2023 state of the air

BC LUNG FOUNDATION

Our climate is changing, creating unprecedented challenges for British Columbians.

We are still reeling years later from the heat dome of 2021 and repeated deadly wildfire seasons. However, our message this year is one of hope. We have the knowledge, expertise, and capacity to protect and improve lung health while also addressing climate change. This year's State of the Air Report documents how BC's lung health researchers and policy makers are combining a growing awareness of how lung health and climate change intersect.

In this report we document several efforts by BC agencies and foundations to cooperate on tools and resources to address wildfire smoke and extreme heat. We reproduce Legacy for Airway Health's Action Plan on Wildfire Smoke and highlight efforts to establish emergency clean and cool air centres in Metro Vancouver.

Every year, the State of the Air Report provides highlights from the Annual Air Quality and Health workshop. This year's theme was "The Long and Winding Road: The Evolution of Mobility-Challenges, and Opportunities." Workshop experts discussed shifts to electric vehicles, improving public transport, and 'active transportation' options such as walking, bicycles, and electric bikes and scooters. Speakers addressed how governments are starting to drive this process (such as through electric vehicle mandates) and the longer-term experience of first movers, such as Norway. Researchers also discussed important but often overlooked issues, such as battery recycling, air quality within public buses and trains, and microplastics from tires.

We highlight two issues BC-based researchers presented at the Workshop. We discuss the Mortality due to Air Pollution at Low levels of Exposure (MAPLE) study. It followed a sample of more than 7 million Canadians over more than 25 years, asking if there was a threshold below which air pollution levels were no longer harmful. While levels of particulate matter and ozone are decreasing over the years, even low levels of these pollutants contribute to lung and heart diseases. With no 'safe level' there is a continued and pressing need to reduce and eliminate these pollutants. We also present the Prince George Road Dust Study, which investigated the chemical composition of road dust in the Spring. Road dust was found to contain chemicals such as aluminum, chromium, iron, lead, tin, vanadium, and zinc. Researchers suggested road dust levels might change with weather patterns. The research suggests switching to electric vehicles may not fully address the problem.

We also discuss recent policy debates around nitrogen dioxide. Nitrogen dioxide is produced from burning fossil fuels—indoors from natural gas stoves when burners are on, and outdoors it's a marker of traffic related air pollution. NO_2 is a lung irritant (affecting people with asthma and COPD), and there are now clear links between childhood asthma and nitrogen dioxide exposures. Canada is tightening its NO_2 standard in 2025 to 12 ppb average annual exposure. Many BC communities now surpass that (see page 10), reinforcing the need to address traffic pollution. We also assess the effects of gas stove use, suggesting they contribute modestly to the development of asthma and respiratory symptoms in children. Solutions include using gas stoves without continuous pilot lights and with good ventilation, or, with climate change and reducing fossil fuel use in mind, switching to electric (induction) stoves.

Every year we show which BC municipalities are surpassing Air Quality Objectives and discuss overall trends. Overall progress is being made with sulphur dioxide and nitrogen dioxide levels decreasing. However, particulate matter levels continue to persist—in some regions from continued open burning and wood burning stoves. Wildfires remain a significant challenge to clean air - driving increases in particulate matter and ozone. We have also provided space for updates from important air quality government partners.

We think there is tremendous room for hope. As the stories in this State of the Air Report document, we are rich in a shared commitment to clean air and better health. We are moving forward through keeping our eyes on the data and supporting research that unsettles complacency, clears up confusions, and asks hard questions that lead to further inquiry.

I salute all those who've put together this "report card" on air quality and health and thank them for the work they do. It helps us with our overarching mission of bringing better lung health to all British Columbians.

CHRISTOPHER LAM
President and CEO, BC Lung Foundation

B.C. Action Tool on Extreme Heat

Wildfire smoke and extreme heat events have become annual occurrences in British Columbia, and are expected to increase in frequency and intensity with time. The health impacts of these events are staggering. Annually, hundreds to thousands of premature deaths in Canada are attributable to wildfire smoke exposures.[1] In British Columbia alone, over 600 deaths were attributed to the 2021 heat dome.[2] Healthcare use such as urgent care, emergency department visits, and hospitalizations, is likewise impacted by these events.

Not everyone is affected equally. People at the extremes of age (infants, children, and the elderly), those with underlying medical conditions (including heart and lung disease), and pregnant individuals are at higher risk of adverse effects. Similarly, people who don't have the knowledge of or access to strategies to reduce exposure to smoke and heat are in danger of health effects.

The BC Centre for Disease Control, Health Canada, and the National Collaborating Centre for Environmental Health (among others), have worked to create info sheets and other public-facing messaging. The messaging provides tools and resources to understand and mitigate exposure to heat and smoke during extreme heat events. Additionally, the B.C. Ministry of Health and Health Authorities continue to expand access to resources and tools (like cool and clean air shelters and cooling kits) to prevent adverse health effects.

A recent survey in the province, conducted by investigators at the Legacy for Airway Health, identified a need for more diverse methods for messaging around wildfire smoke events.[3] Health care providers expressed the importance of discussion with patients, but requested more support in education on how to effectively counsel patients on risk and mitigation.[4] In response to these needs, patient partners, healthcare providers, and researchers in BC have worked with the Legacy for Airway Health to create a Wildfire Smoke and Extreme Heat Action Plan (see pages 3 and 4). Modelled on the Asthma and Chronic Obstructive Disease Action Plans (guideline-based tools completed between a provider and a patient with recommendations and resources to prepare for and respond to changes in health), the single-sheet document is intended to be completed during an encounter with a healthcare professional. The document contains a checklist to ensure patients have access to local health and air quality alerts, supplies to maximize preparedness for events, and resources/development of an individual plan indicating actions to be taken during an event. Clinicians receive a provider handbook which walks through common questions that may arise during the encounter and contains links and references to additional patient-friendly resources. The Action Plan, once completed, can then be posted in a central location in the home for easy reference in advance of, or during an event.

Wildfire smoke and extreme heat events have become annual occurrences in British Columbia, expected to increase in frequency and intensity with time.

The Action Plan was piloted in advance of the 2023 wildfire season. The pilot took place at multiple locations in the Vancouver Coastal Health and Interior Health Authority region, in collaboration with respiratory educators. Multiple pathways for implementation among patients with lung disease, as well as other conditions, are being considered and explored to empower patients and improve the readiness of the population of BC for these annual events.

CONTENTS

1. Matz et al, Science of the Total Environment, 2020
2. https://science.gc.ca/site/science/en/blogs/science-health/surviving-heat-impacts-2021-western-heat-dome-canada
3. Shellington et al, 2022
4. Labossiere et al, 2022.

Wildfire Smoke Action Plan

Wildfire smoke and extreme heat can affect your health, but there are steps you can take to protect yourself. This action plan will help you prepare and respond.

Name: ______________________________ Date:____________
Care Professional's Name ______________________________
Emergency Contact Name: ______________________________
Care Professional's #: ___________________________________
Emergency Contact #: __________________________________

I Know My Air Quality and Temperature

My region: _______________________, BC

☐ I can check air quality

1. phone/email (https://aqss.nrs.gov.bc.ca/subscription.html, or the WeatherCAN app)
2. online (https://www.env.gov.bc.ca/epd/bcairquality/data/aqhi-table.html or www.airmap.ca for Metro Vancouver and Fraser Valley residents)
3. if I can see smoke, I know the risk is high to very high

☐ I will receive extreme heat alerts

1. on my phone (emergency alerts active)
2. online (https://weather.gc.ca/?alertTableFilterProv=BC)
3. by listening to this radio channel: _______AM/FM

☐ If I cannot access this information on my own, I will call: ___________________ at (____) ____-______

My Home and Supplies are Ready Now

I have....

- ☐ extra medications and a pharmacy delivery contact: _______________
- ☐ extra food/water and a grocery delivery contact: _______________
- ☐ window coverings or thermal curtains.
- ☐ a home digital thermometer and extra batteries.
- ☐ purchased/made a portable air cleaner (with HEPA filter) and designated a clean air room.
- ☐ a heat pump, or an air conditioning unit and/or fan to reduce heat exposure.

☐ If I have forced air heating, I have talked to my service provider about filters/settings to use when smoky.

☐ If employed, I have talked to my employer about indoor or work-from-home options during an event.

I Know My Resources

☐ In case I must go outside, I have a to-go bag ready and I have safe transport options.

1. Phone a friend for a ride: contact: ___________________________________
2. Drive myself, with vents and windows closed and air conditioner on "recirculate" mode.
3. I have a supply of well-fitted masks, and my transit route is: ___________________________________

☐ For cleaner air I can go to (daytime:____________________) / (nighttime: ________________________)

☐ For cooler air I can go to (daytime:____________________) / (nighttime: ________________________)

☐ I have a buddy and will check in daily during an event
Buddy Name: ________________________
Number: (_____)____-______
Check-in Time: ___:___AM/PM

*Don't forget to tell your buddy if you need to relocate!

Non-Emergency Questions: Call 8-1-1 or your Family Doctor
Medical Emergency: Call 9-1-1

Continued on Page 4

Continued from page 3 (Wildfire Smoke Action Plan Tool)

Extreme Heat

	1-Hour $PM_{2.5}$ (μg/m^3)	BC AQHI	AQHI Risk Category	Health Message for ***ME***
	0-10	1	**LOW** (blue)	Normal air quality-continue normal activities.
	11-20	2		
	21-30	3		
	31-40	4	**MODERATE** (yellow/orange)	
	41-50	5		
	51-60	6		
	61-70	7	**HIGH** (pink/red)	
	71-80	8		
	81-90	9		
	91-100	10		
	101+	10+	**VERY HIGH** (maroon)	

Over-heating is more dangerous for most people at risk. During an event, call your buddy daily!

(AQHI = Air Quality Health Index; PM2.5 = fine particulate matter)
*If you have a respiratory infection you may have a higher risk from wildfire smoke: take extra precautions.

Body

36.5-37°C (97.7-98.6°F)	Normal, monitor for symptoms
37.1-37.9°C (98.7-100.3°F)	Above normal
38-39°C (100.4-102.2°F)	Possible heat-related illness
Over 39 °C (>102.2°F)	Seek immediate medical help

Home/Indoor

Less than 26°C (<78.8°F)	Usually safe, monitor
26-28.5°C (78.8-83.3°F)	Risk increasing
28.6-31°C (83.4-87.8°F)	Risk increasing further
Over 31 °C (>87.8°F)	High risk

Cooling Your Body

1. Cool your home or relocate to a cooler place
2. Make ice and prepare jugs of cool water
3. Take off extra layers of clothing to expose skin
4. Cool damp towels in the fridge to use
5. Take cool showers
6. Sit with feet in cool water
7. Use a spray bottle to mist cool water on your skin
8. Limit physical activity

Cooling Your Home

1. Turn on your digital thermometer, check batteries
2. Turn on air conditioner*
3.Turn on fans if room temperature <35 degrees
4. Use shades, curtains, blankets, and/or cardboard to block sunlight from windows
5. Close windows during heat of the day
6. Open windows at night or with cool breeze*
7. Turn off appliances that generate heat

if air quality is poor, consider (2) and (6) carefully

AirCnC: Cool 'n' Cleaner Air Centres

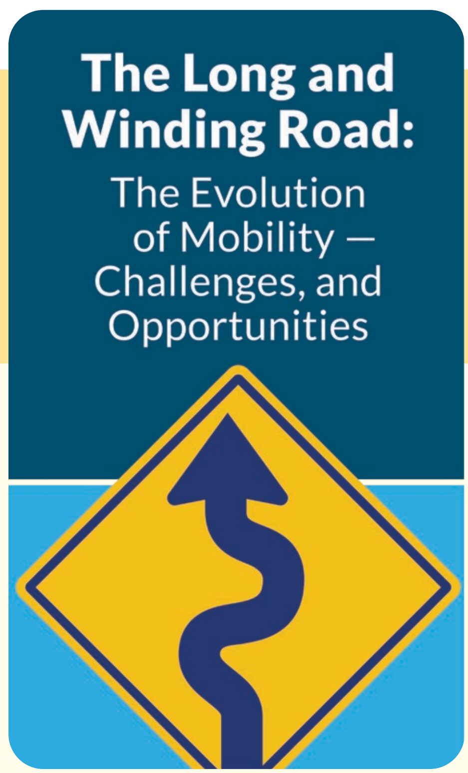
AirCnC (like Airbnb, but for Cool and Cleaner air centres!) is a project led by Metro Vancouver that aims to help municipalities identify and implement cool and cleaner air centres in their jurisdiction. These types of centres offer a space for residents to cool off and breathe easily during heat or air quality events, which are increasingly dangerous as summers get hotter and wildfire season is longer and more severe.

While the need for cool and cleaner air centres is clear, they can be difficult to establish. Metro Vancouver's member jurisdictions have different needs and resources available to them, and many need support and guidance to serve vulnerable residents during heat and air quality events. The AirCnC project will develop a guidance document for local governments to deploy a greater variety of cool, cleaner air centres to a wider range of residents, with a focus on vulnerable populations. To this end, the project intends to:

- Develop a consistent typology of "cool" and/or "cleaner" air centres
- Characterize different services provided by different types of centres
- Identify public and private facilities that could serve as cool, cleaner air centres and overlay resident vulnerability metrics
- Develop a guidance document for local governments and others that provides recommendations on how to expand the availability of cool, cleaner air centres in their communities, particularly for vulnerable residents.

Metro Vancouver, in partnership with a few member jurisdictions and health authorities, began development of this project with multiple cool and cleaner air initiatives in mind. For example, Metro Vancouver is also researching in-suite cooling opportunities, while Vancouver Coastal Health (a partner on the project) is evaluating the effectiveness of cleaner air spaces and creating guidance documents for groups on heat preparedness, wildfire smoke, and cooling spaces. The AirCnC project is expected to kick off in late 2023. Interested community groups and local governments are invited to reach out to AQInfo@metrovancouver.org to learn more about the project.

Air Quality and Health Workshop 2023



The transportation sector is a major source of air pollutants and greenhouse gas (GHG) emissions, affecting our health and the health of the planet.

Over the past several decades, a variety of air quality management policies and initiatives have helped reduce traffic related air pollution (TRAP), contributing to overall improvements in air quality in Canada. Despite these gains, TRAP remains associated with a significant health burden. Furthermore, recent studies have shown that even low levels of air pollution are associated with negative health effects.

While improvements in air quality have been realized in recent years, GHG emissions have remained relatively stable in Canada and have been steadily increasing world-wide. Moving forward, an evolution in transportation and mobility is required to mitigate climate change and reduce the health burden associated with TRAP.

Continued on page 6

Continued from page 5 (Air Quality Health Workshop 2023)

The 20th annual BC Lung Workshop was held on March 30th, 2023 at the Sheraton Vancouver Wall Centre. The theme of the workshop was “The Long and Winding Road: The Evolution of Mobility – Challenges and Opportunities”. Key themes included the health impacts of low levels of air pollution, non-exhaust emissions, air pollution in public transit, electrification of transportation, active transportation, and micromobility.

Dr. Marianne Hatzopoulou from the University of Toronto started the day with a keynote presentation on the challenge of achieving fair, healthy and community-centred transportation decarbonization. She began by noting where we are with respect to GHGs, and where we need to get to. She highlighted strategies that have worked for reducing air pollution from the transportation sector. She then spoke about the changes needed to achieve our GHG targets, including electrification, freight decarbonization, community design, and transportation mode shifts. She also highlighted the need to preserve and promote equity, diversity and inclusion.

Dr. Michael Brauer from UBC spoke about a large Canadian study on the health effects of low levels of ambient air pollution, with a focus on fine particulate matter. He described the study methodology and highlighted key findings. He noted that there was no evidence of a threshold for health effects, and associations between air pollution and non accidental mortality varied regionally, appearing to be attenuated by ozone.

Dr. Rima Habre from University of Southern California provided a presentation on non-exhaust emissions, exposures, and health risks. She noted that while exhaust emissions are decreasing, studies have shown non-exhaust emissions to be increasing. She described strategies for assessing exposure to non-exhaust emissions and associated health risks.

Dr. Eric Coker from the B.C. Centre for Disease Control then spoke about road dust in the interior of British Columbia, with a focus on a recent study evaluating the composition and within season trends for springtime road dust in Prince George. He presented the study approach and findings, noting that chemical composition of PM_{10} varied significantly between high road dust and low road dust days, with significant elevation of heavy metals during high road dust days.

Dr. Barbro Melgert from University of Groningen finished off the morning session with a presentation on microplastics. She described the sources of microplastics in air, noting that tires have been shown to contribute approximately one-third of microplastics in outdoor air. The full health impacts of inhaling microplastics are not known, and need more research.

Keith Van Ryswyk from Health Canada started off the afternoon with a talk on characterization and mitigation of air pollution in public transit systems. He described air pollution exposure across transit systems, including private vehicles, buses, subways, and active transportation. He then described strategies for improving air quality in public transportation.

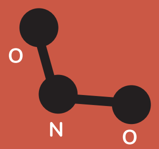
Dr. Alex Bigazzi from UBC spoke about active travel with human-electric hybrid vehicles. He described the costs, benefits, motivators, and deterrents of active transportation and how micromobility changes those relationships. He then described strategies for increasing the use of active transportation including building safe, comfortable, and useful networks; enabling e-assist without discouraging non-motorized transportation; developing multi-modal transportation systems; and ending the policing of active travelers.

Petter Haugneland from the Norwegian EV (electric vehicle) Association provided a presentation on the electrification of transportation in Norway. He described the programs and initiatives in Norway that are driving rapid uptake of electric vehicles, making Norway a world leader in the electrification of transportation. He also highlighted areas for improvement, including new battery technology, new car technology, battery recycling and re-use, and cleaner power.

Paula Viera from Transport Canada presented the Government of Canada’s actions to reduce transportation emissions. She described zero emission vehicle (ZEV) incentives and initiatives related to infrastructure and education; vehicle regulations; and strategies to promote a ZEV industrial transition. She also highlighted challenges and considerations for the future.

Dr. Kelly Clifton from UBC finished off the day with a presentation on the future of transportation. She described a vision for a sustainable, equitable, and healthful transportation system. This vision includes a focus on active transportation, micromobility, and transit, with an evolution of land use planning and the development of a transportation system with consideration for equity and the human experience.

The recordings and slides from the workshop are available online at: https://bclung.ca/health-professionals/air-quality-health-workshop.



Nitrogen Dioxide: Back in Front?

Nitrogen dioxide is a respiratory irritant known to worsen symptoms amongst individuals with asthma and COPD.

Nitrogen dioxide (NO_2), a common air pollutant, is a product of high temperature combustion. Motor vehicles, gas-fired power plants, boilers and appliances that use natural gas (stoves, space heaters, etc) are major sources of exposure. Nitrogen dioxide is a respiratory irritant known to worsen symptoms amongst individuals with asthma and COPD. Levels of NO_2 are managed in relation to guidelines and regulations by relevant agencies worldwide, including in BC and Canada. Prompted by concerns over emissions from gas stoves, the United States Consumer Product Safety Commission and municipal bylaws are considering increased regulations of nitrogen dioxide. This has resulted in nitrogen dioxide being the subject of recent media and public attention. This, along with recently updated guidance from the World Health Organization (WHO), and recent health effects studies of NO_2 from traffic exhaust, prompts our current focus on NO_2 levels in BC communities.

The Canadian Ambient Air Quality Standards (2025) for NO_2 are 42 parts per billion (ppb) (~79 $\mu g/m^3$) for 1 hour and 12 ppb (~22 $\mu g/m^3$) for annual average. The WHO recommendations for ambient air are 25 $\mu g/m^3$ for 24-hour average (no 1-hour recommendation) and 10 $\mu g/m^3$ for annual average. For indoor air, Canada's Residential Indoor Air Quality Guideline for NO_2 (2015, not since updated) are 170 $\mu g/m^3$ for short-term and 20 $\mu g/m^3$ for long-term.

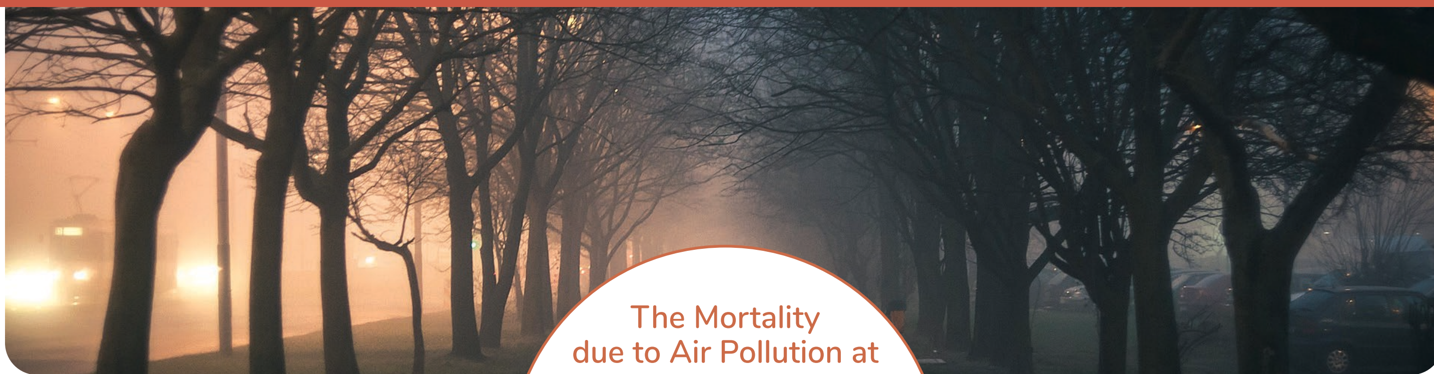
With that background, how does the recent attention given to NO_2 – along with a look back – inform us about the hazards of exposure indoors and outdoors?

Let's first consider the indoor setting. The most recent attention to NO_2 stems more from considerations of the impacts of natural gas appliances on climate change, rather than any new information on human health impacts. Specifically, new research has identified leakage of natural gas from the supply lines into the surrounding air, even when gas stoves are not in use. This leakage does not pose a direct health risk, but the emissions of methane (the main constituent of natural gas) are important contributors to climate warming. When in use, gas stoves emit NO_2 as well as particles that can be hazardous. However, research on gas stove impacts on respiratory health has been inconsistent. For example, the International Study of Asthma and Allergy in Children (ISAAC) a decade ago, reported no significant association between exclusive use of gas for cooking with any of the various presentations of asthma studied. In the same year, a meta-analysis of multiple studies showed approximately 40% increased odds for current asthma in children associated with homes using gas cooking but no increased risk for asthma attributable to NO_2 specifically. However, in the same analysis, NO_2 did increase the risk of wheezing, a common symptom of asthma. Some of this inconsistency may be the result of subpopulations that are at heightened risk due to genetics and/or co-exposures to allergens or other airborne contaminants. This suggests factors other than NO_2 may be responsible for long-term outcomes related to gas stove use, but short-term NO_2 exposures may well drive symptoms driven by acute inflammation. These inflammatory effects are consistent with experimental studies which show that the effect of NO_2 can be definitively observed only when accounting for allergen co-exposures.

The outdoor setting is likely different given that NO_2 is likely to only be a marker of the traffic pollution mixture. A meta-analysis of nearly 20 studies found an increased risk of incident asthma associated with early life NO_2 exposure, and others have connected ambient NO_2 to asthma exacerbations.

In summary, this renewed attention to NO_2-associated health effects supports a reinforcement of recommendations regarding gas stoves and traffic exhaust. Regarding gas stoves, they likely contribute modestly to the development of asthma and respiratory symptoms in children. Stoves commonly used today (those without continuous pilot lights) have lower emissions, which can be further reduced with improved ventilation. Ambient (outdoor) NO_2 has a more solid evidence base for its association with incident childhood asthma, and also somewhat less so for asthma exacerbations, but in this context NO_2 is best thought of as a marker for traffic exhaust. So, while these concerns are perhaps not new, they demand our attention because communities in BC do not currently meet the Canadian Ambient Air Quality Standards anticipated, as noted above, for 2025 (see data elsewhere in this document, noting that the dotted red line is less stringent than that for 2025).

How Low Can You Go?
Health Effects of Low Levels of Air Pollution



The Mortality due to Air Pollution at Low levels of Exposure (MAPLE) study was designed to measure the lowest levels at which air pollution in Canada may lead to measurable increases in death.

Air quality management has been successful. With the exception of worsening wildfire smoke, air pollution levels in Canada, and in British Columbia specifically, are generally low, with substantial improvements in air quality seen over the past fifty years. Over the same period, our knowledge of the health impacts of air pollution, and especially particulate matter ($PM_{2.5}$), has increased dramatically. The health impacts of air pollution are widespread, affecting multiple organ systems and impacting health across the lifespan. Particulate matter exposure leads to lower birthweight babies, worsens the severity of childhood respiratory infections, causes the development of chronic heart and lung disease, exacerbates Type II diabetes, triggers heart attack and strokes, and accelerates the progression of dementia. Given these widespread impacts, air pollution - even at very low levels – has the potential for large impacts on the health of Canadians. In this context, there is uncertainty about the impacts of air pollution at low levels and whether air quality standards are protective of health.

The Mortality due to Air Pollution at Low Levels of Exposure (MAPLE) study was designed to measure the lowest levels of air pollution in Canada which may lead to measurable increases in death. In partnership with Statistics Canada, researchers from the University of British Columbia and multiple other universities followed a representative sample of more than 7 million Canadians over more than 25 years. Records of the residential addresses of participants were linked to satellite-based measurements of air pollution which were used to develop detailed maps of how air pollution varies kilometer by kilometer throughout the entire country. These satellite observations were calibrated to special ground measurements of the chemical characteristics of pollution that the study team made over a year-long period at five locations from Nova Scotia to British Columbia. In this way, very accurate estimates were made of the air pollution exposures of this large population sample – one of the largest and most sophisticated studies of the health impacts of air pollution ever conducted.

Study findings showed consistent links between levels of particulate matter and ozone air pollution with the major causes of death in Canada, including COPD, pneumonia, stroke, ischemic heart disease, heart failure and, Type II diabetes. Unlike many other studies, air pollution was not associated with increased lung cancer deaths. Increases in deaths from air pollution were evident at the very lowest levels of exposure measured, a 10 year average concentration of 2.5 μg/m^3 of $PM_{2.5}$. These levels are below even the recently updated World Health Organization Air Quality Guideline (5 μg/m^3), as well as the Canadian Ambient Air Quality Standards (8.8 μg/m^3) and the British Columbia Air Quality Objective (8 μg/m^3) and Planning Goal (6.6 μg/m^3) levels. Further, there was no evidence of a threshold, or level of exposure at which deaths were not elevated, although the specific relationships were also dependent on the levels of ozone and varied regionally. Weaker relationships were seen in the Prairies, far north and west-Central regions compared to the east-Central, southern Atlantic and Western regions of the country, suggesting that the specific characteristics of the air pollution mixture likely matters in determining its potency. Taken together, these findings strongly argue for the benefits to health of continued reductions in air pollution levels, even when air pollution meets existing standards or guidelines. Despite past successes, continuing to reduce air pollution is now is even more important, given that the Canadian population is aging and growing more susceptible to the impacts of air pollution and that climate change – and worsening wildfire smoke - have begun to erode the many successes of air quality management made to date.

Road Dust Study

Springtime road dust is a common air quality concern among communities in B.C.'s northern interior. Airborne road dust comes from roadway traction material, brake wear, tire wear, and other particles that build up in snow during winter, which are then released back into the air as the snow melts during spring. Previous epidemiological research conducted by the B.C. Centre for Disease Control (BCCDC) found that high air concentrations of particulate matter (PM) from road dust lead to a significant increase in deaths in the spring season in B.C.'s northern interior region. Unfortunately, the reasons as to why road dust may be so impactful on human health are poorly understood. Questions about the complex chemical composition of road dust, which can include a mixture of chemicals of high public health concern such as lead, may explain the adverse health impacts of road dust. However, there is little research to indicate how the chemical mixtures of road dust vary during spring, and what combination of meteorological factors may be driving the toxicity of road dust.

The health impacts from road dust, and questions about its chemical composition, motivated researchers with the BCCDC and the University of Northern British Columbia (UNBC) to collaborate on a new air pollution study in Prince George, B.C. This new study involved collecting daily air samples of PM_{10} at a near-road-site in Prince George, B.C.

Airborne road dust comes from roadway traction material, brake wear, tire wear, and other particles that build up in snow during winter, which are then released back into the air as the snow melts during spring.

The goals of this project were to:

1. measure the daily chemical composition of road dust (including heavy metals) at a near-road site in Prince George,
2. explore the within-springtime temporal trends of coarse PM (PM size fraction between PM_{10} and $PM_{2.5}$)
3. identify days with high levels of springtime road dust using coarse PM data
4. learn about the complex relationships between meteorological factors (e.g., temperature and humidity) and the chemical composition of road dust on days with high levels of road dust versus days with low levels.

The results from this study indicated that 21 days during the spring of 2021 had high levels of road dust. Concentrations of total trace elements and specific trace elements were significantly higher on high road dust days (aluminum, chromium, iron, lead, tin, vanadium, and zinc) compared with low road dust days. High road dust days also had low relative humidity and precipitation, and higher temperature and air pressure.

Collection and chemical analysis of near-road PM_{10} samples indicated that days affected by springtime road dust are substantively different from other days with respect to chemical composition and meteorological factors. The high amounts of trace elements in PM_{10} on high road dust days has important implications for the acute toxicity of inhaled air particulates and subsequent health effects. The complex relationships between road dust and meteorological factors identified in this study may facilitate further research into the health effects of chemical mixtures related to road dust. This research also highlights potential changes in this unique form of air pollution as the climate changes.

pollution levels in 2022:

how does B.C. measure up?

Air quality in 2022 was characterized by high levels of fine particulate matter pollution, especially during the wildfire season. Due to the cool, wet spring, the wildfire season started late in the summer and extended into the fall (Table 1) following high temperature records in many areas of B.C. from late August until mid-October. Smoke from these wildfires was distributed throughout the Northeast, Southern Interior, Central Interior, and the Lower Fraser Valley. In contrast to the 2021 season, the 2022 wildfire season had a much broader impact, rather than being concentrated in the Central and Southern Interior.

Despite the widespread impact of smoke, the area burned during the 2022 wildfire season was actually below average. In 2022, 133,429 hectares of land burned, in contrast to 869,279 hectares burned in 2021, and more than one million hectares burned during the record-breaking wildfire seasons of 2017 and 2018.

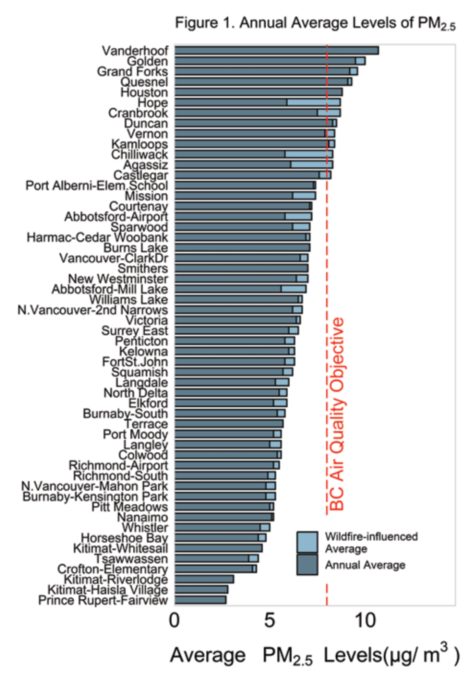
Wildfire smoke caused $PM_{2.5}$ levels to increase above the provincial air quality objectives in at least 20 communities in the province. Communities such as Cranbrook and Golden in the Southern Interior, and Hope and Agassiz in the Lower Fraser Valley, for example, experienced more than 10 days of high $PM_{2.5}$ levels in the fall because of the wildfire smoke.

In addition to wildfire smoke, some communities were also exposed to episodes of high $PM_{2.5}$ levels from local wintertime smoke produced from wood heating and open burning sources. These communities are all located in valleys where topography and meteorology favour trapping pollutants. The communities of Golden, Grand Forks, Houston, Quesnel, Vanderhoof, and Valemount all experienced at least five days of elevated wintertime $PM_{2.5}$ levels.

In the following sections, air quality data collected in 2022 are summarized and compared against provincial or national objectives. Data from all available monitoring sites, except temporary mobile sites and industrial fence line sites, are summarized in the Technical Appendix.

Community	Number of Days with High $PM_{2.5}$ Levels				
	Summer	Fall	Winter	Spring	Total
Golden	0	10	9	0	19
Cranbrook	0	16	1	0	17
Hope	0	14	0	0	14
Vanderhoof	0	8	6	0	14
Fort St John	1	12	0	0	13
Grand Forks	0	8	5	0	13
Chilliwack	0	12	0	0	12
Houston	0	4	7	0	11
Agassiz	0	10	0	0	10
Elkford	0	9	0	1	10
Sparwood	1	9	0	0	10
Quesnel	0	3	6	0	9
Abbotsford	0	8	0	0	8
Mission	0	8	0	0	8
Port Alberni	0	6	2	0	8
Castlegar	0	7	0	0	7
Langdale	0	7	0	0	7
North Vancouver	0	7	0	0	7
Vernon	0	7	0	0	7
Williams Lake	0	6	0	1	7

Table 1. Number of days with high $PM_{2.5}$ levels in communities that experienced at least 7 days above the Provincial Air Quality Objective of 25ug/m³ (2022 Data).



$PM_{2.5}$ Fine Particulate Matter

Fine particulate matter ($PM_{2.5}$) refers to microscopic particles that are 2.5 micrometres (millionths of a metre) or smaller in diameter. These particles can travel deep into the lungs, causing short-term health effects such as airway irritation and inflammation, and can aggravate heart diseases. There is also strong evidence that prolonged exposure to $PM_{2.5}$ increases the risk of chronic diseases, such as bronchitis and heart disease.

More than 50 monitoring stations reported $PM_{2.5}$ levels during 2022. The annual average concentration ranged from 2.7 micrograms per cubic metre (µg/m³) at Prince Rupert-Fairview to 10.7 µg/m³ at Vanderhoof. Thirteen of these stations exceeded the provincial $PM_{2.5}$ air quality objective of 8 µg/m³ (based on annual average). When adjusted for wildfire influence, seven stations (Vanderhoof, Golden, Grand Forks, Quesnel, Houston, Duncan, and Kamloops) still exceeded the objectives.

Figure 2. Annual Average Levels of O_3

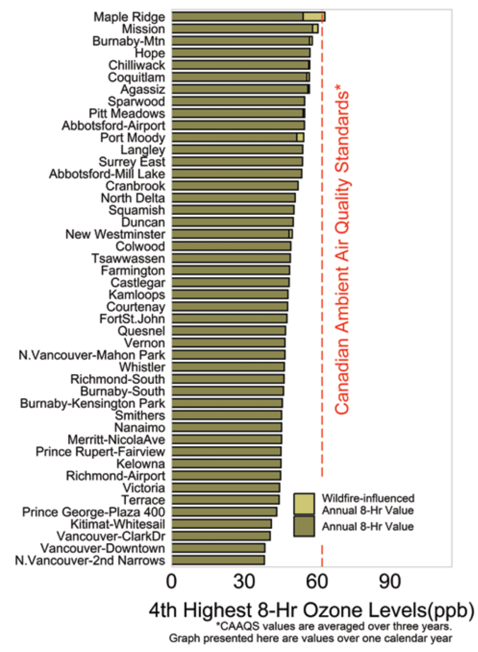


Figure 3. Annual Average Levels of NO_2

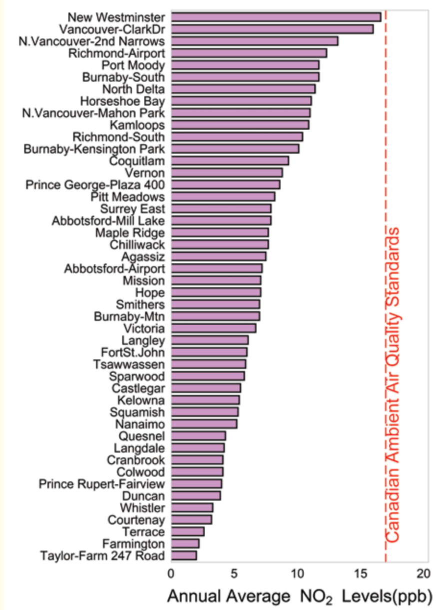
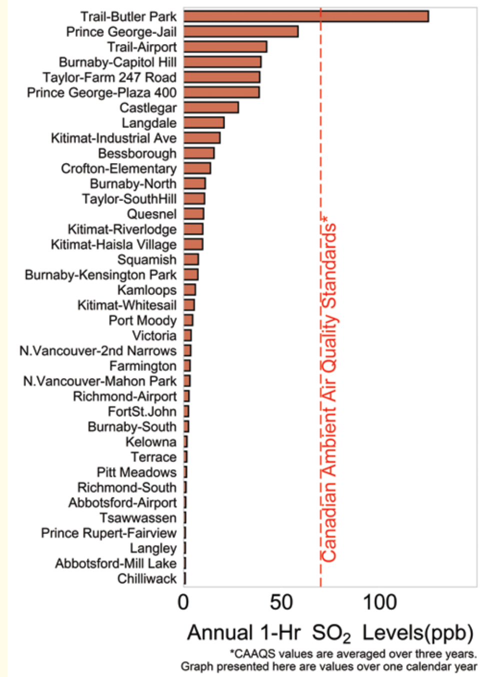


Figure 4. Annual Average Daily Maximum Levels of SO_2



O_3 Ground-level Ozone

Ground-level ozone (O_3) is a reactive gas created from complex chemical reactions between nitrogen oxides (NOx) and volatile organic compounds (VOCs) in the presence of sunlight. In B.C., the largest source of both NOx and VOCs remains the transportation sector, where the combustion of fossil fuels in motor vehicles releases NOx, VOCs, and other air pollutants. Short-term exposure to ozone can cause breathing difficulties, an aggravation of asthma symptoms and other lung diseases, and may even lead to premature death. There is growing evidence that long-term exposure may be associated with the development of respiratory effects, especially in the young and the elderly.

In 2022, ozone was monitored at 46 monitoring stations. Annual concentrations (based on the annual 4th highest daily 1-hour maximum concentration) ranged from 38 parts per billion (ppb) in downtown Vancouver and North Vancouver to 63 ppb in Maple Ridge. Several areas of the province broke temperature records during the "heat dome" of 2021 and the late summer heat wave of 2022. These extreme temperatures led to elevated O_3 levels that had not been observed in B.C. since the late 1980s. The influence of nearby wildfire smoke in July also contributed to elevated O_3 levels in the eastern Fraser Valley. When adjusted for the influence of wildfire, all stations met the Canadian Ambient Air Quality Standards for ozone of 62 ppb.

NO_2 Nitrogen Dioxide

Nitrogen Dioxide (NO_2) is a reddish-brown gas emitted directly from high-temperature combustion and is also formed in the atmosphere by the chemical reaction between nitric oxide (NO) and O_3. The largest sources of NO and NO_2 in B.C. are the transportation sector and the upstream petroleum industry. Short-term exposure to NO_2 is linked to respiratory illnesses, and there is growing evidence of effects from long-term exposure, including cardiovascular mortality, cancer, and reproductive effects.

There were 46 monitoring stations that reported NO_2 levels for at least part of 2022. Based on the annual average concentration (annual average of hourly measurements), NO_2 levels ranged from 2 ppb at Farmington and Taylor to 17 ppb at New Westminster. All sites in B.C. were below the 17-ppb defined by the provincial air quality objectives and national Canadian Ambient Air Quality Standards. The highest annual levels were observed in urban areas and near roadside locations, emphasizing the significance of vehicular transportation as a major source of emissions.

SO_2 Sulphur Dioxide

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

In 2022, SO_2 was monitored at 38 stations, excluding mobile and industrial fence line sites. SO_2, calculated using the 1-hour metric (99th percentile of the daily 1-hour maximum concentration), ranged from 0.9 ppb at Chilliwack to 124.8 ppb at Trail-Butler Park. Most monitoring stations reported 1-hour levels below 6 ppb. However, in Trail, the values from the Trail-Butler Park station exceeded the Canadian Ambient Air Quality Standards, which have a threshold of 70 ppb.

trends

air pollution in B.C. through the years

Looking at historical trends in air pollution can help evaluate the effectiveness of the actions taken to improve air quality and determine the areas that need more attention. Figures 5 to 8 show annual levels of pollutants measured in B.C. over the last 20 years. Graphs depict the lowest and highest observed concentrations, as well as the levels at selected monitoring stations.

Wildfire smoke has increasingly affected $PM_{2.5}$ levels, as shown in the 20-year trend of the annual average. In 2017 and 2018, back-to-back record wildfire seasons caused widespread impacts due to the resulting smoke, culminating in record high $PM_{2.5}$ concentrations at several monitoring stations. The 2019 and 2020 wildfire seasons were comparatively mild. These were followed by the 2021 season, which was dominated by smoke from western United States, and the 2022 season that was influenced by a late wildfire season.

Wildfire smoke can also influence ozone levels. The record-breaking wildfire seasons of 2018 and 2019 produced the two highest reported annual ozone values (based on the 4th highest daily 8-hour maximum) of the past 30 years, as shown in the figure 6. The long-range transport of wildfire smoke from other parts of British Columbia, the western United States, and even as far away as Siberia can also elevate ozone levels. The high temperatures from the 'heat dome' of 2021 created warm, stable, and sunny conditions that favored ozone formation. As a result, there were several days in 2021 when ozone levels far exceeded normal values, reaching levels as high as those observed in the 1980s. This also caused annual ozone values to surpass the national standard value of 62 ppb. Progressive actions to reduce emission of ozone precursors (Volatile Organic Compounds, NOx), such as implementing better vehicle and fuel standards, have led to reductions in peak ozone levels over the years.

Annual average NO_2 levels (calculated as annual average of hourly measurements) have generally declined over the past three decades, primarily due to more stringent vehicle emission and gasoline standards, the introduction of new engines and industrial equipment with better emission control technology. Current initiatives towards lower emissions and even zero emission vehicles are expected to further improve NO_2 levels over the next decade. The 2020 COVID-19 pandemic also had a noticeable impact on NO_2 levels, as less traffic reduced the amount of NO_2 in urban areas.

SO_2 levels, represented as the annual average (calculated as annual average of hourly measurements), have shown large declines, and have mostly remained at a low concentration below 5 ppb (shown as red dashed line) over the past two decades. This decline reflects concerted efforts to reduce sulphur emissions from sources such as motor vehicles, marine vessels, and industries such as petroleum refining, pulp and paper, and cement production.

Figure 6. Trends in the Annual Levels of O_3

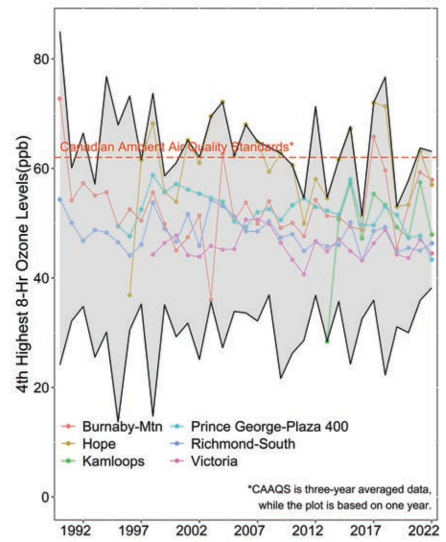


Figure 7. Trends in the Annual Average Levels of NO_2

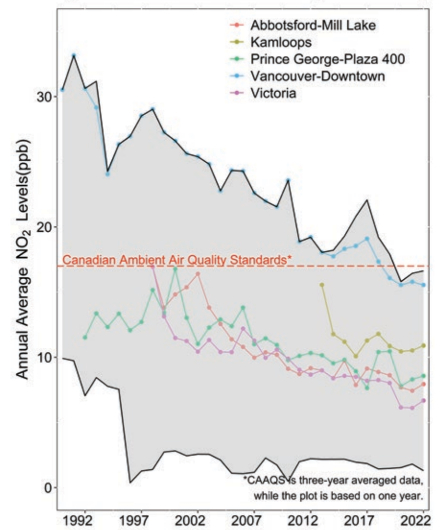


Figure 5. Trends in the Annual Average Levels of $PM_{2.5}$

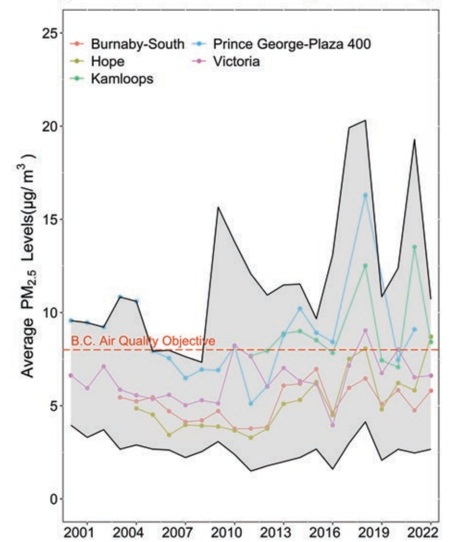
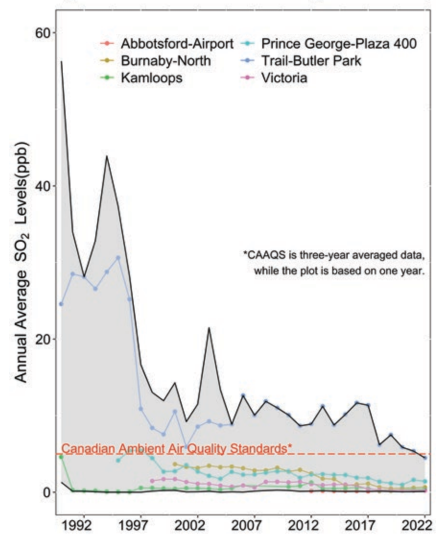


Figure 8. Trends in the Annual Average Levels of SO_2



updates
from partner agencies

Health Canada Santé Canada

Health Canada works with Environment and Climate Change Canada, provinces, territories, municipalities, and stakeholders to improve air quality through regulations, standards, guidelines, outreach and public information. Some highlights of the last year are presented below.

Indoor Air Quality

Three important issues have been addressed in new publications:

Mould indoors is the greatest indoor air issue of concern among members of the public contacting Health Canada. With the changing climate and an increased frequency of extreme weather events, mould indoors is expected to continue to be a health concern in the indoor environment. *The Guide to Addressing Moisture and Mould Indoors* provides practical recommendations to address the health hazard of indoor mould.

Health Canada continues to conduct human health risk assessments on priority indoor air contaminants, developing recommended health-based exposure limits and providing evidence-based risk mitigation strategies. *The Residential Indoor Air Quality Guidelines for xylenes* have been finalized, a contaminant for concern in particular for newly constructed or renovated homes, and those with an attached garage.

In addition to residential environments, indoor air quality in indoor public spaces is an important issue from a health perspective, and a priority for many of Health Canada's partners and stakeholders. *Draft guidance on improving indoor air quality in office buildings* was published for comment. It summarizes ways to remediate, maintain and improve indoor air quality in office buildings, and is an update of a 1995 document of similar scope.

Air Pollution Health Burden

The report *Health Impacts of Air Pollution from Transportation, Industry and Residential Sources in Canada: estimates of Premature Mortality and Morbidity Outcomes at National, Provincial, Territorial and Air Zone Levels* provides a comparative analysis of the health impacts associated with $PM_{2.5}$, NO_2, and ozone air pollution attributable to 20 individual anthropogenic sectors/subsectors. The top three sectors contributing to air pollution health impacts in 2015 were home firewood burning (2,300 deaths), on-road transportation (1,200 deaths), and ore and mineral industry (910 deaths).

The report *Health Benefits per Tonne of Air Pollutant Emissions Reduction: Region-, Sector- and Pollutant-specific Estimates for Two Canadian Regions* provides a way to calculate the dollar value of health benefits associated with a one tonne reduction in air pollutant emissions in the regions of southwestern British Columbia and the Windsor-Quebec City corridor). These calculations can support local/regional decision makers in the evaluation of air pollution or GHG mitigation strategies.

Air Health Trend Indicators

The air health trends indicators included among the Canadian Environmental Sustainability Indicators (CESI) have been updated. These indicators present trends in risk of hospitalization and death attributable to short-term exposures to ozone and particulate matter. The trends vary according to pollutant, age, sex and region.

Understanding vulnerability to air pollution is important to recognising the implications of exposure impacts and to designing protective measures that can reduce population risks. Maternal exposure during pregnancy has implications for the health of both the mother and child after birth. Health Canada continues to investigate air pollution impacts on the Maternal Infant Research on Environmental Chemicals (MIREC) cohort and in the last year has published new research papers on ***critical time windows for exposure and birth weight*** (Johnson et al., 2022) and ***metal exposure and maternal hypertension*** (Borghese et al., 2023).

COMING SOON:

CanOSSEM-SmoKE

Health Canada is working with partners and stakeholders (including BCCDC, UBC, Assembly of First Nations, First Nations Health Authority, CHEO, CANUE) to build a wildfire season internet-based forecast and risk communications tool which incorporates Indigenous knowledge and languages and is responsive to community needs. This tool will help communities evaluate smoke exposure, communicate health risks, support resiliency and emergency preparedness, and promote effective interventions.

Web-based AQBAT

The Air Quality Benefits Assessment Tool (AQBAT) applies epidemiological research results to the estimation of short- and long-term health impacts of air pollution in Canada. It has been applied to burden of disease calculations, sector analyses and regulatory processes but its use has been relatively complex and software dependent. Health Canada has now developed an internet-based fully open-source application for AQBAT, which will be made available in the near future.

Continued on page 14

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

British Columbia Ministry of Environment and Climate Change Strategy

Community Wood Smoke Reduction Program

Since 2008, the Community Wood Smoke Reduction Program (formerly known as the Provincial Wood Stove Exchange Program) has provided $4.1 million of funding for incentives to help replace more than 10,000 wood stoves with cleaner heating alternatives. Through the partnership of the Ministry of Environment and Climate Change Strategy, the British Columbia Lung Foundation, and participating communities, the program has distributed funds for the 2023-2024 term. These funds will enable one new community (District of Mackenzie) to join the program and will fund the continuation of the program in 20 other communities.

Several updates were made to the Community Wood Smoke Reduction Program to improve its effectiveness. To further encourage exchanges, program rebate levels were increased, particularly for those communities where pollutant levels exceeded the Canadian Ambient Air Quality Standards. The program is now better aligned with provincial climate goals, as outlined in the Clean BC Roadmap to 2030. This means more focus on encouraging heat pumps and non-fossil fuel replacements, with incentives no longer provided for gas or propane appliances. In addition, the program now includes an option for the replacement of outdoor wood boilers. New brochures and online educational materials produced by the program support local efforts to educate on wood smoke and clean burning. Funding from the program is also supporting citizen science work to conduct local woodsmoke monitoring in the Regional District of Nanaimo and the Comox Valley Regional District. For more details on the Community Woodsmoke Reduction Program, visit: gov.bc.ca/woodstoveexchange

Stewardship Activities

The City of Courtenay launched an air quality awareness campaign by installing low cost "Purple Air" monitors for fine particulate matter ($PM_{2.5}$). The campaign aims to educate local residents about the impact of wood smoke from residential heating on the levels of $PM_{2.5}$, actions to reduce smoke, and the available rebates to replace wood-fired heating systems.

In the Village of Valemount, the Valemount Task Force developed a five-year air quality management plan (2022-2026) that was approved by the council in August 2022. The Task Force is in the early phase of implementing its five-year plan.

The ministry installed an ambient monitoring station at Chetwynd to monitor levels of particulate matter (PM_{10}) from local dust sources such as road dust and fugitive emissions. New monitoring is also being installed at Merritt. This station contains a full set of equipment to monitor multiple pollutants to help understand the impacts of air quality within the community.

The Ministry completed a community emissions inventory for the District of Vanderhoof and surrounding areas. This inventory will inform priorities for actions to improve air quality in that community.

Fraser Valley Regional District (FVRD)

AQMP Implementation

The Fraser Valley Regional District (FVRD) adopted its new Air Quality Management Plan (AQMP) in late 2021 and have since been focused on implementation of the various actions identified within this plan. The AQMP identifies four goals to pursue for the airshed: Improving community and ecosystem health affected by air contaminants, keeping visual air quality excellent, preventing or mitigating nuisance odour, and reducing climate change emissions. The FVRD uses various tools to accomplish these goals, including monitoring, planning, advocacy, outreach, research, and collaborating with other airshed partners and agencies. Some examples of programs and initiatives taken as part of AQMP implementation include delivery of a classroom program that provides air quality education to over 50 elementary schools each year, timely distribution of air quality advisories, air quality signage installations, and improved awareness of airshed conditions using community-level air quality sensors (see below).

Community-Level Air Quality Monitoring

The FVRD contains six monitoring stations as part of the Lower Fraser Valley Air Quality Monitoring Network that measure a wide range of air pollutants that impact human and environmental health. Despite the robust ability of these stations to provide regional air quality data, their high costs to set-up and operate requires strategic placements and precludes the ability to have an air quality monitoring station in every community in the region. Consequently, some communities may experience ambient air quality that could differ from conditions measured regionally, depending on the community's local topography, microclimate, pollution sources, and proximity to the nearest air quality station.

To better understand air quality throughout the region, and to take advantage of recent major advances in the use of 'low-cost' air quality monitoring equipment, the FVRD is piloting a study using community-level air quality sensors in these smaller and more remote communities. Costs of these sensors have fallen, yet their accuracy and reliability has increased, allowing them to now play a legitimate role in complementary air quality monitoring. The two-year study is focused on particulate matter with a lesser focus on NO_2 and O_3. Community-level-sensors have been acquired and are being installed in areas such as Cultus Lake and the Fraser Canyon. Once data is obtained, the monitors can be assessed for their ability to fill in data gaps, to better undertand air pollutant distribution within the region, and to contribute to education and research efforts for these communities.

Environment and Climate Change Canada / Environnement et Changement climatique Canada

Environment and Climate Change Canada works with federal partners, provinces, and territories to improve air quality and reduce negative air quality impacts on human health and the environment; and to provide authoritative forecasts, warnings, data, and information services related to weather and air quality conditions to help Canadians make informed decisions about health, safety, and economic prosperity. Some highlights of regional work in the last year are presented here.

Personal notifications for AQHI on WeatherCan app

In Spring 2022, ECCC added custom Air Quality Health Index (AQHI) notifications to the WeatherCAN app. Custom notifications can be set up for user's current location, or any location where an AQHI is available. When the AQHI reaches the number that has been set, i.e. AQHI from 3 to 10+, a notification will be sent to the user's phone. When the user clicks on the notification, it will go directly to an AQHI page within the app where the user will see the observation, call to action and forecasts for 72 hours. This notification system replaces the AQHI app previously hosted by Alberta Environment. The WeatherCan app is available for download at Apple and Google Play stores. Here is a link that explains how to set up notifications once you download the app.

Low-Cost PM Sensor Pilot Project

Environment Climate Change Canada (ECCC) continues its Low-Cost PM Sensor Pilot Project, which aims to assess the value of using PM sensors to expand the spatial coverage of $PM_{2.5}$ measurements during high PM events such as forest fires. The project is a collaboration with universities, provinces and territories, communities, First Nations, and other air quality agencies. A mapping tool for the low-cost PM sensor data has been developed through a collaboration between Dr. Peter Jackson from the University of Northern British Columbia (UNBC) and ECCC (https://cyclone.unbc.ca/aqmap). New features were added to the mapping tool in 2022, including additional forecast data layers. Work by ECCC scientists to assess potential for low-cost sensors to improve $PM_{2.5}$ forecasting is on-going.

Ventilation Index

ECCC continued work on updating the science behind the BC-based Ventilation Index forecast, which estimates how well the atmosphere disperses smoke on any given day. Testing and evaluation of a newly developed national gridded Ventilation Index is nearing completion, with the expectation that the new product will be available within the next year.

metrovancouver

SERVICES AND SOLUTIONS FOR A LIVABLE REGION

Air Quality Advisories Help Residents Stay Informed and Safe

When air quality degrades, Metro Vancouver issues air quality advisories. Wildfire smoke advisories in six of the last eight summers and elevated ground-level ozone due to extreme heat waves emphasize how climate change is affecting air quality. Metro Vancouver's air quality advisory service is for the entire Lower Fraser Valley airshed, including Metro Vancouver and the Fraser Valley Regional District. Real-time air quality data is available at www.airmap.ca. For information on wildfire smoke preparation, visit *Wildfire Smoke and Air Quality*.

Indoor Wood Burning Requirements Will Reduce Wood Smoke in Our Communities

New bylaw requirements came into effect in Metro Vancouver in September 2022. Metro Vancouver residents who operate an indoor wood burning appliance, such as a fireplace or wood stove, must register their appliance and declare use of best burning practices. Use of residential indoor wood burning appliances is also prohibited from May 15 to September 15 each year in Metro Vancouver to protect residents from the health effects of wood smoke. Additionally, residents who replace their old wood-burning appliances with heat pumps or clean wood-burning appliances can now receive increased rebates, thanks to new funding from the Province. More information is available online at *Metro Vancouver's residential indoor wood burning* website and ***Community Wood Smoke Reduction Program.***

Climate 2050 Roadmaps – Path to a Carbon Neutral Region

Climate 2050 is an overarching long-term strategy that will guide our region's policies and collective actions to transition to a carbon neutral and resilient region over the next 30 years, using a series of roadmaps that describe the goals, targets, and actions for specific sectors. Each roadmap presents a suite of actions to be implemented by Metro Vancouver and our partners and stakeholders throughout the region.

Climate 2050 roadmaps have been developed for Transportation, Buildings, Energy, Industry and Business, and Nature and Ecosystems. For more, visit www.metrovancouver.org and search 'Climate 2050', to see how the roadmaps explore the most effective actions for reducing greenhouse gas emissions and preparing our communities for a changing climate.

Metro Vancouver has also developed an online learning program for residents to explore local climate information at

Continued on page 16

Cont'd from p.15 (Metro Vancouver Update)

their own pace and discover examples of what we are doing, and can do, to reduce emissions and prepare our communities for change. To learn more, visit *Climate Literacy Programs*.

New Requirements for Open Burning of Vegetative Debris

New bylaw requirements for open burning took effect on May 15, 2023. These requirements apply to the outdoor burning of vegetative debris such as leaves, branches, and other plant material from activities including agriculture, land clearing, and residential yard maintenance without the use of a chimney or emission stack. Because of the population density in parts of Metro Vancouver, smoke emissions from open burning can impact many people. To learn more, visit our *open burning website*.

New Air Contaminant Fees for Industrial Emissions

Metro Vancouver is increasing air quality permit and regulatory fees, with a phased-in approach between 2022 and 2028. The new fees reflect updated information on the health costs of air contaminants and support the additional resources needed to manage and protect regional air quality. Metro Vancouver charges fees for permits that specify the maximum amount and types of air contaminants a facility is authorized to emit. These fees encourage facilities to reduce emissions, and also recover the costs of air quality regulatory services like inspections and enforcement.

Air Quality and Climate Actions

For additional updates on Metro Vancouver's projects and activities, visit https://metrovancouver.org/services/air-quality-climate-action.

contact information

BC LUNG FOUNDATION
www.bclung.ca
2675 Oak St., Vancouver, B.C. V6H 2K2
(604) 731-5864 or toll-free at
1-800-665-5864 (in B.C. but outside the Lower Mainland)

B.C. MINISTRY OF ENVIRONMENT AND CLIMATE CHANGE STRATEGY
www.gov.bc.ca/bcairquality
525 Superior Street
Victoria, B.C. V8W 9M1
(250) 387-9537

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
Vancouver, B.C. V6C 1A1
(604) 666-2083

B.C. CENTRE FOR DISEASE CONTROL
www.bccdc.ca
655 West 12th Ave
Vancouver, B.C. V5Z 4R4
(604) 707-2400

ENVIRONMENT AND CLIMATE CHANGE CANADA
www.canada.ca/en/environment-climate-change
401 Burrard Street
Vancouver, B.C. V6C 3S5
(604) 664-9100

METRO VANCOUVER
www.metrovancouver.org
Metrotower III, 4515 Central Boulevard
Burnaby, B.C. V5H 0C6
(604) 432-6200

FRASER VALLEY REGIONAL DISTRICT
www.fvrd.ca
45950 Cheam Ave.
Chilliwack, B.C. V2P 1N6
(604) 702-5000
1-800-528-0661

B.C. MINISTRY OF HEALTH
www2.gov.bc.ca/gov/content/health/keeping-bc-healthy-safe
Health Protection Branch
PO BOX 9412 STN PROV GOVT
Victoria, B.C., V8W 9V1
(250) 952-1911

NORTHERN HEALTH AUTHORITY
www.northernhealth.ca
Suite 600, 299 Victoria St.
Prince George, B.C. V2L 5B8
(250) 565-2649

ISLAND HEALTH AUTHORITY
www.viha.ca
1952 Bay Street
Victoria, B.C. V8R 1J8
(250) 370- 8699

VANCOUVER COASTAL HEALTH AUTHORITY
www.vch.ca
601 West Broadway, 11th Floor,
Vancouver, B.C. V5Z 4C2
(604) 736-2033 or
1-866-884-0888

FRASER HEALTH AUTHORITY
www.fraserhealth.ca
Suite 400, Central City Tower
13450 – 102nd Ave
Surrey, B.C. V3T 0H1
(604) 587-4600 or
1-877- 935-5699

INTERIOR HEALTH AUTHORITY
www.interiorhealth.ca
220 – 1815 Kirschner Rd.
Kelowna, B.C. V1Y 4N7
(250) 862-4200

FIRST NATIONS HEALTH AUTHORITY
www.fnha.ca
501-100 Park Royal South
Coast Salish Territory
West Vancouver, B.C. V7T 1A2
(250) 862-4200

LEGACY FOR AIRWAY HEALTH
www.legacyairwayhealth.ca
Diamond Health Care Centre
The Lung Centre, Rm 7267
2775 Laurel Street, Vancouver, BC.
Canada, V5Z 1M9
(604)-875-4111 x 23137

We welcome your feedback!
Please send correspondence to:
Dr. Menn Biagtan
biagtan@bclung.ca
(604) 731-5864

2023 Working Group:

Menn Biagtan
Michael Brauer
Emily Brigham
Chris Carlsten
Eric Coker
Derek Jennejohn
John Morton
Noah Quastel
Jerome Robles
Meghan Roushorne
Matthew Wong


2023
state
of
the
air
technical
appendix

2023 BC Lung State of the Air Report -- Technical Appendix

Data Source:

B.C. Ministry of Environment and Climate Change Strategy, Metro Vancouver, Prince Rupert Port Authority, BC Hydro

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.

Disclaimer:

While the information in these data summaries is believed to be accurate, the data summaries are provided "as is" without any warranty, and are subject to change as part of an ongoing data validation process. For updates on data validation and changes to this summary, visit the latest news and updates on gov.bc.ca/airquality.

Disclaimer (Metro Vancouver data):

1. Permission is granted to produce or reproduce these data, or any substantial part of them, for personal, non-commercial, educational and informational purposes only, provided that the data are not modified or altered and provided that this disclaimer notice is included in any such production or reproduction.
2. While the information in these data is believed to be accurate, these data and all of the information contained therein are provided “as is” without warranty of any kind, whether express or implied. All implied warranties, including, without limitation, implied warranties of merchantability and fitness for a particular purpose, are expressly disclaimed by Metro Vancouver. Metro Vancouver reserves the right to update data files from time to time and will not be held responsible for the validity of the archives maintained by other parties. It is the user’s responsibility to ensure that the data is up-to-date and to follow-up with Metro Vancouver should any questions related to the data arise.
3. The information provided in these data is intended for educational and informational purposes only. These data are not intended to endorse or recommend any particular product, material or service provider nor is it intended as a substitute for engineering, legal or other professional advice. Such advice should be sought from qualified professionals.

2022 Fine Particulate Matter (continued)

Site	Instrument	Year	No. Valid Hrs	Percentiles (1h)					Max 1h	No. Valid Days	24h Average			No. of Days		% of Valid Days Per Quarter				CAAQS Metrics for $PM_{2.5}$*	
				25th	50th	75th	98th	99th			Annual Avg	Annual 98th Percentile*	Annual Max	>25 µg/m^3	>27 µg/m^3	Q1	Q2	Q3	Q4	Annual	24-Hour
Abbotsford-Airport	PM25 SHARP5030	2022	8552	2.5	4.5	7.8	29.4	49.6	320.3	355	7.2	30.2	162.4	8	8	100	100	99	90	6.2	22
Abbotsford-Mill Lake	PM25 SHARP5030	2022	8701	2.4	4.3	7.6	25.5	47.3	345.8	361	6.9	20.5	160.4	7	7	98	99	99	100	5.8	17
Agassiz	PM25_SHARP5030i	2022	8252	2.9	4.9	8	47	97.7	213.3	342	8.3	48.4	168.6	10	10	96	93	100	86	7	38
Burnaby-Kensington Park	PM25 SHARP5030	2022	8704	1.7	3.3	6.4	21.8	32.1	115.3	363	5.3	18.7	61.5	5	4	99	99	100	100	5.3	27
Burnaby-South	PM25 SHARP5030	2022	8663	2.2	4	7	20.6	30.6	212.2	360	5.8	19.3	65.5	3	3	100	99	96	100	5.4	16
Burns Lake	PM25 SHARP5030	2022	8718	2.4	4.6	9.3	27.4	32.5	116.2	363	7.1	18.9	29.2	1	1	100	100	100	98	7.1	19
Castlegar	SHARP	2022	8718	2.9	5.7	10.6	31.2	40.5	125.6	365	8.2	24.1	76	7	6	100	100	100	100	12.8	107
Chilliwack	PM25 SHARP5030	2022	8700	2.4	4.3	7.9	48.8	80.2	271.8	361	8.3	51.5	208.6	12	11	98	100	98	100	6.5	28
Colwood	BAM1020	2022	8263	2	4	7	22	26	73	341	5.6	18.8	44.4	3	2	99	90	95	90	6.3	26
Courtenay	BAM1020	2022	8699	3	5	8	31	37	56	362	7.2	20.8	34	3	3	98	99	100	100	8	24
Cranbrook	PM25_SHARP5030i	2022	8705	2.4	5.3	11.2	39.9	51	115.1	362	8.7	32.9	66.3	17	15	100	100	99	98	8.1	35
Crofton-Elementary	BAM1020	2022	8520	1	3	6	20	26	96	357	4.3	18.4	61	3	2	100	96	100	96	4.4	29
Crofton-Substation	BAM1020	2022	8449	2	4	6	19	25	91	360	4.8	16.5	50.2	1	1	99	100	100	96	5.2	23
Duncan	BAM1020	2022	8587	3	7	11	29	34	112	361	8.5	22.2	66	5	3	100	97	100	99	7.7	26
Duncan-Deykin	BAM1020	2022	8633	2	4	8	21	24	227	360	5.9	16.4	58.7	2	2	98	100	98	99	6.2	23
Campbell River	BAM1020	2022	7674	2.1	4.3	7	23.6	27.5	86.8	317	5.6	18.2	31.9	2	2	100	95	53	100	7.2	23
Elkford	PM25 SHARP5030	2022	8451	2.1	3.7	6.7	27.3	49.8	435.7	350	5.9	32.6	64.2	10	10	99	88	98	99		
FortSt.John-85th Avenue	PM25_SHARP5030i	2022	8537	2	4.1	7.6	31.7	48.8	115.8	353	6.4	28.6	54.5	12	11	100	93	99	95	5.2	22
FortSt.John	PM25 SHARP5030	2022	8724	2.3	4	7.1	30.3	49.8	149.2	363	6.3	26.8	49.6	13	6	100	100	99	99	5.6	23
Fort St.John-N.CampC	PM25 SHARP5030	2022	8437	2.1	4	7.2	28.7	44.5	172.2	347	6.1	27.6	44.9	9	7	97	98	98	88	5.1	22
FortSt.John-OldFort	PM25 SHARP5030	2022	8693	1.4	3	6.5	31.3	43.1	132.8	364	5.5	27.8	41.9	10	8	100	99	100	100	4.6	22
Golden	PM25_SHARP5030i	2022	8718	3.6	7	12.7	42.2	50.8	112.3	364	10	29.1	45.6	19	14	100	100	100	99	11	50
Grand Forks	TEOM/SHARP	2022	8699	3.5	6.9	12.2	37.9	45.1	91.8	363	9.6	28.5	55.6	13	12	100	100	98	100	11.6	50
Harmac-Cedar Woobank	BAM1020	2022	8528	2	5	9	32	40	98	363	7.1	21.3	56.5	3	3	100	99	99	100	7.4	29
Hope	PM25 SHARP5030	2022	8518	2.4	4.5	8	51.8	127	355.6	352	8.7	60.9	165.1	14	13	98	98	96	95	6.9	32
Horseshoe Bay	PM25 SHARP5030	2022	8710	2	3.3	5.6	18.2	28.9	99.8	364	4.8	17.6	46.4	4	4	100	100	99	100	5.1	31
Houston	PM25 SHARP5030	2022	8693	2.3	4.6	9.7	48.3	61.4	143	360	8.8	26.8	53.8	11	7	100	99	100	96	8.3	29
Hudson's Hope	PM25 SHARP5030	2022	8645	1.4	3.4	7.8	61.6	87.5	417.2	362	8.4	61.4	202.6	21	19	99	100	100	98	6.8	44
Kamloops	BAM1020/SHARP	2022	8736	3.8	6.6	10.9	28.6	38.2	66.9	364	8.4	21.1	48.5	5	5	100	99	100	100	9.7	49
Kelowna	PM25 SHARP5030	2022	8745	2.5	4.7	8.5	20.7	30.9	98.8	365	6.3	18.8	47.5	4	3	100	100	100	100	8.5	47
Kitimat-Haisla Village	BAM1020/TEOM	2022	8351	0	2	4	13	16	98	353	2.8	10.2	13.9	0	0	99	100	90	98	3.1	8
Kitimat-Haul Rd	BAM1020	2022	8310	0	2	5	18	22	120	353	3.4	12.8	20.6	0	0	98	98	93	98	4.1	13
Kitimat-Riverlodge	BAM1020	2022	8486	1	2	4	12	14	38	356	3.1	10.9	16.5	0	0	99	100	95	97	3.1	9
Kitimat-Whitesail	BAM1020/TEOM	2022	8418	2	4	6	15	17	174	348	4.6	13.5	16.5	0	0	99	99	92	91	3.3	10
Langdale	PM25_T640	2022	8642	3.3	4.3	6	25	41.8	122.2	359	6	23.1	69.9	7	6	100	96	100	98		
Langley	PM25 SHARP5030	2022	8638	2	3.5	6.2	26.7	38	156.5	361	5.6	21.6	90.7	6	6	100	100	96	100	5.5	25
Merritt-NicolaAve	PM25 SHARP5030	2022	4479	2.4	4.5	8.4	42.1	64.8	108.3	173	7	28.8	71.4	4	4	21	59	57	52		
Mission	PM25_SHARP5030i	2022	8057	2.4	4.7	8.8	29.3	45.6	258.2	335	7.4	33	104.5	8	8	100	68	99	100	6.8	33
Nanaimo	BAM1020	2022	8671	2	4	7	18	23	98	362	5.2	16	51.5	3	2	100	99	98	100	5.8	24
New Westminster	PM25_SHARP5030i	2022	8631	2.9	4.9	8.2	25.5	35.4	252.9	359	7	22.9	59	6	5	99	97	98	100	6.4	18
North Delta	PM25 SHARP5030	2022	8637	2.6	4.3	7.1	20.7	31.1	147.1	359	5.9	17.8	64.1	3	3	100	100	95	99	6.2	21
N.Vancouver-Mahon Park	PM25 SHARP5030	2022	8714	2.1	3.6	6	20.8	31.4	136.1	364	5.3	18.9	78.4	5	4	100	100	99	100	5.1	30

2022 Fine Particulate Matter (continued)

Site	Instrument	Year	No. Valid Hrs	Percentiles (1h)					Max 1h	No. Valid Days	24h Average			No. of Days		% of Valid Days Per Quarter				CAAQS Metrics for $PM_{2.5}$*	
				25th	50th	75th	98th	99th			Annual Avg	Annual 98th Percentile*	Annual Max	>25 µg/m^3	>27 µg/m^3	Q1	Q2	Q3	Q4	Annual	24-Hour
N.Vancouver-2nd Narrows	PM25 SHARP5030	2022	8682	3.2	5	7.8	23.3	33.1	102.3	363	6.7	22.6	57.6	6	5	100	98	100	100	6.6	20
Peace Valley	PM25 SHARP5030	2022	8536	1.8	3.7	7.1	41.4	65.8	300.6	361	6.6	42.8	61.6	12	12	99	99	99	99	5	25
Penticton	BAM1020	2022	8487	1.8	4.8	8.4	26	37.5	101.7	364	6.3	20.4	47	5	5	100	100	99	100		
Pitt Meadows	PM25 SHARP5030	2022	8492	1.7	3.6	6.7	20.5	28.8	138.2	349	5.2	19.4	48.9	3	2	97	93	100	92	5.3	26
Port Alberni-Elem.School	BAM1020	2022	8691	3	5	9	33	39	240.7	362	7.4	25.3	35.3	8	7	100	100	100	97	7.8	24
Port Edward-Sunset Drive	PM25_SHARP5030i	2022	6721	0.6	1.4	2.9	9	11.3	49.3	272	2.2	6.7	8	0	0	16	96	88	98		
Port Moody	PM25 SHARP5030	2022	8541	2	3.7	6.6	22.2	31.9	119.6	357	5.6	18.9	58.3	4	4	100	100	99	92	5.6	28
Powell River-J Thomson	PM25_T640	2022	4649	2.2	3.3	4.5	13.1	17.9	47.6	193	3.9	8.6	12	0	0	100	97		16	6.1	24
Prince George-Plaza 400	PM25 SHARP5030	2022	6115	3	4.9	8.9	24.9	30	59.5	252	6.9	17.4	27.1	2	1	97	98	35	48		
Prince Rupert-Fairview	PM25_SHARP5030i	2022	8014	1	2	3.5	9.6	11.5	34.3	334	2.7	7.1	9.5	0	0	100	98	68	100	2.7	7
Quesnel**	SHARP	2022	8404	3.1	6.5	13.1	33.6	40.9	61	350	9.3	27	44.2	9	7	100	84	100	100	9.6	35
Richmond-South	PM25 SHARP5030	2022	8695	2.1	3.9	6.6	19	22	124.1	363	5.3	16.5	63.1	3	3	99	100	99	100	5.7	19
Smithers	SHARP	2022	8742	2.3	4.3	8.9	30.1	35	195.8	365	7	19.9	28.5	2	1	100	100	100	100	6.7	19
Sparwood	PM25_SHARP5030i	2022	7520	2.3	4.8	9.1	32.9	52.3	86.2	310	7.1	29.5	70.1	10	8	66	95	92	87		
Squamish	BAM1020/SHARP	2022	8618	2.7	4.5	7.5	22.2	32	80.4	358	6.2	20.5	49.5	5	5	96	100	98	99	6.2	28
Surrey East	PM25 SHARP5030	2022	8536	2.8	4.6	7.8	21.7	30.3	213.7	354	6.5	20.7	92.3	3	3	93	99	97	99	6.1	25
Terrace	PM25 SHARP5030	2022	8225	2.2	3.8	6.9	24.5	33.7	151.7	339	5.7	16.7	19.4	0	0	98	78	100	96	4.8	14
Tsawwassen	PM25 SHARP5030	2022	8697	1.7	3	5.1	16.3	21.3	193.1	362	4.4	14	105.8	3	3	100	98	99	100	4.7	13
Valemount	PM25 SHARP5030	2022	2761	2.2	3.9	9.1	61.7	74.9	147.3	114	9.6	26.3	32.5	5	2	99	27				63
Vancouver-ClarkDr	PM25 SHARP5030	2022	8687	3.1	5.2	8.5	23.5	29.2	117.6	364	7	20.9	51.2	3	3	100	100	100	99	7	27
Richmond-Airport	PM25 SHARP5030	2022	8701	2.1	3.9	6.8	20.5	26.8	135.4	363	5.5	16.6	52.5	3	3	100	100	98	100	5.4	21
Vanderhoof	BAM1020	2022	8220	6	8	14	33	38	143	330	10.7	29.5	34.3	14	11	96	96	79	91	10.3	28
Vernon	PM25 SHARP5030	2022	8733	3.4	6.5	11.7	27.3	40.8	80.6	364	8.4	21.9	55	7	6	100	100	99	100	11	70
Victoria	BAM1020	2022	8631	4	6	8	22	27	175	361	6.6	16.5	40.6	2	2	100	100	100	96	7	27
Whistler	BAM1020	2022	7777	0	2	6	27	34	134	326	5	20.2	57.8	4	4	92	86	80	99	5.5	24
Williams Lake	PM25 SHARP5030	2022	8609	2.4	4.4	8.3	30.7	38.4	98.6	357	6.7	23.5	45.6	7	5	100	96	100	96	6.4	27

*CAAQS metrics for $PM_{2.5}$ are an annual metric based on the average of daily values and a 24-hour metric based on the 98th percentile of the daily concentrations, averaged over three consecutive years. Data are normally adjusted for transboundary flow and exceptional events (e.g., wildfires) for air zone management purposes under the national Air Quality Management System. Data in this table were NOT adjusted for transboundary flow and exceptional events. For details, visit: https://gov.bc.ca/.

**Data collected from two monitoring stations: Quesnel Kinchant St., and Quesnel Johnston Ave.

2022 Ozone (continued)

Site	Year	No. Valid Days	Annual Avg.	Percentiles (1h)						Daily 8h Max		No. Days >62 ppb	% of Valid Days Per Quarter					CAAQS 8-Hr Metric*
				25th	50th	75th	98th	99th	1h Max	Annual Max	Annual 4th Highest		Q1	Q2	Q3	Q4	Q2+Q3	
Abbotsford-Airport	2022	365	20.6	9.7	21.5	30.1	44.1	49	68.7	59.5	54.7	0	100	100	100	100	100	54
Abbotsford-Mill Lake	2022	360	19.9	9.1	19.9	29.6	45.6	48.7	66.6	57.8	53.6	0	100	96	100	99	98	52
Agassiz	2022	362	19.9	8.8	20	29.1	46.1	53	78.8	63.9	56.7	1	97	100	100	100	100	56
Burnaby-Kensington Park	2022	358	18	8.6	17.7	26.2	41.2	43.3	70.7	60.2	45.6	0	100	100	92	100	96	47
Burnaby-Mtn	2022	364	26.7	20.7	27	33.2	44	46.9	76.9	67.1	57.9	1	100	100	100	99	100	57
Burnaby-South	2022	364	18.5	9.2	18.5	26.8	42.1	44.1	66.3	56.8	46.2	0	100	100	99	100	99	45
Castlegar	2022	364	20.2	11.5	19.7	27.5	44.9	46.8	60.7	50.6	48.4	0	100	99	100	100	99	52
Chilliwack	2022	365	20.1	8.6	20.1	29.4	47.1	54.7	81.1	67	56.9	1	100	100	100	100	100	59
Colwood	2022	361	22.6	12.5	23.2	32.4	44	46.2	61.2	53.7	49.1	0	98	100	100	98	100	51
Coquitlam	2022	361	17	6.7	15.3	26.1	42.6	45.4	85.3	71.1	56.7	1	100	98	98	100	98	57
Courtenay	2022	362	19.7	8.4	19.5	29.2	44.2	46.6	56.7	49.6	47.8	0	100	99	100	98	99	48
Cranbrook	2022	364	28.2	18.7	28.5	37.9	49.7	51.6	61.6	56.7	52.1	0	99	100	100	100	100	53
Duncan	2022	365	18.7	6.6	18	29.3	43.6	45.6	68.9	57.9	50.1	0	100	100	100	100	100	50
Farmington	2022	361	26.3	19	27.8	34.2	44.2	45.5	58.9	55.5	48.6	0	98	98	100	100	99	49
FortSt.John	2022	335	25.5	18.5	26.9	33	43.7	45.6	59.3	56.2	47.5	0	92	93	82	100	87	48
Hope	2022	361	18.3	7	17.7	27.2	45.3	50.2	81.7	61.9	57	0	99	100	100	97	100	58
Kamloops	2022	365	21.3	10.8	21.7	31.3	44.7	46.6	60.6	55.1	47.9	0	100	100	100	100	100	51
Kelowna	2022	365	21.4	13.6	21.8	28.9	40.8	42.8	57.3	47.4	45.1	0	100	100	100	100	100	50
Kitimat-Whitesail	2022	346	19.4	11.4	19.5	27.9	37.1	39.2	48.8	46.4	41.1	0	87	97	98	98	97	41
Langley	2022	365	20.9	10.2	22.1	30.3	44.3	48.7	75.2	60.7	54	0	100	100	100	100	100	54
Maple Ridge	2022	365	19.4	8.4	18.9	28.9	45	51.1	76.7	67.7	63.1	4	100	100	100	100	100	61
Merritt-NicolaAve	2022	305	22.5	11.6	23.9	32.4	42.8	44.3	53.3	48.9	45.3	0	44	100	89	100	95	
Mission	2022	336	20.5	10.5	21	29.3	45.9	53.1	79.9	66.6	60.3	1	100	68	100	100	84	60
Nanaimo	2022	364	22.7	16.7	22.8	28.9	40.8	42.6	71.7	55.5	45.3	0	100	99	100	100	99	45
New Westminster	2022	346	12.3	1.6	9.1	20.1	38.9	42.3	74.6	65.2	49.7	1	96	85	99	100	92	50
North Delta	2022	365	19.1	8.9	19.3	27.9	43.5	45.7	60.7	53.4	50.9	0	100	100	100	100	100	47
N.Vancouver-Mahon Park	2022	363	17.4	7.6	17.1	25.8	40.2	42.8	73.6	56	46.7	0	100	100	100	98	100	46
N.Vancouver-2nd Narrows	2022	364	13.2	4.7	11.7	20.2	35.2	37.5	62.9	43.4	38.2	0	100	100	100	99	100	38
Pitt Meadows	2022	358	18.1	5.7	17.9	28.4	43.7	46.6	81.6	68.4	54.8	1	96	99	98	100	98	53
Port Moody	2022	365	14.7	2.8	12.3	24.1	42.3	45	85	65.9	54.4	1	100	100	100	100	100	51
Prince George-Plaza 400	2022	356	18.7	7.9	19.2	28.1	40.2	41.6	50.8	48.6	43.3	0	97	100	100	93	100	46
Prince Rupert-Fairview	2022	363	21.1	10.8	20.7	32	42.2	43.3	49.2	47.5	45.1	0	100	100	100	98	100	41
Quesnel**	2022	333	18	6.9	16.6	27.5	44.1	46.2	57.2	49.4	46.9	0	64	100	100	100	100	46
Richmond-South	2022	360	17.9	5.7	17.8	27.8	44	45.7	66.5	56.6	46.3	0	96	99	100	100	99	46
Smithers	2022	344	13.8	3.2	11.4	22.3	38.5	40.7	51.5	48.7	45.3	0	100	93	89	95	91	44
Sparwood	2022	361	27.8	16.6	29.5	38.8	50.1	52.7	67.8	60.6	54.8	0	100	100	100	96	100	
Squamish	2022	355	16.9	6.2	16	26.1	41.5	43.8	70.9	61.8	50.4	0	100	98	100	91	99	46
Surrey East	2022	355	20.4	11.3	21	29	43.5	46.5	65.1	57.4	53.9	0	94	99	96	100	97	52

2022 Ozone (continued)

Site	Year	No. Valid Days	Annual Avg.	Percentiles (1h)						Daily 8h Max		No. Days >62 ppb	% of Valid Days Per Quarter					CAAQS 8-Hr Metric*
				25th	50th	75th	98th	99th	1h Max	Annual Max	Annual 4th Highest		Q1	Q2	Q3	Q4	Q2+Q3	
Taylor-Townsite	2022	360	24.7	15	25.7	33.8	46.5	48.4	65.5	53	50	0	99	97	99	100	98	51
Terrace	2022	326	19.5	9.3	19.3	29.5	41.2	42.8	46.8	45.3	44.3	0	82	86	91	98	89	46
Tsawwassen	2022	358	23.2	15.3	23.3	31	44.6	46.9	63.1	56.1	48.9	0	98	99	100	96	99	47
Vancouver-ClarkDr	2022	354	12.2	1.4	10	20	37.8	40.1	64.7	46.8	40.6	0	89	100	100	99	100	42
Richmond-Airport	2022	357	17.3	6.7	17	26.1	41.8	43.5	64	56.1	44.9	0	98	93	100	100	97	45
Vancouver-Downtown	2022	311	12.1	2.6	9	19.5	37	38.3	54.3	40.3	38.4	0	100	97	93	51	95	40
Vernon	2022	365	20.5	10.2	19.9	29.8	44.2	46	54	51.8	46.7	0	100	100	100	100	100	51
Victoria	2022	359	20.3	12	20.4	28.6	41	42.5	49.1	45.8	44.5	0	100	96	100	98	98	45
Whistler	2022	364	20.6	9.9	21.2	29.7	43.7	45.1	57.2	52.9	46.4	0	100	99	100	100	99	48

*CAAQS metric for O_3 is an 8-hour metric based on the annual 4th highest of the daily maximum 8-hour averaged concentration averaged over three years. Data are normally adjusted for transboundary flow and exceptional events (e.g., wildfires) for air zone management purposes under the national Air Quality Management System. Data in this table were NOT adjusted for transboundary flow and exceptional events. For details, visit: https://gov.bc.ca/.

**Data collected from two monitoring stations: Quesnel Kinchant St., and Quesnel Johnston Ave.

2022 Sulfur Dioxide (continued)

	Year	No. Valid Hrs	No. Valid Days	Annual Avg	Percentiles (1h)					Max	Annual 99th Percentile of D1HM*	No. of Days		% of Valid Days Per Quarter				CAAQS SO_2 Metrics*	
					25th	50th	75th	98th	99th			>65 ppb	>70 ppb	Q1	Q2	Q3	Q4	Annual	1-Hour
Abbotsford-Airport	2022	8747	365	0.2	0.1	0.2	0.3	0.6	0.7	1.7	1.2	0	0	100	100	100	100	0.2	1.7
Abbotsford-Mill Lake	2022	8733	364	0.2	0.1	0.2	0.2	0.5	0.5	1.2	1	0	0	100	100	100	99	0.2	1.3
Bessborough	2022	8267	361	0.5	0.2	0.3	0.5	1.8	2.5	51.8	15.6	0	1	96	100	100	100	0.5	22.5
Birchbank Golf Course	2022	8275	359	4.1	0.3	0.6	3.9	29.5	36.8	102.8	94.1	13	21	98	99	98	99	4.1	87.2
Burnaby-Kensington Park	2022	8736	365	0.3	0.1	0.2	0.3	1.4	2	11.1	7.4	0	0	100	100	100	100	0.3	5.8
Burnaby-North	2022	8731	365	0.6	0.2	0.3	0.7	3.6	4.5	16.5	11.1	0	0	100	100	100	100	0.6	13.9
Burnaby-South	2022	8738	364	0.3	0.1	0.2	0.3	1.2	1.5	3.4	2.6	0	0	100	100	99	100	0.3	3.1
Castlegar	2022	8387	364	1.3	0.1	0.1	0.7	12	15.5	41.7	28	0	0	100	99	100	100	1.3	31.6
Chilliwack	2022	8744	365	0.1	0.1	0.1	0.1	0.4	0.4	1.6	0.9	0	0	100	100	100	100	0.1	1.1
Crofton-Elementary	2022	7961	346	1	0.5	0.8	1.2	4.2	6	20.1	13.8	0	0	100	99	100	80	1	12
Farmington	2022	8557	361	0.3	0.1	0.2	0.4	1.4	1.8	7.2	3.4	0	0	98	98	100	100	0.3	5.7
FortSt.John	2022	8232	355	0.3	0.1	0.2	0.3	1	1.2	7.5	2.6	0	0	94	95	100	100	0.3	3.7
Fort St.John-N.CampC	2022	8428	351	0.2	0	0.1	0.2	1.5	2	10.4	4.1	0	0	100	100	90	95	0.2	5.7
Hudson's Hope	2022	8352	353	0.1	0	0.1	0.1	0.4	0.5	2.2	0.7	0	0	99	91	100	97	0.1	0.9
Kamloops	2022	8386	364	0.4	0.2	0.3	0.4	1.4	2.1	12.4	6.1	0	0	99	100	100	100	0.4	4.9
Kelowna	2022	8391	365	0.3	0.2	0.3	0.4	0.7	0.9	2.3	1.8	0	0	100	100	100	100	0.3	1.6
Kitimat-Haisla Village	2022	8332	364	0.2	0.1	0.2	0.2	1	1.4	30.3	9.8	0	0	100	100	99	100	0.2	12.9
Kitimat-Haul Rd	2022	8071	352	2.2	0.2	0.4	1.3	22.8	32.9	67.2	57.5	1	7	88	98	100	100	2.2	66.7
Kitimat-Industrial Ave	2022	8019	344	0.9	0.2	0.4	0.9	5.2	6.9	48.1	18.6	0	0	77	100	100	100	0.9	26
Kitimat-Riverlodge	2022	8328	364	0.3	0.1	0.2	0.3	1.6	2.5	16.2	9.9	0	0	100	100	100	99	0.3	19
Kitimat-Whitesail	2022	8191	355	0.2	0.1	0.2	0.2	1.1	1.7	11.5	5.5	0	0	99	97	96	98	0.2	10.6
Langdale	2022	8336	362	0.7	0.2	0.3	0.7	4.8	6.8	56.9	20.7	0	1	99	100	100	98	0.7	16.4
Langley	2022	8726	365	0.1	0.1	0.1	0.1	0.4	0.5	1.4	1	0	0	100	100	100	100	0.1	1.4
Merritt-NicolaAve	2022	7204	313	0.2	0.1	0.1	0.2	0.5	0.6	2.2	1.5	0	0	44	100	98	100		
Burnaby-Capitol Hill	2022	8731	365	0.6	0.1	0.1	0.4	5.8	11.1	52.9	39.5	0	2	100	100	100	100	0.6	28.6
N.Vancouver-Mahon Park	2022	8746	365	0.3	0.2	0.3	0.4	1.1	1.3	5	3.3	0	0	100	100	100	100	0.3	3.3
N.Vancouver-2nd Narrows	2022	8721	365	0.4	0.1	0.3	0.4	1.3	1.6	19.4	3.7	0	0	100	100	100	100	0.4	3.1
Pine River-Gas Plant	2022	8344	363	3.1	0.2	0.4	2.3	24.2	29.4	302.5	111	6	6	100	100	98	100	3.1	99.2
Pine River-Hasler	2022	8370	364	0.3	0.1	0.2	0.3	1.1	1.4	17.7	3.2	0	0	99	100	100	100	0.3	4
Pitt Meadows	2022	8700	363	0.1	0	0.1	0.2	0.7	0.9	2.2	1.6	0	0	100	98	100	100	0.1	2
Port Moody	2022	8719	365	0.4	0.1	0.1	0.3	2.5	3.1	88.5	4.7	1	2	100	100	100	100	0.4	5.4
Prince George-Jail	2022	8363	362	2.6	0.4	0.6	1.7	22.4	31.5	129.1	58.4	2	11	100	99	100	98	2.6	69.8
Prince George-Marsulex Acid Plant	2022	7857	334	0.9	0.5	0.7	1.1	2.8	3.8	13.8	6.5	0	0	90	93	95	88	0.9	10.3
Prince George-Plaza 400	2022	8291	359	1.4	0.4	0.6	1.2	10.4	14.6	64.3	38.6	0	1	94	100	99	100	1.4	36.2
Prince Rupert-Fairview	2022	8636	365	0.2	0.1	0.1	0.2	0.6	0.7	1.6	1	0	0	100	100	100	100	0.2	1.4
Quesnel**	2022	8256	358	0.4	0.2	0.3	0.4	1.5	2.9	26.3	10.3	0	0	100	92	100	100	0.4	9.6
Richmond-South	2022	8694	363	0.1	0	0.1	0.1	0.6	0.8	1.4	1.3	0	0	100	98	100	100	0.1	1.5

2022 Sulfur Dioxide (continued)

	Year	No. Valid Hrs	No. Valid Days	Annual Avg	Percentiles (1h)					Max	Annual 99th Percentile of D1HM*	No. of Days		% of Valid Days Per Quarter				CAAQS SO_2 Metrics*	
					25th	50th	75th	98th	99th			>65 ppb	>70 ppb	Q1	Q2	Q3	Q4	Annual	1-Hour
Squamish	2022	8331	362	0.3	0.1	0.2	0.3	1	1.4	11.2	7.6	0	0	100	100	99	98	0.3	4.6
Taylor-Farm 247 Road	2022	8344	363	1.2	0.3	0.5	1	8.1	10.5	60.3	38.9	0	1	99	100	99	100	1.2	
Taylor-SouthHill	2022	8361	365	0.4	0.1	0.2	0.4	1.9	2.9	21.6	10.8	0	0	100	100	100	100	0.4	9.1
Taylor-Townsite	2022	8309	363	0.8	0.1	0.3	0.5	6.9	10.6	27.9	25.1	0	0	100	98	100	100	0.8	26.7
Terrace	2022	8115	352	0.3	0.1	0.2	0.4	0.8	1	2	1.7	0	0	100	86	100	100	0.3	3.3
Trail-Butler Park	2022	8235	355	4.5	0.3	1	3.8	38.2	52.7	155.5	124.8	29	55	90	99	100	100	4.5	167.2
Trail-Airport	2022	8350	364	2.3	0.4	0.7	2.1	15.8	20.8	53.3	42.4	0	1	99	100	100	100	2.3	52.4
Tsawwassen	2022	8715	363	0.2	0.1	0.2	0.3	0.5	0.6	1.4	1.1	0	0	100	99	99	100	0.2	1.8
Richmond-Airport	2022	8559	357	0.3	0.1	0.2	0.4	1.1	1.4	4.8	2.8	0	0	98	93	100	100	0.3	4.7
Vancouver-Downtown	2022	7397	309	0.3	0.1	0.2	0.4	1.6	2	4.7	4.2	0	0	100	93	95	51		5.9
Victoria	2022	7996	348	0.2	0.1	0.2	0.3	1.2	1.6	5.7	3.9	0	0	92	100	100	89	0.2	4.6
Warfield Elementary	2022	8238	357	4.8	0.3	0.6	2.8	43.4	65.7	332.3	201.8	43	62	93	100	98	100	4.8	221.3

*CAAQS metrics for SO_2 are an annual metric based on the average of all 1-hour concentrations over the year, and a 1-hour metric based on the 99th percentile of the daily maximum 1-hour concentration averaged over three years.

**Measurements were taken from two monitoring stations: Quesnel Kinchant St., and Quesnel Johnston Ave.

2022 Nitrogen Dioxide (continued)

Site	Year	No. Valid Hrs	No. Valid Days	Annual Avg	Percentiles (1h)					Max 1h	Annual 98th Percentile of Daily 1-Hour Maximum	No. Days		% of Valid Days Per Quarter				CAAQS NO_2 Metrics*	
					25th	50th	75th	98th	99th			>42 ppb	>60 ppb	Q1	Q2	Q3	Q4	Annual	1-Hour
Abbotsford-Airport	2022	8743	365	7.2	2.9	5.6	10.3	21.3	23.2	35	27.2	0	0	100	100	100	100	7.2	27.8
Abbotsford-Mill Lake	2022	8732	364	7.9	3.4	6.2	11.3	23.1	25.9	37	31.1	0	0	100	100	100	99	7.9	31.6
Agassiz	2022	8658	362	7.5	3	5.5	11	22.1	24.5	39	31.2	0	0	97	100	100	100	7.5	28.8
Burnaby-Kensington Park	2022	8735	365	10.1	5	8.6	13.8	27.4	30.1	47.2	36.3	1	0	100	100	100	100	10.1	34.1
Burnaby-Mtn	2022	8635	360	7	3.1	5.6	9.1	23.6	27.5	41	32.5	0	0	96	100	100	99	7	30.4
Burnaby-South	2022	8700	364	11.7	6.1	10.2	16.1	29.1	31.4	49.5	37	3	0	100	100	99	100	11.7	36.8
Castlegar	2022	8350	362	5.5	1.9	4	7.9	18.4	20.7	37.8	25.3	0	0	100	99	100	98	5.5	25.6
Chilliwack	2022	8742	365	7.7	3.4	6.2	11	21.6	24.4	37.3	31.5	0	0	100	100	100	100	7.7	29.5
Colwood	2022	8269	362	4.1	1.1	2.9	5.7	15.2	17	25.1	22.6	0	0	100	100	98	99	4.1	22.4
Coquitlam	2022	8672	363	9.3	4.2	7.5	13	26.4	28.9	52.5	33.1	1	0	100	100	98	100	9.3	31.7
Courtenay	2022	8135	350	3.2	1.1	2.1	4.1	12.7	15.2	26.1	21.6	0	0	100	99	95	90	3.2	21.9
Cranbrook	2022	8378	365	4.1	0.9	2	5.3	20.7	23.7	43.2	28.1	1	0	100	100	100	100	4.1	27.2
Duncan	2022	8341	363	3.9	1.5	2.9	5.3	13.9	15.7	25	21	0	0	100	100	100	98	3.9	21.3
Farmington	2022	8551	360	2.2	0.5	1.3	2.7	11.1	13.7	25.1	19.5	0	0	98	98	99	100	2.2	18.6
FortSt.John	2022	8382	365	6	1.4	3	7	30.9	38.1	87.9	50.7	14	3	100	100	100	100	6	47.5
Fort St.John-N.CampC	2022	8696	364	3.9	1.2	2.6	5	16.1	19.4	36.7	26.3	0	0	100	100	100	99	3.9	27.3
Hope	2022	8625	360	7.1	3.1	5.8	9.8	20.6	22.9	35.3	28.2	0	0	99	100	100	96	7.1	25
Horseshoe Bay	2022	8688	363	11.1	4.8	9.5	15.5	32.6	37.1	65.3	46.3	18	1	98	100	100	100	11.1	
Hudson's Hope	2022	8380	358	2.1	0.5	1.1	2.6	10.8	12.9	24.4	17.5	0	0	99	93	100	100	2.1	19.6
Kamloops	2022	8385	365	10.9	4.5	8.4	15.7	32.1	35.3	46.7	40.9	4	0	100	100	100	100	10.9	38.4
Kelowna	2022	8388	365	5.4	2.2	4	6.9	19.2	23	36.1	28.2	0	0	100	100	100	100	5.4	26.4
Kitimat-Whitesail	2022	7034	305	1.3	0.6	0.9	1.4	6.3	8.5	21.4	13.4	0	0	99	96	48	92		14.3
Langdale	2022	8337	362	4.2	1.8	3.4	5.7	13.2	15.2	37.1	23.1	0	0	99	100	100	98	4.2	21.7
Langley	2022	8732	365	6.1	2.8	4.7	8.1	19.3	21.9	28.3	25.8	0	0	100	100	100	100	6.1	23.5
Maple Ridge	2022	8686	362	7.7	3.2	6.1	10.6	23.2	26.4	44.2	32.8	2	0	100	100	100	97	7.7	29.8
Merritt-NicolaAve	2022	7209	313	6.2	2.6	4.5	8.3	20.6	23	39.1	27	0	0	44	100	98	100		
Mission	2022	8069	336	7.1	2.8	5.1	9.8	22.7	25.3	40.1	30.5	0	0	100	68	100	100	7.1	27.9
Nanaimo	2022	8337	364	5.2	1.9	3.9	7.1	17.5	19.6	38	27	0	0	100	99	100	100	5.2	25.8
New Westminster	2022	7480	310	16.6	11	16.4	21.6	33.4	36.9	58.7	45.6	11	0	100	73	67	100	16.6	40.7
North Delta	2022	8738	365	11.4	5.1	9.4	16.6	30.5	33	48.1	40.7	3	0	100	100	100	100	11.4	39.1
N.Vancouver-Mahon Park	2022	8746	365	11	5	9	15.6	29.8	31.7	40.8	36.5	0	0	100	100	100	100	11	35.9
N.Vancouver-2nd Narrows	2022	8726	365	13.2	6.8	11	17.6	35.6	38.9	68.1	50.1	24	3	100	100	100	100	13.2	52.7
Pitt Meadows	2022	8721	365	8.2	2.8	6.6	11.8	25.7	28.5	47.8	36.2	1	0	100	100	100	100	8.2	34.1
Port Edward-Sunset Drive	2022	6855	287	1.9	0.4	1.5	3	6.7	7.8	16.3	12.4	0	0	16	99	100	99		
Port Moody	2022	8704	365	11.7	6.4	10.7	15.9	27.8	29.8	52.3	37	3	0	100	100	100	100	11.7	35.9
Prince George-Plaza 400	2022	8332	362	8.6	2.6	5.9	12.2	31.4	34.7	49.9	41.8	7	0	97	100	100	100	8.6	40.8
Prince Rupert-Fairview	2022	8613	362	4	1.2	2.7	5.8	14.8	17.1	34.5	22.4	0	0	100	97	100	100	4	23.1
Quesnel**	2022	8390	365	4.3	1.3	2.7	5.7	17.9	19.8	29.2	24	0	0	100	100	100	100	4.3	32.1
Richmond-South	2022	8697	365	10.4	3.8	8.7	15.7	28.6	30.9	38.5	34.6	0	0	100	100	100	100	10.4	35.3
Smithers	2022	8373	363	7	3.3	5.4	9.7	19.8	21.4	30.6	24.3	0	0	100	100	100	98	7	26
Sparwood	2022	8301	364	5.8	2.1	4	7.8	21.9	24.8	36.7	31.6	0	0	100	100	100	99	5.8	
Squamish	2022	8406	361	5.3	2.4	4.3	7.1	17	19.5	33.4	24.5	0	0	99	99	98	100	5.3	23.2
Surrey East	2022	8628	360	7.9	3.4	6	10.9	24.1	25.7	36.7	29.9	0	0	94	100	100	100	7.9	30.9

2022 Nitrogen Dioxide (continued)

Site	Year	No. Valid Hrs	No. Valid Days	Annual Avg	Percentiles (1h)					Max 1h	Annual 98th Percentile of Daily 1-Hour Maximum	No. Days		% of Valid Days Per Quarter				CAAQS NO_2 Metrics*	
					25th	50th	75th	98th	99th			>42 ppb	>60 ppb	Q1	Q2	Q3	Q4	Annual	1-Hour
Taylor-Farm 247 Road	2022	8303	355	2	0.7	1.4	2.5	8.1	10.2	21.3	14.9	0	0	97	97	97	99	2	
Taylor-Townsite	2022	8251	350	5	1	2.7	6.4	24.7	28.2	47.9	37.6	2	0	97	95	97	96	5	36.4
Terrace	2022	7951	343	2.6	0.7	1.3	3	13.6	15.9	25.4	21.2	0	0	100	76	100	100	2.6	22.6
Tsawwassen	2022	8726	364	5.9	2.2	4.2	7.9	21.1	23.3	41.2	28.4	0	0	100	99	100	100	5.9	29
Vancouver-ClarkDr	2022	8172	341	16	9.4	15.3	21.8	34.6	37.2	48	41.8	6	0	90	85	100	99	16	44.1
Richmond-Airport	2022	8557	357	12.3	5.6	10.5	17.9	31.1	33.3	50.2	39.8	2	0	98	93	100	100	12.3	39.2
Vancouver-Downtown	2022	7429	310	15.5	9.4	14.5	20.9	32.5	35.2	47.2	40	4	0	100	97	95	49		39.3
Vernon	2022	8388	365	8.8	3.7	6.4	11.9	28.3	31.5	43.1	36	1	0	100	100	100	100	8.8	36.2
Victoria	2022	8275	360	6.7	2.4	5	9.2	22.8	25.8	42.4	34.2	1	0	100	100	95	100	6.7	33.2
Whistler	2022	8436	362	3.3	1.1	2.1	4.2	13.5	15.3	30.7	19.7	0	0	99	99	100	99	3.3	20.1

*CAAQS metrics for NO_2 are an annual metric based on the average of all 1-hour concentrations over the year, and a 1-hour metric based on the 98th percentile of the daily maximum 1-hour concentration averaged over three years.

**Measurements were taken from two monitoring stations: Quesnel Kinchant St., and Quesnel Johnston