	98
N. Vancouver-Mahon Park	2018	8680	11.3	6	10	15	31	34	54	41	0	0	6	98	98	100	100
N. Vancouver-2nd Narrows	2018	8705	12.5	7	11	16	34	40	64	52	0	3	25	100	100	100	100
Pitt Meadows	2018	8671	8.6	4	7	12	26	29	44	37	0	0	3	97	100	100	98
Port Moody	2018	8688	11.8	7	11	16	28	31	63	39	0	1	2	99	99	100	99
Powell River-Cranberry Lake	2018	663	.	.	.	.	.	.	14	.	0	0	0	31	0	0	0
Powell River-Wildwood	2018	7660	2.4	1	2	3	8	10	74	18	0	1	1	64	100	100	100
Prince George-Plaza 400	2018	7648	10.4	4	7	14	41	45	59	52	0	0	29	83	87	88	99
Quesnel	2018	8383	8.7	3	6	12	29	33	53	40	0	0	5	100	99	100	100
Richmond-Airport	2018	8667	14	6	12	20	36	39	70	47	0	1	19	98	99	100	100

2018 Nitrogen Dioxide Levels

Site	Year	No. Valid Hrs	Annual Avg	Percentiles (1h)					Max 1h	Annual 98th Percentile of D1HM*	No. Days			% of Valid Days Per Quarter			
				25th	50th	75th	98th	99th			>100 ppb	>60 ppb	>42 ppb	Q1	Q2	Q3	Q4
Richmond South	2018	8676	11.2	4	9	16	31	34	50	39	0	0	3	100	99	100	99
Smithers	2018	7800	5.7	2	4	8	26	29	41	34	0	0	0	97	100	99	73
Squamish	2018	8586	6.2	3	5	8	18	20	33	26	0	0	0	93	100	100	100
Surrey	2018	8674	9	4	7	12	26	29	42	36	0	0	0	99	99	100	100
Taylor-Lone Wolf Golf Course	2018	1462	.	.	.	.	.	.	31	.	0	0	0	70	0	0	0
Taylor-Townsite	2018	8338	7.3	2	4	11	30	34	57	44	0	0	9	99	99	99	98
Terrace	2018	8374	3	1	1	4	18	23	38	30	0	0	0	100	100	100	99
Tsawwassen	2018	8651	6.6	2	5	9	23	26	55	34	0	0	2	100	100	100	97
Vancouver-Clark Dr	2018	8424	19.2	12	19	26	40	43	65	52	0	2	50	89	96	100	100
Vancouver-Dwtn	2018	8571	17.3	11	17	22	34	37	82	44	0	1	12	97	96	100	100
Vernon	2018	8386	9.8	5	8	13	29	32	41	37	0	0	0	100	100	100	100
Victoria-Topaz	2018	8321	8.3	3	6	11	27	31	58	41	0	0	4	100	98	99	99
Whistler	2018	8708	4.2	1	3	5	16	18	27	22	0	0	0	100	98	100	100
Williams Lake	2018	8259	7	2	5	10	28	32	46	37	0	0	4	100	96	98	96

*Percentiles of daily 1-hour maximum (D1HM) based on "Guidance on Application of Provincial Air Quality Objectives for NO_2" at:
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/no2_aqo-implementation_guide.pdf

2018 Ozone Levels

Site	Year	No. Valid Hrs	Annual Avg.	Percentiles (1h)						Daily 8h Max		No. Days >63 ppb	% of Valid Days Per Quarter			
				25th	50th	75th	98th	99th	1h Max	Annual Max	Annual 4th Highest		Q1	Q2	Q3	Q4
Abbotsford-Airport	2018	8613	21.0	10	21	31	47	53	92	78.3	63.4	4	100	99	97	99
Abbotsford-Mill Lake	2018	8707	20.3	10	20	30	48	56	95	79.4	68.3	5	100	98	100	99
Agassiz	2018	8734	19.3	9	18	28	49	60	92	74.1	66.2	5	100	100	100	100
Burnaby-Kensington	2018	8726	18.3	9	18	26	43	46	77	65.9	51.8	1	100	100	100	100
Burnaby-Mtn	2018	8695	27.2	20	27	34	49	52	77	72.0	59.6	3	98	100	97	100
Burnaby South	2018	8721	17.1	9	17	25	37	40	68	58.5	47.8	0	99	99	100	100
Castlegar	2018	8130	18.3	9	16	26	45	48	63	57.6	48.8	0	99	87	95	100
Chilliwack	2018	8664	18.3	7	17	28	47	55	86	76.0	65.8	4	99	97	100	99
Colwood	2018	8137	23.8	14	24	34	46	49	73	63.1	51.2	1	96	99	89	96
Coquitlam	2018	8674	18.0	7	17	27	47	51	83	74.0	62	3	100	100	95	100
Courtenay	2018	7959	18.7	8	18	29	43	46	62	52.8	48.4	0	83	98	96	99
Cranbrook	2018	3029	.	.	.	.	.	.	61	59.1	.	0	0	0	42	98
Duncan-Cairnsmore	2018	317	.	.	.	.	.	.	32	26.7	.	0	16	0	0	0
Duncan-College St	2018	7871	19.3	8	18	30	47	51	86	77.0	57.3	3	77	99	100	96
Farmington Community Hall	2018	5545	.	.	.	.	.	.	64	60.4	.	0	97	96	40	27
Fort St. John	2018	8107	24.1	15	24	33	46	49	61	54.2	50.2	0	99	96	86	98
Hope	2018	8667	19.8	8	18	29	55	64	28	78.0	71.3	12	97	100	100	95
Kamloops-Fed. Bldg.	2018	8342	19.8	8	19	30	47	50	68	61.2	53.3	0	97	99	99	100
Kelowna	2018	8329	23.3	13	23	33	51	53	70	65.0	56.4	1	99	97	100	97
Langley	2018	8631	21.6	12	22	31	47	54	89	79.4	68.3	5	100	99	96	98
Maple Ridge	2018	8709	20.5	10	20	29	48	55	104	86.7	69.9	5	100	97	100	100
Mission	2018	8688	22.2	14	22	30	51	61	97	81.5	76.7	8	98	98	100	100
Nanaimo	2018	8198	21.7	15	22	28	41	44	61	53.9	45.7	0	100	93	96	97
New Westminster	2018	8663	13.4	2	11	22	41	45	77	63.1	50.7	1	100	95	99	98
North Delta	2018	8705	17.7	8	17	26	42	45	76	63.5	46.4	1	100	99	100	98
N. Vancouver-Mahon Park	2018	8716	18.6	9	18	27	44	48	83	70.6	41.2	1	100	97	100	100
North Vancouver Second Na	2018	8644	14.6	6	13	22	37	39	67	43.9	50.7	0	92	97	99	98
Pitt Meadows	2018	8659	18.3	6	18	28	45	49	86	71.3	59.2	3	97	99	99	97
Port Moody	2018	8685	14.8	3	12	24	43	47	85	65.5	50.9	1	97	99	100	100
Prince George-Plaza 400	2018	8078	20.6	8	21	31	48	51	62	58.6	53.1	0	86	97	93	98

2018 Ozone Levels

Site	Year	No. Valid Hrs	Annual Avg.	Percentiles (1h)						Daily 8h Max		No. Days >63 ppb	% of Valid Days Per Quarter			
				25th	50th	75th	98th	99th	1h Max	Annual Max	Annual 4th Highest		Q1	Q2	Q3	Q4
Quesnel	2018	8363	16.3	5	13	26	45	47	59	51.7	51.3	0	100	97	100	97
Richmond-Airport	2018	8701	17.2	6	17	27	41	44	78	59.9	45.4	0	100	99	99	99
Richmond South	2018	8712	17.6	5	17	28	44	46	79	67.7	49.3	1	100	99	100	99
Smithers	2018	6606	18.2	5	17	29	46	48	60	55.4	49.5	0	41	98	99	72
Squamish	2018	8654	17.8	7	17	26	45	47	78	65.8	51.9	2	100	99	99	96
Surrey	2018	8673	20.9	12	21	30	46	51	90	80.5	60.3	3	98	97	100	99
Taylor-Golf Course	2018	1462	.	.	.	.	.	.	36	35.1	.	0	70	0	0	0
Taylor-Townsite	2018	8364	21.8	11	21	32	48	50	60	56.6	52.9	0	98	97	97	98
Terrace	2018	8356	20.9	12	20	29	45	47	57	53.4	49.7	0	99	100	99	98
Tsawwassen	2018	8656	22.3	14	22	31	43	45	76	70.5	49.1	1	99	100	100	95
Vancouver-Clark Dr	2018	8410	12.1	2	9	20	38	42	72	58.3	47.1	0	86	95	99	100
Vancouver-Dwtn	2018	8660	10.5	2	8	16	32	35	55	50.3	38.4	0	93	98	100	99
Vernon	2018	8282	18.1	6	16	29	47	49	70	58.0	52.9	0	100	97	96	99
Victoria-Topaz	2018	8318	21.5	13	22	31	43	46	68	51.1	48.8	0	96	99	98	96
Whistler	2018	8734	21.6	11	20	31	49	51	67	64.8	52.6	1	100	100	100	99
Williams Lake	2018	8278	21.0	10	21	31	48	51	60	56.3	53.9	0	100	99	96	95

2018 Fine Particulate Matter Levels

Site	Year	No. Valid Hrs	Annual Avg	Percentiles (1h)					Max 1h	No. Valid Days	24h Average			% of Valid Days Per Quarter			
				25th	50th	75th	98th	99th			Annual Avg	Annual Max	Annual 98th Percentile*	Q1	Q2	Q3	Q4
Abbotsford-Airport	2018	8704	7.3	2	4	8	35	56	193	364	7.3	127	29	100	100	99	100
Abbotsford-Mill Lake	2018	8643	6.9	2	4	8	33	51	197	360	6.9	119	31	100	100	100	95
Agassiz	2018	8621	7.7	3	5	8	36	75	154	358	7.4	117	27	96	99	98	100
Burnaby-Kensington	2018	8523	6.3	2	4	6	32	56	175	355	6.3	99	34	91	98	100	100
Burnaby South	2018	8691	6.4	2	4	7	30	51	179	362	6.5	112	25	100	98	99	100
Burns Lake	2018	7496	.	.	.	.	.	.	1696	311	.	883	72	57	86	100	98
Campbell River	2018	7239	.	.	.	.	.	.	218	304	.	147	.	40	99	96	98
Castlegar	2018	8398	17.0	4	7	13	148	225	464	350	17.0	420	143	83	100	100	100
Chilliwack	2018	8363	7.7	3	5	9	41	66	186	349	7.7	119	52	100	98	88	97
Colwood	2018	8417	7.7	3	5	9	32	57	294	347	7.7	113	32	90	100	91	99
Courtenay	2018	7700	.	.	.	.	.	.	172	322	.	117	30	52	100	100	100
Cranbrook	2018	2670	.	.	.	.	.	.	175	107	.	93	.	0	0	39	77
Crofton-Substation	2018	8639	6.9	2	5	8	28	57	180	365	6.9	131	23	100	100	100	100
Duncan-Cairnsmore	2018	344	.	.	.	.	.	.	52	14	.	20	.	16	0	0	0
Duncan-College St	2018	7834	7.6	2	5	9	36	53	162	327	7.6	103	28	60	100	99	99
Duncan-Deykin	2018	8160	8.8	4	6	10	34	28	169	339	8.9	117	25	100	77	96	99
Fort St. John	2018	8708	8.9	3	5	9	51	94	784	363	8.9	178	50	98	100	100	100
Gibsons Municipal Hall	2018	6028	.	.	.	.	.	.	160	249	.	104	.	92	96	86	0
Golden	2018	8180	12.1	3	7	13	74	94	284	340	12.1	160	76	92	80	100	100
Grand Forks	2018	8501	15.5	4	8	17	90	124	503	354	15.5	410	92	100	99	100	89
Harmac	2018	8559	10.5	3	7	12	48	74	198	359	10.5	136	31	99	100	100	95
Hope	2018	8641	8.1	2	4	8	48	93	380	360	8.1	241	64	99	100	99	97
Horseshoe Bay	2018	8242	5.3	2	3	6	27	58	169	342	5.4	96	41	87	93	100	95
Houston	2018	2885	.	.	.	.	.	.	111	118	.	38	.	4	0	24	100
Kamloops-Aberdeen	2018	446	.	.	.	.	.	.	30	18	.	14	.	20	0	0	0
Kamloops-Fed. Bldg.	2018	8645	12.4	4	7	12	75	144	486	359	12.5	327	68	98	96	100	100
Kelowna	2018	8345	11.6	3	6	10	82	132	459	348	11.6	308	82	82	100	100	99
Kitimat-Haisla	2018	4683	.	.	.	.	.	.	165	196	.	67	.	0	13	100	100
Kitimat-Riverlodge	2018	8560	5.3	3	5	6	16	21	122	360	5.3	58	14	100	99	97	99
Kitimat-Whitesail	2018	4640	.	.	.	.	.	.	121	192	.	61	.	0	13	99	97
Langdale	2018	8482	9.0	4	7	11	38	60	154	353	9.1	92	39	99	100	95	93
Langley	2018	8667	7.0	2	4	8	35	55	207	360	7.0	114	30	100	98	99	98

2018 Fine Particulate Matter Levels

Site	Year	No. Valid Hrs	Annual Avg	Percentiles (1h)					Max 1h	No. Valid Days	24h Average			% of Valid Days Per Quarter			
				25th	50th	75th	98th	99th			Annual Avg	Annual Max	Annual 98th Percentile*	Q1	Q2	Q3	Q4
Lavington	2018	8681	13.7	4	7	13	96	153	424	363	13.7	292	96	100	100	100	98
Mission	2018	8548	7.6	2	4	9	40	59	183	355	7.7	111	38	98	99	95	98
Nanaimo	2018	8527	5.4	1	3	6	22	62	244	358	5.4	160	17	92	100	100	100
New Westminster	2018	8601	7.8	3	5	9	34	53	246	358	7.9	128	32	100	92	100	100
North Delta	2018	8638	6.9	3	5	8	31	50	185	359	6.9	125	27	100	97	99	98
N. Vancouver-Mahon Park	2018	8695	6.5	2	4	7	32	55	169	362	6.5	95	36	100	99	100	98
N. Vancouver-2nd Narrows	2018	8530	7.5	3	5	8	33	56	155	354	7.5	102	29	98	92	99	99
Pitt Meadows	2018	8542	6.8	2	5	8	32	50	190	352	6.9	106	31	91	100	98	97
Port Alberni-Elem. School	2018	8642	10.3	4	7	12	46	58	146	360	10.4	84	28	99	96	100	100
Port Moody	2018	8662	6.4	2	4	7	32	56	175	361	6.4	96	32	100	99	97	100
Powell River-James Thomson	2018	8099	4.1	0	2	4	25	61	142	342	4.1	102	26	86	98	99	92
Powell River-Wildwood	2018	729	.	.	.	.	.	.	9	30	.	2	.	33	0	0	0
Prince George-Plaza 400	2018	8357	16.5	4	7	15	125	168	787	348	16.3	366	120	82	100	99	100
Quesnel	2018	8730	16.6	4	9	17	126	184	388	364	16.6	296	119	100	100	99	100
Richmond-Airport	2018	8650	7.0	3	4	8	30	58	210	361	6.9	122	27	100	99	97	100
Richmond South	2018	7829	7.3	3	5	8	31	59	188	326	7.3	123	31	100	78	80	99
Smithers	2018	8093	9.0	2	5	11	40	49	423	337	9.0	127	30	98	100	99	73
Squamish	2018	8417	7.0	3	5	8	40	66	163	352	7.0	94	45	100	91	100	95
Surrey	2018	8614	6.8	2	4	8	30	46	199	357	6.8	126	30	99	97	98	98
Taylor	2018	1523	.	.	.	.	.	.	64	63	.	20	.	70	0	0	0
Terrace	2018	8739	6.1	2	4	7	31	40	133	365	6.1	44	17	100	100	100	100
Tsawwassen	2018	8631	5.3	2	3	6	22	53	183	360	5.3	125	22	100	98	100	97
Valemount	2018	7367	.	.	.	.	.	.	340	306	.	181	112	96	41	100	99
Vancouver-Clark Dr	2018	8410	8.7	4	6	10	37	54	185	348	8.7	117	39	90	93	100	98
Vanderhoof	2018	8113	20.3	3	8	19	154	249	909	335	20.3	631	145	100	88	93	86
Vernon	2018	8713	13.8	4	8	14	82	136	363	363	13.8	285	80	98	100	100	100
Victoria-Topaz	2018	8735	9.0	5	7	10	34	53	298	365	9.0	110	25	100	100	100	100
Whistler	2018	8290	7.9	1	4	8	44	81	310	349	7.9	233	64	100	95	88	100
Williams Lake	2018	7810	15.7	3	7	13	139	193	681	324	15.4	528	117	100	60	98	97

*Percentile of 24h average concentrations based on approach outlined in "Guidance Document on Achievement Determination. Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone" at: https://www.ccme.ca/files/Resources/air/aqms/pn_1483_gdad_eng.pdf

2018 Sulfur Dioxide Levels

Site	Year	No. Valid Hrs	No. Valid Days	Annual Avg	Percentiles (1h)					Max	Percentiles (D1HM)*				No. Valid Yrs	3y Avg of 97.5th Percentile	No. of Days			% of Valid Days Per Quarter			
					25th	50th	75th	98th	99th		97th	97.5th	98th	99th			>75 ppb	>70 ppb	>65 ppb	Q1	Q2	Q3	Q4
Abbotsford-Airport	2018	8375	361	0.2	0	0	0	1	1	6	3	3	3	4	3	3	0	0	0	100	98	99	99
Abbotsford-Mill Lake	2018	8413	363	0.2	0	0	0	1	2	7	3	3	3	5	3	3	0	0	0	100	100	100	98
Bessborough	2018	8321	363	0.4	0	0	0	2	2	26	6	6	6	8	3	5	0	0	0	99	100	99	100
Burnaby-Capitol Park	2018	8744	365	0.6	0	0	0	5	10	71	29	29	34	60	3	32	0	1	2	100	100	100	100
Burnaby-Kensington	2018	8683	362	0.3	0	0	0	2	2	9	3	4	5	6	3	4	0	0	0	100	100	97	100
Burnaby North	2018	8725	364	0.6	0	0	1	4	5	20	8	9	11	13	3	12	0	0	0	100	100	100	99
Burnaby South	2018	8364	364	0.3	0	0	0	2	2	9	3	3	4	4	3	4	0	0	0	100	100	99	100
Castlegar	2018	8092	349	1.7	0	0	1	16	21	83	29	31	31	40	3	37	1	1	1	89	93	100	100
Chilliwack	2018	8325	363	0.1	0	0	0	1	1	6	2	2	3	3	3	2	0	0	0	100	98	100	100
Farmington	2018	7843	338	0.3	0	0	0	2	2	12	4	4	5	8	3	3	0	0	0	100	96	100	75
Fort St. John	2018	7953	343	0.3	0	0	0	1	2	6	4	4	4	5	3	4	0	0	0	91	97	88	100
Kamloops-Fed. Bldg.	2018	8336	361	0.2	0	0	0	1	2	7	3	3	3	5	3	5	0	0	0	98	99	99	100
Kelowna	2018	8367	364	0.4	0	0	0	1	1	2	2	2	2	2	3	2	0	0	0	100	100	100	99
Kitimat-Haisla	2018	8338	363	0.2	0	0	0	2	3	31	9	10	10	18	3	8	0	0	0	100	99	100	99
Kitimat-Riverlodge	2018	8345	364	0.5	0	0	0	5	8	35	20	21	25	29	3	17	0	0	0	99	100	100	100
Kitimat-Whitesail	2018	8351	364	0.3	0	0	0	3	28	24	14	16	16	20	3	13	0	0	0	100	100	100	99
Langdale	2018	8229	353	0.6	0	0	1	3	5	17	9	12	13	14	3	9	0	0	0	94	100	99	93
Langley	2018	8314	361	0.1	0	0	0	1	1	6	2	2	3	3	3	2	0	0	0	99	99	100	98
N. Vancouver-Mahon Park	2018	8721	364	0.3	0	0	0	2	2	25	3	3	3	5	3	3	0	0	0	100	99	100	100
N. Vancouver-2nd Narrows	2018	8538	356	0.3	0	0	0	2	2	8	3	3	3	6	3	5	0	0	0	97	96	100	98
Pitt Meadows	2018	8313	361	0.3	0	0	0	2	2	5	3	3	4	4	3	3	0	0	0	98	100	100	98
Port Moody	2018	8313	360	0.4	0	0	0	3	4	12	6	6	6	8	3	5	0	0	0	99	99	97	100
Prince George-Plaza 400	2018	7842	334	1.4	0	0	1	12	19	108	39	42	49	56	3	36	1	1	2	80	100	86	100
Quesnel	2018	8184	353	0.3	0	0	0	2	3	20	7	9	10	12	3	8	0	0	0	100	92	100	95
Richmond South	2018	8670	363	0.3	0	0	0	1	2	6	2	2	2	3	3	3	0	0	0	100	99	100	99
Squamish	2018	8271	359	0.2	0	0	0	1	1	10	2	3	3	4	3	4	0	0	0	100	97	99	98
Taylor-Lone Wolf Golf Course	2018	1462	63	.	.	.	.	.	.	28	.	.	.	.	2	13	0	0	0	70	0	0	0
Taylor-S. Hill	2018	8364	363	0.4	0	0	0	3	5	55	13	13	16	39	3	12	0	0	0	100	99	99	100
Taylor-Townsite	2018	8374	365	0.9	0	0	0	9	14	81	31	32	39	44	3	25	1	1	1	100	100	100	100
Terrace	2018	8372	364	0.4	0	0	0	2	3	8	5	5	5	6	3	5	0	0	0	100	100	100	99
Trail-Birchbank	2018	7848	331	5.7	0	1	5	45	56	140	83	100	102	112	3	118	16	20	23	96	74	95	99
Trail-Butler Park	2018	7811	330	6.2	0	2	6	49	66	227	144	146	178	182	3	200	40	48	53	96	71	95	100
Trail-Columbia Gardens Airport	2018	8296	361	3.7	0	1	4	24	30	104	53	53	57	68	3	68	2	2	4	96	100	100	100
Tsawwassen	2018	8058	347	0.3	0	0	0	1	2	8	3	4	4	6	3	3	0	0	0	99	100	96	86
Vancouver-Clark Dr	2018	8210	352	0.6	0	0	1	2	3	76	4	4	4	5	1	4	1	1	1	90	96	100	100
Richmond-Airport	2018	8330	362	0.5	0	0	1	2	3	6	3	3	4	4	3	3	0	0	0	100	99	99	99
Vancouver-Pandora	2018	7990	339	0.8	0	1	1	3	5	23	7	7	8	11	1	11	0	0	0	100	99	73	100
Vancouver-Dwtn	2018	8710	364	0.4	0	0	1	2	2	9	4	4	4	5	3	4	0	0	0	100	99	100	100
Victoria-James Bay	2018	7395	308	0.2	0	0	0	1	1	5	2	2	3	4	3	2	0	0	0	69	100	100	68
Victoria-Topaz	2018	8325	363	0.3	0	0	0	2	2	7	4	4	4	5	3	4	0	0	0	100	98	100	100

2018 Sulfur Dioxide Levels

Site	Year	No. Valid Hrs	No. Valid Days	Annual Avg	Percentiles (1h)					Max	Percentiles (D1HM)*				No. Valid Yrs	3y Avg of 97.5th Percentile	No. of Days			% of Valid Days Per Quarter			
					25th	50th	75th	98th	99th		97th	97.5th	98th	99th			>75 ppb	>70 ppb	>65 ppb	Q1	Q2	Q3	Q4
Williams Lake	2018	7819	336	0.2	0	0	0	1	1	2	1	1	1	2	3	2	0	0	0	80	98	98	92

*Percentiles of daily 1-hour maximum (D1HM) based on "Guidance on Application of Provincial Air Quality Objectives for SO_2" at:
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/so2_aqo-implementation_guide.pdf