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INDOOR AIR QUALITY TRENDS ACROSS CANADA DURING THE 2020 COVID-19 PANDEMIC

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Consulting Services for
Indoor air quality
Mould, Occupational Hygiene
Hazardous materials

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1.0 INTRODUCTION

Sterling IAQ Consultants Ltd. (Sterling IAQ) and its team members have been conducting annual proactive indoor air quality testing in commercial buildings across Canada for over 20 years.

In March 2020, the outbreak of the virus SARS- CoV-2 (popularly known as Covid-19) drastically changed the way physical interactions in business environments take place. After a couple of months of total lockdown that initiated in mid-March 2020 in several provinces across Canada, non-essential service workers were allowed to return to business as long as they followed the provincial health officer orders. That led to an increase on the use of hand sanitizers in closed spaces that might have had an effect on indoor air quality.

Since we have many years of indoor and outdoor air quality testing data from across Canada, Sterling IAQ determined it would be interesting to prepare a report that discusses how the Covid-19 pandemic changed indoor air quality in business environments.

This report was compiled based on IAQ tests conducted in 15 different buildings scattered across different provinces in Canada and are summarized below:

British Columbia

Building A

238,285 ft² office building located in Vancouver.

Building B

317,634 ft² office building situated in Burnaby.

Building C

381,644 ft² office building located in Vancouver.

Building D

550,000 ft² office building sited in Surrey.

Building E

50,035 ft² office building situated in Burnaby.



Alberta

Building F

850,000 ft² office building located in Calgary.

Building G

184,000 ft² office building sited in Calgary.

Building H

159,000 ft² office building situated in Calgary.

Building I

399,928 ft² office building located in Edmonton.

Building J

682,024 ft² office building situated in Calgary.

Ontario

Building K

177,871 ft² office building sited in Toronto.

Building L

189,210 ft² office building located in Markham.

Building M

934,630 ft² office building and retail space situated in Toronto.

Building N

57,605 ft² office building located in Toronto.

Building O

154,378 ft² office building sited in Toronto.



2.0 SCOPE OF WORK

Sterling IAQ conducts the following scope of work when we complete proactive indoor air quality testing.

- Measurement of common indoor air quality (IAQ) parameters in various sites within the subject area using direct reading instantaneous monitors:
 - Total volatile organic compounds (TVOC) – as an indicator of potential off-gassing building materials or other indoor sources of organic compounds.
 - Carbon dioxide (CO₂) – as an indicator of the effectiveness of the ventilation system at providing sufficient amounts of outdoor air to the occupied spaces of a building.
 - Carbon monoxide (CO) – as a measurement of combustion sources potentially affecting the indoor air quality.
 - Temperature & relative humidity – comfort parameters.
 - Particulates (PM₁₀) – as a measurement of the ability of the ventilation system to remove particulate from the outdoor air and as a measurement of potential indoor sources of particulate.

For the purpose of this report on the Covid-19 pandemic, we will focus only on TVOCs, CO₂, and PM₁₀ measurements as they appear to be most applicable due to the rise on the use of hand sanitizers and possible increase of outdoor air ventilation and filtration in office buildings.

3.0 METHODOLOGY

Indoor Air Quality Monitoring

Indoor air quality monitoring was conducted by our trained site technicians using properly calibrated direct reading instantaneous instruments. For the detection of TVOCs and carbon dioxide, the Graywolf IQ610 Air Quality Probe was used. Measurements for particulates were acquired using a Thermo Scientific pDR-1500 particulate meter. These instruments were connected to an AdvancedSense handheld computer and logged data instantaneously on site while Sterling IAQ denoted locations of testing.



4.0 APPLICABLE GUIDELINES

Carbon Dioxide (CO₂)

With respect to indoor air quality in office environments, Part 4 (sections 4.70 to 4.80) of the WorksafeBC Occupational Health and Safety Regulation offers some guidance. Even though the WorksafeBC OHS Regulation does not apply to other provinces outside of British Columbia, its specific indoor air quality regulations are transferrable to other areas since these other jurisdictions do not have regulations pertaining to indoor air quality.

In addition to requirements for design and operation, effective distribution of outdoor air, proper balancing of ventilation system and preventative maintenance of ventilation system, section 4.79(1) of the WorksafeBC Occupational Health and Safety Regulation states:

“The employer must ensure that the indoor air quality is investigated when ... complaints are reported.”

Section 4.79(2) even suggests:

“An air quality investigation must include assessment of the ventilation rate, unless the indoor carbon dioxide level is less than 650 ppm above ambient outdoor levels”.

For example, given the average outdoor CO₂ level of 433 ppm determined by Sterling IAQ after years of indoor and outdoor air quality testing, an assessment of the ventilation rate would not be required until indoor CO₂ concentrations measure at least 1,083 ppm.

It is important to understand that the carbon dioxide measurements are an important part of an indoor air quality investigation but should not be considered a measurement of a toxic contaminant. For example, the WorkSafeBC Regulation states:

“carbon dioxide is considered a marker indicator of sufficient outdoor air, not as a toxic air contaminant for which the exposure limit established by section 5.48 would apply”.



Total Volatile Organic Compounds (TVOC)

There is much literature available for guideline levels related to TVOC. Sterling IAQ has been involved with the development of indoor air quality guidelines and standards and has reviewed much of the data available regarding TVOCs.

Based on our experience and review of the available data, Sterling IAQ has developed a guideline of 500 parts per billion (ppb) or 0.5 parts per million (ppm) for TVOCs when evaluated with direct reading instrumentation.

It is important to note that the development of this guideline took into account comfort and odour primarily – not health. Therefore, should TVOC readings exceed this guideline, health is not necessarily affected, but comfort may be.

Particulate (PM₁₀)

For the purpose of reporting on our proactive indoor air quality testing projects, we have been referencing the Canada Green Building Corporation (CaGBC) for a PM₁₀ guideline of 50 µg/m³.

We understand there are many guidelines available for PM₁₀ around the world but believe this CaGBC guideline is the most practical for the intent of our testing and reporting.



5.0 RESULTS AND DISCUSSION

Some observations and historical data should be presented regarding the sites tested between May 19, 2020 and October 16, 2020:

- Through reference to our extensive database of indoor and outdoor testing data, the historical **OUTDOOR** PM₁₀ concentration across Canada is 24.1 µg/m³.
- Additionally, through reference to our extensive database of indoor and outdoor testing data, the historical **INDOOR** PM₁₀ concentration across Canada is 11.2 µg/m³.
- All sites visited during the period of this assessment were only partially open to the public (appointment only) and/or were operating at 50% of its maximum capacity due to Covid-19 distancing restrictions.
- All sites tested during the times where wildfire smoke from the United States affected western Canada from September 10, 2020 to September 23, 2020 and from October 2, 2020 to October 6, 2020 are not included in this list. A separate report on the matter can be found at [Sterling IAQ Consultants](#) website.

5.1 Indoor Air Quality Monitoring in Building A

A comparison between TVOC, CO₂, and PM₁₀ data acquired in 2020 and 2019 can be found in **Table 5.1.1**.

Table 5.1.1 – Measurements in Building A (Vancouver, BC)
August 11, 2020 & May 14, 2019

	TVOC (ppb) 2020	TVOC (ppb) 2019	CO ₂ (ppm) 2020	CO ₂ (ppm) 2019	PM ₁₀ (µg/m ³) 2020	PM ₁₀ (µg/m ³) 2019
Minimum	27.0	46.0	391.0	409.0	8.2	11.6
Maximum	219.0	94.0	560.0	843.0	15.4	19.6
Average	52.5	59.6	454.6	546.5	10.2	13.5
Outdoors	37.5	54.0	413.5	387.0	18.2	21.6

ppb – parts per billion ppm – parts per million µg/m³ – micrograms per cubic meter



TVOC measurements in Building A did not show a notable difference in averaged numbers apart from the maximum measurement taken on site. In 2019, the maximum TVOC measurement was 94 ppb while in 2020 the measurement jumped to 219 ppb which possibly indicated an increase in the use of hand sanitizers and cleaning chemicals.

But on an overall building perspective, TVOC results in 2020 appeared similar to that from 2019 and the use of hand sanitizers did not appear to have caused a notable difference.

Building A appeared to provide good filtration of particulate indoor PM_{10} concentrations not only remained consistently below the guideline of $50 \mu g/m^3$ in 2020 but also decreased from 2019.

In 2019, there was roughly a 37.5% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). In 2020, there was roughly a 44% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). This could suggest the filtration had been upgraded and therefore, a higher level of filtration was offered. But in reality, this difference is negligible and results from 2020 were essentially the same as measured in 2019.

CO_2 levels also dropped in comparison to 2019 indicating that good ventilation was provided by the HVAC system in the building.

It is also worth mentioning that a common health and safety guideline across provinces and territories in Canada is to maintain business at a maximum of 50% capacity which shifted employees from office buildings to their offices at home. The latter caused the number of people occupying office spaces to drop thus possibly helping the drop in CO_2 levels in said spaces.



5.2 Indoor Air Quality Monitoring in Building B

A comparison between TVOC, CO₂, and PM₁₀ data acquired in 2020 and 2019 can be found in **Table 5.2.1**.

Table 5.2.1 – Measurements in Building B (Burnaby, BC)
September 2, 2020 & July 29, 2019

	TVOC (ppb) 2020	TVOC (ppb) 2019	CO ₂ (ppm) 2020	CO ₂ (ppm) 2019	PM ₁₀ (µg/m ³) 2020	PM ₁₀ (µg/m ³) 2019
Minimum	80.0	65.0	516.0	457.0	9.8	9.2
Maximum	327.0	220.0	786.0	962.0	27.0	29.2
Average	116.8	93.0	610.9	613.1	12.3	11.3
Outdoors	78.5	76.0	449.5	420.5	30.2	17.3

ppb – parts per billion ppm – parts per million µg/m³ – micrograms per cubic meter

TVOC results from Building B showed a slight increase in TVOC levels. Minimum and maximum numbers saw a rise that remained consistent throughout the building which resulted in a higher average in 2020 than the previous year.

Therefore, data from Building B did suggest that the use of hand sanitizers has slightly increased TVOC concentrations throughout the building.

CO₂ averaged measurement within the building dropped slightly thus indicating the building still provided good ventilation with outdoor air. This slight decrease could be associated with the lack of employees present in the office space or with an increase in ventilation efforts.

Indoor PM₁₀ concentrations for Building B in 2020 presented little difference when compared to 2019. However, when comparing indoor:outdoor ratio of particulate for Building B, the 2020 results did actually show a much higher level of filtration.

In 2019, there was roughly a 34.7% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). In 2020, there was roughly a 59.3% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). This could suggest the filtration had been upgraded and therefore, a higher level of filtration was offered.



5.3 Indoor Air Quality Monitoring in Building C

A comparison between TVOC, CO₂, and PM₁₀ data acquired in 2020 and 2019 can be found in **Table 5.3.1**.

Table 5.3.1 – Measurements in Building C (Vancouver, BC)
August 25, 2020 & May 21, 2019

	TVOC (ppb) 2020	TVOC (ppb) 2019	CO ₂ (ppm) 2020	CO ₂ (ppm) 2019	PM ₁₀ (µg/m ³) 2020	PM ₁₀ (µg/m ³) 2019
Minimum	74.0	46.0	466.0	363.0	10.8	11.6
Maximum	365.0	118.0	728.0	646.0	23.5	19.1
Average	101.6	63.5	542.7	491.5	12.9	14.0
Outdoors	131.0	72.0	434.0	352.5	24.5	17.3

ppb – parts per billion ppm – parts per million µg/m³ – micrograms per cubic meter

The 2020 data from Building C did show a substantial increase in the TVOC concentrations when compared to 2019. The minimum, maximum, and average TVOC measurements revealed an increase suggesting that the use of hand sanitizers and other cleaning chemicals might have had an impact in indoor air quality within the building.

The PM₁₀ concentrations remained somewhat consistent between the two years of testing. However, when comparing indoor:outdoor ratio of particulate for Building C, the 2020 results did actually show a much higher level of filtration.

In 2019, there was roughly a 19.1% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). In 2020, there was roughly a 47.3% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). This could suggest the filtration had been upgraded and therefore, a higher level of filtration was offered.

CO₂ concentrations for Building C in 2020 were slightly elevated when compared to 2019. However, the 2019 CO₂ results were very low, so we are not going to make deductions from the 2020 CO₂ results from Building C.



5.4 Indoor Air Quality Monitoring in Building D

A comparison between TVOC, CO₂, and PM₁₀ data acquired in 2020 and 2019 can be found in **Table 5.4.1**.

Table 5.4.1 – Measurements in Building D (Surrey, BC)
September 28, 2020 & July 18, 2019

	TVOC (ppb) 2020	TVOC (ppb) 2019	CO ₂ (ppm) 2020	CO ₂ (ppm) 2019	PM ₁₀ (µg/m ³) 2020	PM ₁₀ (µg/m ³) 2019
Minimum	45.0	44.0	500.0	403.0	10.1	9.5
Maximum	340.0	198.0	774.0	837.0	25.3	23.0
Average	82.5	61.8	598.5	488.2	12.7	12.1
Outdoors	57.5	58.0	451.5	341.0	17.9	14.2

ppb – parts per billion ppm – parts per million µg/m³ – micrograms per cubic meter

The 2020 data from Building D did show a moderate increase in the TVOC concentrations when compared to 2019. The minimum, maximum, and average TVOC measurements revealed an increase suggesting that the use of hand sanitizers and other cleaning chemicals might have had an impact in indoor air quality within the building.

The PM₁₀ concentrations remained somewhat consistent between the two years of testing. However, when comparing indoor:outdoor ratio of particulate for Building D, the 2020 results did actually show a much higher level of filtration.

In 2019, there was roughly a 14.8% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). In 2020, there was roughly a 29.1% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). This could suggest the filtration had been upgraded and therefore, a higher level of filtration was offered.

CO₂ concentrations for Building D in 2020 were moderately elevated when compared to 2019. However, the 2019 CO₂ results were very low, so we are not going to make deductions from the 2020 CO₂ results from Building D.



5.5 Indoor Air Quality Monitoring in Building E

A comparison between PM₁₀ measurements acquired in 2020 during the smoke period and in 2019 in building E can be found at **Table 5.5.1**.

Table 5.5.1 – Measurements in Building E (Surrey, BC)
July 15, 2020 & July 15, 2019

	TVOC (ppb) 2020	TVOC (ppb) 2019	CO ₂ (ppm) 2020	CO ₂ (ppm) 2019	PM ₁₀ (µg/m ³) 2020	PM ₁₀ (µg/m ³) 2019
Minimum	79.0	47.0	452.0	422.0	9.6	25.2
Maximum	187.0	90.0	585.0	690.0	16.0	40.0
Average	111.4	63.4	520.0	594.3	11.5	29.4
Outdoors	153.5	64.0	389.5	436.5	16.8	36.3

ppb – parts per billion

ppm – parts per million

µg/m³ – micrograms per cubic meter

The 2020 data from Building E did show a significant increase in the TVOC concentrations when compared to 2019. The minimum, maximum, and average TVOC measurements revealed an increase suggesting that the use of hand sanitizers and other cleaning chemicals might have had an impact in indoor air quality within the building.

The PM₁₀ concentrations from Building E in 2020 were notably lower than measured in 2019. This is expected to be the result of the 2020 outdoor PM₁₀ results also be notably lower than measured in 2019. However, when comparing indoor:outdoor ratio of particulate for Building E, the 2020 results did actually show a much higher level of filtration.

In 2019, there was roughly a 19% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). In 2020, there was roughly a 31.5% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). This could suggest the filtration had been upgraded and therefore, a higher level of filtration was offered.

CO₂ concentrations for Building E in 2020 were slightly lower when compared to 2019. This could have been the result of higher levels of ventilation or lower occupant density due to COVID restrictions.



5.6 Indoor Air Quality Monitoring in Building F

A comparison between TVOC, CO₂, and PM₁₀ data acquired in 2020 and 2019 can be found in **Table 5.6.1**.

Table 5.6.1 – Measurements in Building F (Calgary, AB)
May 28, 2020 & August 12, 2019

	TVOC (ppb) 2020	TVOC (ppb) 2019	CO ₂ (ppm) 2020	CO ₂ (ppm) 2019	PM ₁₀ (µg/m ³) 2020	PM ₁₀ (µg/m ³) 2019
Minimum	0.0	0.0	390.0	343.0	1.0	14.4
Maximum	51.0	158.0	464.0	680.0	10.0	28.2
Average	0.5	19.3	402.9	472.9	4.3	19.2
Outdoors	0.0	0.0	397.8	395.0	3.9	12.7

ppb – parts per billion ppm – parts per million µg/m³ – micrograms per cubic meter

All of this IAQ data from 2020 showed dramatic reductions compared to 2019. Because this testing was actually conducted in May of 2020, it is expected that occupancy was very low and therefore not very representative of the partial occupant loading we encountered in other buildings.



5.7 Indoor Air Quality Monitoring in Building G

A comparison between TVOC, CO₂, and PM₁₀ data acquired in 2020 and 2019 can be found in **Table 5.7.1**.

Table 5.7.1 – Measurements in Building G (Calgary, AB)
July 20, 2020 & February 7, 2019

	TVOC (ppb) 2020	TVOC (ppb) 2019	CO ₂ (ppm) 2020	CO ₂ (ppm) 2019	PM ₁₀ (µg/m ³) 2020	PM ₁₀ (µg/m ³) 2019
Minimum	0.0	0.0	381.0	367.0	1.0	3.4
Maximum	376.0	95.0	501.0	714.0	24.0	45.8
Average	19.2	18.1	410.8	467.5	7.3	12.3
Outdoors	46.0	3.2	391.5	567.0	10.0	12.6

ppb – parts per billion ppm – parts per million µg/m³ – micrograms per cubic meter

The 2020 data from Building G showed results consistent with TVOC concentrations from 2019. Therefore, there did not appear to have been an impact from the use of hand sanitizers or other cleaning chemicals.

The PM₁₀ concentrations from Building G in 2020 were slightly lower than measured in 2019. This is expected to be the result of the 2020 outdoor PM₁₀ results also be notably lower than measured in 2019. However, when comparing indoor:outdoor ratio of particulate for Building G, the 2020 results did actually show a much higher level of filtration.

In 2019, there was roughly a 2.4% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). In 2020, there was roughly a 27% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). This could suggest the filtration had been upgraded and therefore, a higher level of filtration was offered.

CO₂ concentrations for Building G in 2020 were slightly lower when compared to 2019. This could have been the result of higher levels of ventilation or lower occupant density due to COVID restrictions.



5.8 Indoor Air Quality Monitoring in Building H

A comparison between TVOC, CO₂, and PM₁₀ data acquired in 2020 and 2019 can be found in **Table 5.8.1**.

Table 5.8.1 – Measurements in Building H (Calgary, AB)
June 10, 2020 & June 5, 2019

	TVOC (ppb) 2020	TVOC (ppb) 2019	CO ₂ (ppm) 2020	CO ₂ (ppm) 2019	PM ₁₀ (µg/m ³) 2020	PM ₁₀ (µg/m ³) 2019
Minimum	0.0	0.0	402.0	398.0	0.0	5.5
Maximum	339.0	1148.0	780.0	879.0	110.0	24.7
Average	8.3	23.5	462.0	515.5	2.4	11.9
Outdoors	0.0	0.0	415.5	526.5	10.5	53.0

ppb – parts per billion ppm – parts per million µg/m³ – micrograms per cubic meter

The 2020 TVOC data from Building H showed results much lower than measured in 2019. Therefore, there did not appear to have been an impact from the use of hand sanitizers or other cleaning chemicals.

The PM₁₀ concentrations from Building H in 2020 were significantly lower than measured in 2019. This is expected to be the result of the 2020 outdoor PM₁₀ results also be notably lower than measured in 2019. Additionally, when comparing indoor:outdoor ratio of particulate for Building H, the 2020 results were quite consistent with 2019 results.

In 2019, there was roughly a 77.5% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). In 2020, there was roughly a 77.1% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). This data suggests similar levels of filtration between 2019 and 2020 for Building H.

CO₂ concentrations for Building H in 2020 were slightly lower when compared to 2019. This could have been the result of higher levels of ventilation or lower occupant density due to COVID restrictions.



5.9 Indoor Air Quality Monitoring in Building I

A comparison between TVOC, CO₂, and PM₁₀ data acquired in 2020 and 2019 can be found in **Table 5.9.1**.

Table 5.9.1 – Measurements in Building I (Edmonton, AB)
May 22, 2020 & October 19, 2019

	TVOC (ppb) 2020	TVOC (ppb) 2019	CO ₂ (ppm) 2020	CO ₂ (ppm) 2019	PM ₁₀ (µg/m ³) 2020	PM ₁₀ (µg/m ³) 2019
Minimum	0.0	88.0	435.0	462.0	1.0	1.4
Maximum	450.0	904.0	633.0	758.0	9.0	24.0
Average	25.1	132.0	507.0	547.6	2.8	3.7
Outdoors	0.0	142.5	406.0	417.5	1.5	6.2

ppb – parts per billion ppm – parts per million µg/m³ – micrograms per cubic meter

The 2020 TVOC data from Building I showed results much lower than measured in 2019. Therefore, there did not appear to have been an impact from the use of hand sanitizers or other cleaning chemicals. However, testing was conducted in May 2020 when building occupant density was noted to be very low.

The PM₁₀ concentrations from Building I in 2020 were quite consistent with those measured in 2019. Outdoor PM₁₀ results were so low in 2020 that indoors was actually shown to be higher than outside.

CO₂ concentrations for Building I in 2020 were slightly lower when compared to 2019. This could have been the result of higher levels of ventilation or lower occupant density due to COVID restrictions.



5.10 Indoor Air Quality Monitoring in Building J

A comparison between TVOC, CO₂, and PM₁₀ data acquired in 2020 and 2019 can be found in **Table 5.10.1**.

Table 5.10.1 – Measurements in Building J (Calgary, AB)
May 19, 2020 & July 22, 2019

	TVOC (ppb) 2020	TVOC (ppb) 2019	CO ₂ (ppm) 2020	CO ₂ (ppm) 2019	PM ₁₀ (µg/m ³) 2020	PM ₁₀ (µg/m ³) 2019
Minimum	0.0	100.0	385.0	400.0	2.0	9.7
Maximum	115.0	299.0	560.0	599.0	15.0	26.2
Average	1.5	200.3	413.9	462.3	6.0	11.6
Outdoors	0.0	155.3	407.5	411.3	26.5	16.5

ppb – parts per billion ppm – parts per million µg/m³ – micrograms per cubic meter

The 2020 TVOC data from Building J showed results much lower than measured in 2019. Therefore, there did not appear to have been an impact from the use of hand sanitizers or other cleaning chemicals. However, testing was conducted in May 2020 when building occupant density was noted be very low.

The PM₁₀ concentrations from Building J in 2020 were significantly lower than measured in 2019. However, when comparing indoor:outdoor ratio of particulate for Building J, the 2020 results did actually show a much higher level of filtration.

In 2019, there was roughly a 29.7% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). In 2020, there was roughly a 77.4% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data).

CO₂ concentrations for Building J in 2020 were slightly lower when compared to 2019. This could have been the result of higher levels of ventilation or lower occupant density due to COVID restrictions.



5.11 Indoor Air Quality Monitoring in Building K

A comparison between TVOC, CO₂, and PM₁₀ data acquired in 2020 and 2019 can be found in **Table 5.11.1**.

Table 5.11.1 – Measurements in Building K (Toronto, ON)
October 16, 2020 & October 11, 2019

	TVOC (ppb) 2020	TVOC (ppb) 2019	CO ₂ (ppm) 2020	CO ₂ (ppm) 2019	PM ₁₀ (µg/m ³) 2020	PM ₁₀ (µg/m ³) 2019
Minimum	0.0	0.0	393.0	423.0	1.0	5.0
Maximum	56.0	158.0	492.0	689.0	10.0	16.0
Average	1.6	19.3	421.3	541.3	1.8	8.9
Outdoors	0.0	0.0	397.0	449.5	12.5	13.0

ppb – parts per billion ppm – parts per million µg/m³ – micrograms per cubic meter

The 2020 TVOC data from Building K showed results much lower than measured in 2019. Therefore, there did not appear to have been an impact from the use of hand sanitizers or other cleaning chemicals.

The PM₁₀ concentrations from Building K in 2020 were significantly lower than measured in 2019. When comparing indoor:outdoor ratio of particulate for Building K, the 2020 results did also show a much higher level of filtration.

In 2019, there was roughly a 31.5% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). In 2020, there was roughly a 85.6% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data).

CO₂ concentrations for Building K in 2020 were significantly lower when compared to 2019. This could have been the result of higher levels of ventilation or lower occupant density due to COVID restrictions.



5.12 Indoor Air Quality Monitoring in Building L

A comparison between TVOC, CO₂, and PM₁₀ data acquired in 2020 and 2019 can be found in **Table 5.12.1**.

Table 5.12.1 – Measurements in Building L (Markham, ON)
October 8, 2020 & July 18, 2019

	TVOC (ppb) 2020	TVOC (ppb) 2019	CO ₂ (ppm) 2020	CO ₂ (ppm) 2019	PM ₁₀ (µg/m ³) 2020	PM ₁₀ (µg/m ³) 2019
Minimum	0.0	0.0	390.0	407.0	1.0	0.0
Maximum	25.0	82.0	507.0	797.0	21.0	14.0
Average	14.3	13.1	407.6	571.9	2.5	2.5
Outdoors	14.0	8.5	366.5	386.0	6.5	23.5

ppb – parts per billion ppm – parts per million µg/m³ – micrograms per cubic meter

The 2020 TVOC data from Building L showed results slightly higher than measured in 2019. Therefore, there did not appear to have been an impact from the use of hand sanitizers or other cleaning chemicals.

The PM₁₀ concentrations from Building K in 2020 were essentially the same as measured in 2019. However, when comparing indoor:outdoor ratio of particulate for Building K, the 2020 results did actually show a much lower level of filtration because outdoors was much lower than in 2019.

In 2019, there was roughly a 89.4% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). In 2020, there was roughly a 61.5% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data).

CO₂ concentrations for Building K in 2020 were significantly lower when compared to 2019. This could have been the result of higher levels of ventilation or lower occupant density due to COVID restrictions.



5.13 Indoor Air Quality Monitoring in Building M

A comparison between TVOC, CO₂, and PM₁₀ data acquired in 2020 and 2019 can be found in **Table 5.13.1**.

Table 5.13.1 – Measurements in Building M (Toronto, ON)
August 27, 2020 & April 17, 2019

	TVOC (ppb) 2020	TVOC (ppb) 2019	CO ₂ (ppm) 2020	CO ₂ (ppm) 2019	PM ₁₀ (µg/m ³) 2020	PM ₁₀ (µg/m ³) 2019
Minimum	302.0	23.0	391.0	476.0	1.0	2.3
Maximum	467.0	166.0	557.0	942.0	9.7	11.2
Average	361.9	78.2	426.6	638.9	4.6	6.4
Outdoors	168.8	76.3	400.3	390.8	21.4	20.3

ppb – parts per billion ppm – parts per million µg/m³ – micrograms per cubic meter

The 2020 TVOC data from Building M showed results significantly higher than measured in 2019. These results do appear to suggest that the use of hand sanitizers or other cleaning chemicals had a dramatic effect on the indoor air quality.

The PM₁₀ concentrations from Building M in 2020 were slightly lower than measured in 2019. However, when comparing indoor:outdoor ratio of particulate for Building M, the 2020 results did actually show a much higher level of filtration.

In 2019, there was roughly a 68.5% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). In 2020, there was roughly a 78.5% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data).

CO₂ concentrations for Building M in 2020 were significantly lower when compared to 2019. This could have been the result of higher levels of ventilation or lower occupant density due to COVID restrictions.



5.14 Indoor Air Quality Monitoring in Building N

A comparison between TVOC, CO₂, and PM₁₀ data acquired in 2020 and 2019 can be found in **Table 5.14.1**.

Table 5.14.1 – Measurements in Building N (Toronto, ON)
October 14, 2020 & October 17, 2019

	TVOC (ppb) 2020	TVOC (ppb) 2019	CO ₂ (ppm) 2020	CO ₂ (ppm) 2019	PM ₁₀ (µg/m ³) 2020	PM ₁₀ (µg/m ³) 2019
Minimum	0.0	1.0	411.0	437.0	1.0	1.0
Maximum	128.0	117.0	650.0	870.0	18.0	19.0
Average	1.6	75.9	461.5	577.2	3.7	4.5
Outdoors	0.0	0.0	417.5	450.0	28.5	17.0

ppb – parts per billion ppm – parts per million µg/m³ – micrograms per cubic meter

The 2020 TVOC data from Building N showed results significantly lower than measured in 2019. These results do NOT appear to suggest that the use of hand sanitizers or other cleaning chemicals had an effect on the indoor air quality.

The PM₁₀ concentrations from Building N in 2020 were slightly lower than measured in 2019. However, when comparing indoor:outdoor ratio of particulate for Building M, the 2020 results did actually show a much higher level of filtration.

In 2019, there was roughly a 73.5% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). In 2020, there was roughly a 87% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data).

CO₂ concentrations for Building N in 2020 were notably lower when compared to 2019. This could have been the result of higher levels of ventilation or lower occupant density due to COVID restrictions.



5.15 Indoor Air Quality Monitoring in Building O

A comparison between TVOC, CO₂, and PM₁₀ data acquired in 2020 and 2019 can be found in **Table 5.15.1**.

Table 5.15.1 – Measurements in Building O (Toronto, ON)
June 18, 2020 & May 19, 2019

	TVOC (ppb) 2020	TVOC (ppb) 2019	CO ₂ (ppm) 2020	CO ₂ (ppm) 2019	PM ₁₀ (µg/m ³) 2020	PM ₁₀ (µg/m ³) 2019
Minimum	154.0	11.0	401.0	510.0	3.5	3.1
Maximum	199.0	76.0	470.0	955.0	14.5	70.0
Average	169.3	50.6	425.5	696.8	6.1	9.1
Outdoors	189.0	14.5	428.5	369.0	18.3	14.5

ppb – parts per billion ppm – parts per million µg/m³ – micrograms per cubic meter

The 2020 TVOC data from Building O showed results significantly higher than measured in 2019. These results do appear to suggest that the use of hand sanitizers or other cleaning chemicals had a dramatic effect on the indoor air quality.

The PM₁₀ concentrations from Building O in 2020 were slightly lower than measured in 2019. When comparing indoor:outdoor ratio of particulate for Building O, the 2020 results did actually show a much higher level of filtration.

In 2019, there was roughly a 37.2% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data). In 2020, there was roughly a 66.7% particulate reduction of outdoor:indoor (when using the average outdoor data and average indoor data).

CO₂ concentrations for Building O in 2020 were significantly lower when compared to 2019. This could have been the result of higher levels of ventilation or lower occupant density due to COVID restrictions.



6.0 OVERALL SUMMARY OF RESULTS

Below is a summary of various details associated with our testing after the mid-March lockdown under Covid-19 safety guidelines established by provincial health officers:

- From May 19 to October 16, 2020, Sterling IAQ conducted proactive IAQ testing in 5 buildings across British Columbia, 5 buildings in Alberta, and 5 more buildings in Ontario, totalling 15 buildings tested.
- During the months March and April, most office employees as well as building operators and janitors were requested to stay home due to strict physical distancing rules in several provinces and territories across Canada.



6.1 Carbon Dioxide (CO₂)

Table 6.1 shows CO₂ results for all 15 buildings tested. Eleven (11) of the 15 buildings were shown to have a notable DECREASE in CO₂ concentrations in 2020 versus 2019 (highlighted in green). This notable decrease does tend to suggest a much lower occupant density in 2020 versus 2019 – which is logical given the pandemic.

One building was shown to have similar CO₂ results in 2020 versus 2019.

This table also showed that 3 buildings were shown to have a notable increase in TVOC concentrations in 2020 versus 2019. For these 3 buildings, it does appear as though the 2019 CO₂ results were very low – suggesting occupant densities happened to have been low during the 2019 testing.

Table 6.1 – Overall Summary of Carbon Dioxide Results

Building	Avg CO2 2020	Avg CO2 2019	Difference
A	454.6	546.5	-91.9
B	610.9	613.1	-2.2
C	542.7	491.5	51.2
D	598.5	488.2	110.3
E	520	594.3	-74.3
F	402.9	472.9	-70
G	410.8	467.5	-56.7
H	462	515.5	-53.5
I	507	547.6	-40.6
J	413.9	462.3	-48.4
K	421.3	541.3	-120
L	407.6	571.9	-164.3
M	426.6	638.9	-212.3
N	461.5	577.2	-115.7
O	428.5	369	59.5

All results in ppm – parts per million



6.2 Total Volatile Organic Compounds (TVOCs)

Table 6.2 shows TVOC results for all 15 buildings tested. Seven buildings were shown to have a notable DECREASE in TVOC concentrations in 2020 versus 2019 (highlighted in green). Two buildings were shown to have similar TVOC results in 2020 versus 2019.

This table also showed that 6 buildings were shown to have a notable increase in TVOC concentrations in 2020 versus 2019.

Determining whether or not the use of hand sanitizer has caused TVOC results to be increased is difficult since our CO₂ results have shown that most buildings had a much lower occupant density in 2020 versus 2019. It is important to note that **ALL buildings** that were shown to have a lower 2020 TVOC concentration than 2019 also were shown to have a lower 2020 CO₂ concentration than 2019.

Therefore, this data is suggesting that as occupant densities increase again as the pandemic nears an end, it is likely that indoor TVOC concentrations will increase if the use of hand sanitizers continues.

Table 6.2 – Overall Summary of TVOC Results

Building	Avg TVOC 2020	Avg TVOC 2019	Difference
A	52.5	59.6	-7.1
B	116.8	93	23.8
C	101.6	63.5	38.1
D	82.5	61.8	20.7
E	111.4	63.4	48
F	0.5	19.3	-18.8
G	19.2	18.1	1.1
H	8.3	23.5	-15.2
I	25.1	132	-106.9
J	1.5	200.3	-198.8
K	1.6	19.3	-17.7
L	14.3	13.1	1.2
M	361.9	78.2	283.7
N	1.6	75.9	-74.3
O	169.3	50.6	118.7

All results in ppb – parts per billion



6.3 PM₁₀

Table 6.3 shows PM₁₀ results for all 15 buildings tested. Twelve (12) of the 15 buildings were shown to have a DECREASE in PM₁₀ concentrations in 2020 versus 2019 (highlighted in green). One building was shown to have similar PM₁₀ results in 2020 versus 2019.

This table also showed that 2 buildings were shown to have a very slight increase in PM₁₀ concentrations in 2020 versus 2019.

Table 6.3 – Overall Summary of PM₁₀ Results

Building	Avg PM ₁₀ 2020	Avg PM ₁₀ 2019	Difference
A	10.2	13.5	-3.3
B	12.3	11.3	1.0
C	12.9	14.0	-1.1
D	12.7	12.1	0.6
E	11.5	29.4	-17.9
F	4.3	19.2	-14.9
G	7.3	12.3	-5.0
H	2.4	11.9	-9.5
I	2.8	3.7	-0.9
J	6.0	11.6	-5.6
K	1.8	8.9	-7.1
L	2.5	2.5	0.0
M	4.6	6.4	-1.8
N	3.7	4.5	-0.8
O	6.1	9.1	-3.0

All results in µg/m³ – micrograms per cubic meter

7.0 OVERALL CONCLUSIONS

Carbon dioxide results did confirm that occupant densities were notably lower in 2020 compared to 2019. This decrease in occupant density did appear to cause a lowering of TVOC concentrations in 2020. But many buildings did show an overall increase of TVOC concentrations in 2020 compared to 2019.

Therefore, these results are suggesting that when buildings return to normal occupant densities, then TVOC concentrations are likely to increase if the use of hand sanitizers continues.

