BREATHE EASY

COMMUNITY-LED AIR QUALITY MONITORING IN OTTAWA

succession

ECOLOGY OTTAWA ECOLOGIE OTTAWA

envirocentre OS Fund Ottawa Sustainability Fund

FONDATION FAMILIALE TROTTIER FAMILY FOUNDATION

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Acknowledgements

Our dream of a crowd-sourced air quality monitoring project would not have been possible without Ecology Ottawa's devoted volunteers. Over 150 trained for the air quality monitoring, while five more were involved in the data management, analysis and mapping effort.

A special acknowledgement is due for Robbie Venis, a Ph.D. candidate at Carleton University, who provided recommendations on data monitoring, led the data analysis, and authored parts of this report.

Succession's community partner Sierra Club Canada Foundation was central in planning the final launch event, where the results of the campaign were shared with concerned residents in Ottawa and beyond.

Our funders, the Trottier Foundation and the Ottawa Sustainability Fund from EnviroCentre, made this project possible.

Introduction

head directly to page 12 for the policy proposals

The Government of Canada estimates that 14,600 premature deaths per year in the country can be linked to air pollution from fine particulate matter, nitrogen dioxide and ozone[1]. Air pollution can negatively affect your lungs and heart. High levels of air pollution may also increase the risk of stroke or developing asthma. Indeed, one third of deaths from stroke, lung cancer and heart disease are due to air pollution[2].

Yet a lack of data makes it difficult to link national trends to local impacts. Before Succession's Breathe Easy campaign, there was no regular collection of localized air quality information across Ottawa's neighbourhoods.

While the City of Ottawa conducted an air quality monitoring pilot project between 2007 and 2009, and while Carleton University professor Paul Villeneuve studied air quality in the Experimental Farm from 2016-2017, there remains a gap in public understanding of localized air pollution effects. This project sought to target this information gap and demonstrate the need for localized air quality information.

"We may actually have been underplaying the adverse effects of air pollution on our health from cradle to grave."

Dr Ian Mudway — lecturer at Imperial College London

[1] https://www.canada.ca/en/health-canada/services/air-quality/health-effects-indoor-air-pollution.html#a2
[2] https://www.who.int/airpollution/news-and-events/how-air-pollution-is-destroying-our-health

Opportunity

Taking lessons learned from the INHALE Project conducted by Environment Hamilton and the Toronto Environmental Alliance (2014-2016), we employed the use of mobile air quality monitors to measure and map air pollution in 40 locations in the city. Over 150 volunteers generated a publicly accessible map, where air quality data is accessible to all.

"Beginning to identify some of the causes of air pollution in a neighbourhood also helps you start thinking about solutions."
The INHALE Project

As part of site selection for air quality monitoring, Ecology Ottawa prioritized areas with schools, day cares and seniors' residences, linking national data on acute risk to places where Ottawa's most vulnerable populations congregate.

Ecology Ottawa's main goal was to analyze linkages between, and present solutions towards, air pollution and climate change emissions. This allows for climate change challenges and solutions to be conceptualized using a public health frame, which may prompt more ambitious climate change mitigation measures. We hope to have contributed to an improved understanding of local air pollution challenges among the general public and decision-makers at all levels, and to have highlighted the need for improved air quality monitoring across the city.

Methodology

Breathe Easy is a community-level project which measures Ottawa's air quality. Over 150 volunteers reached out to our volunteer coordinator to help monitor Ottawa's air quality. Measurements were taken near daycares, schools, and senior centres by volunteers who walked, rolled, or rode with an easy-to-use mobile air monitoring device. Ottawa's Arboretum was monitored as a comparative location due to its significant tree density and relative distance from high-traffic roads.

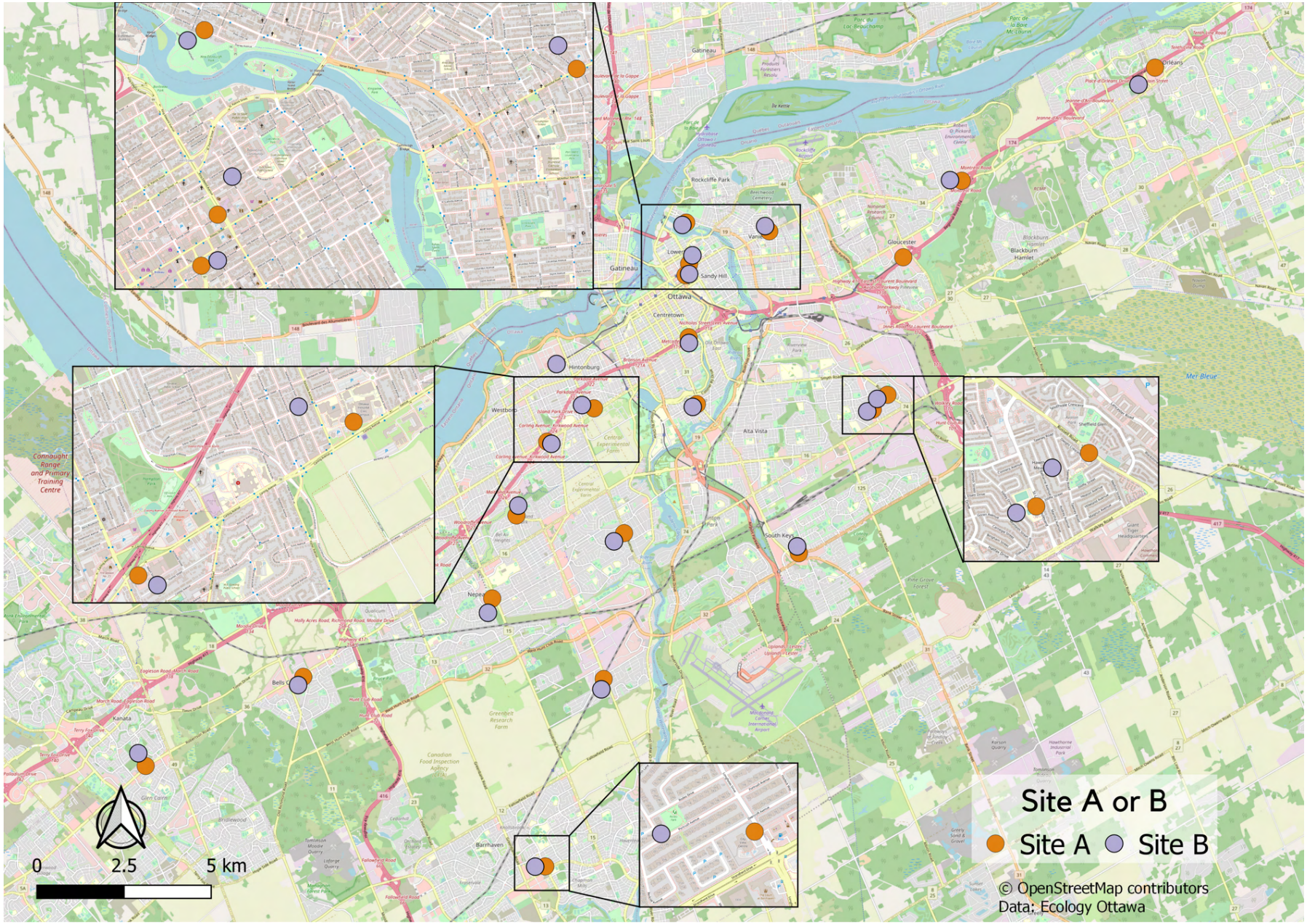
Nitrogen dioxide (NO_2) is a gaseous air pollutant produced from vehicular traffic and fossil fuel combustion. Symptoms of bronchitis in asthmatic children increase in association with long-term exposure to NO_2 as well as reduced lung function growth. Once in the atmosphere, it aids in the formation of ozone (O_3) and particulate matter (PM). Excessive ozone in the air can have a marked effect on human health. It can cause breathing problems, trigger asthma, reduce lung function and cause lung diseases.

Each site was monitored four times; during the morning and the afternoon, once during the week and once on the weekend. This structure aimed to capture snapshots of how data may change depending on differences in expected activity near each site. The air quality data, matched with GPS coordinates, was uploaded to an online map in October 2020. This tool allowed online users to identify both good and bad air quality areas in their neighbourhoods. Identifying 'hot spots' across the city for air particulate (PM2.5), ozone (O_3) and nitrogen dioxide (NO_2) pollution is an important first step in sparking community dialogue around neighbourhood-level solutions designed to improve air quality and ultimately, quality of life.

"Nothing is as elemental, as essential to human life, as the air we breathe. Yet around the world, in rich countries and poor ones, it is quietly poisoning us."

Beth Gardiner — author of
Choked: Life and Breath in the Age of Air Pollution

Locations monitored across Ottawa by Ecology Ottawa volunteers

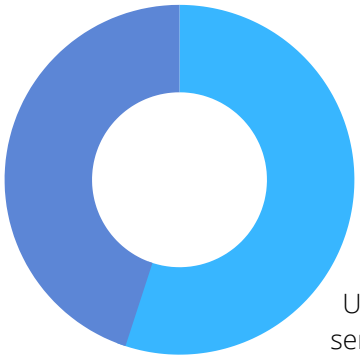


The map on the previous page shows the "Site As" and "Site Bs" monitored during the months of August and September 2020. The Site As were selected based on the fact that they were potential problem areas where vulnerable populations congregate, and the Site Bs were chosen as they are areas a few hundred meters away from the Site As, located further away from major roads. It was theorized that this methodology would allow for two different readings in proximity to one another, with a target site (Site A) contrasted with a control site (Site B).

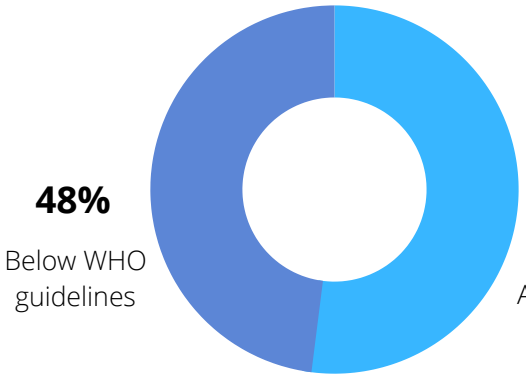
Site A	**Site B**
Villagia in the Glebe	Strathcona
Ottawa Mission	Daly/Cumberland
Andrew Fleck Children's Services	York/Nelson
Embassy West Senior Living	Thames/Meast
Mega Shelter at the Salvation Army	St Anne/Monfort Vanier
Civic Hospital Entrance	Ruskin/Hamilton
Fairfield Manor Kanata	Shearer Crescent
Place D'Orléans Play Care Center	St Pierre/Rocque
Blair Station	Tunney's Pasture Station
City View Daycare	Portrush/Rodeo Park
Peter D. Clark Centre	Mattamy Place
Hopewell Avenue Public School	Hopewell/Grosvenor
Revera Hunt Club Manor Retirement Residence	Holmes Crescent
Little Love Bugs Daycare	Castle Hill Cr/Greyrock Cr
St. Monica School	Miriam Av/Pineglen Cr
St. Rita School	Inverness Av/Goodwin Av
Service à l'enfance Aladin Childcare services	Mayood/Nerta
The Caregard Group	Hadley Cir / Wareham St
JH Putman Public School	Cline Cr/Whitmore Ave
Beacon Heights Retirement	Loyola park
Hawthorne Public School	Valley Dr/Goren Ave

Results

Please refer to Annex 1 for details on the data analysis.

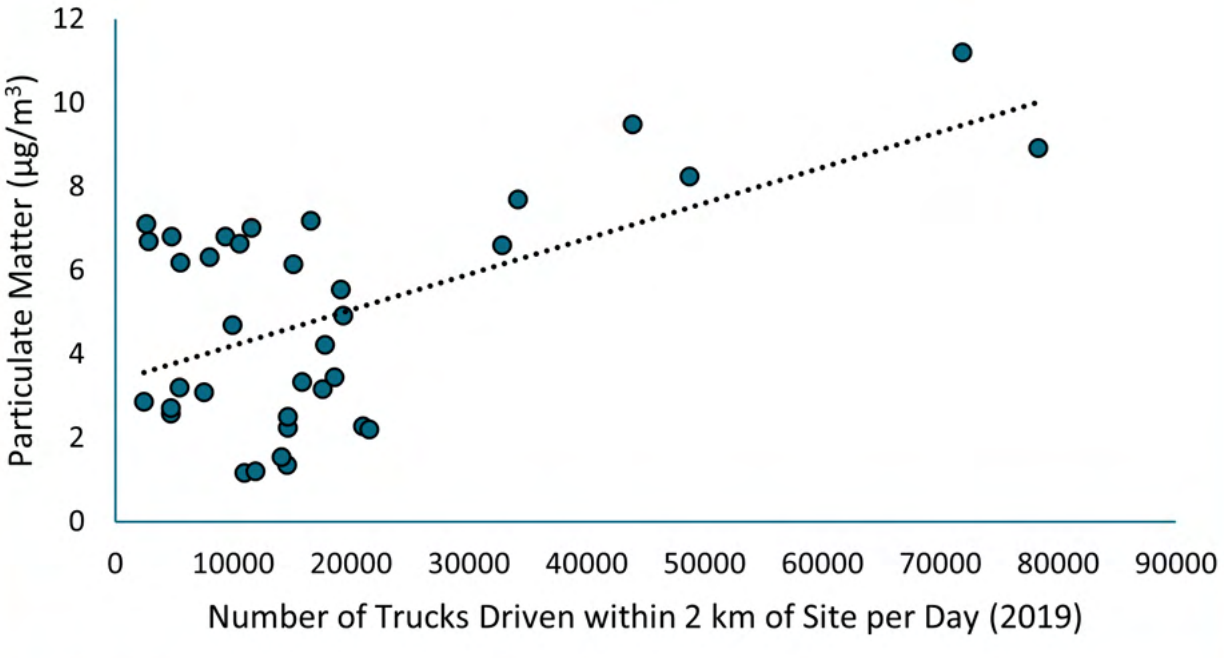


55% of all monitoring days showed levels that are unhealthy for sensitive groups. 74.2% of the times we saw pollutant levels above World Health Organization (WHO) guidelines, it was due to high levels of O_3.



52% of measurements were above the WHO's recommended "short term ingestion" limit for at least one contaminant.

Truck traffic and particulate matter at the locations monitored



Source of truck traffic data: https://open.ottawa.ca/datasets/17bd5892d1b74964953076aa3ab25b2b_0

As shown in the graph above, there is a substantive, positive correlation (57%, R=0.57) between the number of trucks driven within 2km of the Breathe Easy sites per day in 2019 and the average PM2.5 measurements taken during this study (assuming traffic patterns around the city have remained consistent since 2019).

PM2.5 can form in the air through a diversity of pathways, and can rarely be attributed to a single source [3]. Finding this significant correlation is therefore suggestive that trucks are a particularly problematic source of pollution within the city. Those living along high-volume trucking routes are therefore subject to a greater health risk than others.

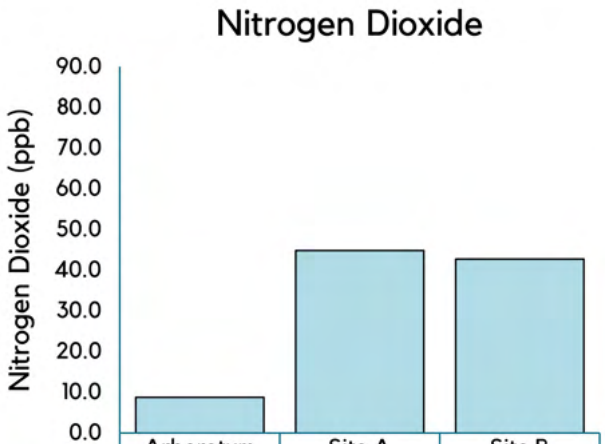
[3] https://www.epa.gov/pm-pollution/particulate-matter-pm-basics

The lowest average for PM2.5 was monitored at Andrew Fleck Children's Services on George and King Edward. With an average of 11.2mg/m3 of PM2.5, it was well below the WHO guidelines which advise a maximum of 25mg/m3 of PM2.5. This is good news!

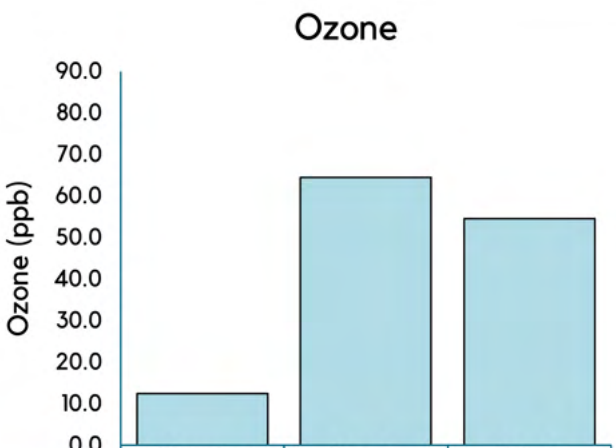
St. Rita School, Hawthorne Public School, The Caregard Group Retirement Community, St. Monica School, Villagia in the Glebe, Beacon Heights Retirement residence, and Revera Retirement Living had significantly higher NO_2 levels than the city average.

Embassy West Senior Living, Blair Station, Governor's Walk Retirement Residence, St. Monica's School, The Ottawa Mission, and Villagia in the Glebe had significantly higher O_3 levels than the city average.

NO_2 and O_3 at all locations in parts per billion



	Arboretum	Site A	Site B
Average	8.8	44.9	42.8
Std. Dev	42.2	103.2	99.0



	Arboretum	Site A	Site B
Average	12.5	64.6	54.6
Std. Dev	75.1	84.1	63.5

Legend

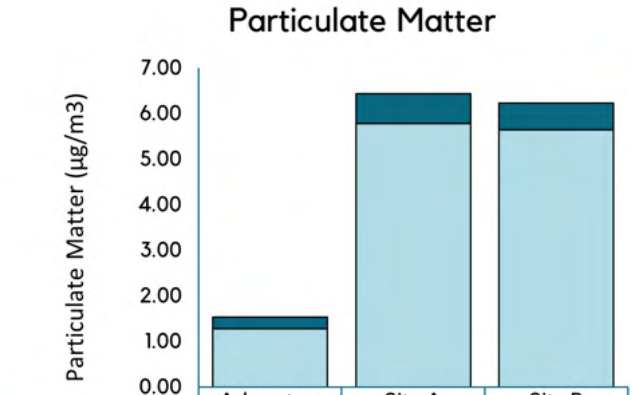
Std. Dev.: Standard deviation

ppb: Parts per billion

ug/m3: micrograms (one-millionth of a gram) per cubic meter of air

Continued on next page.

PM at all locations in parts per billion



	Arboretum	Site A	Site B
PM10.0	0.25	0.65	0.59
PM2.5	1.29	5.79	5.65
Std. Dev (PM2.5)	1.35	6.04	5.14
Std. Dev (PM10.0)	0.14	0.37	0.30

Legend

Std. Dev.: Standard deviation

ppb: Parts per billion

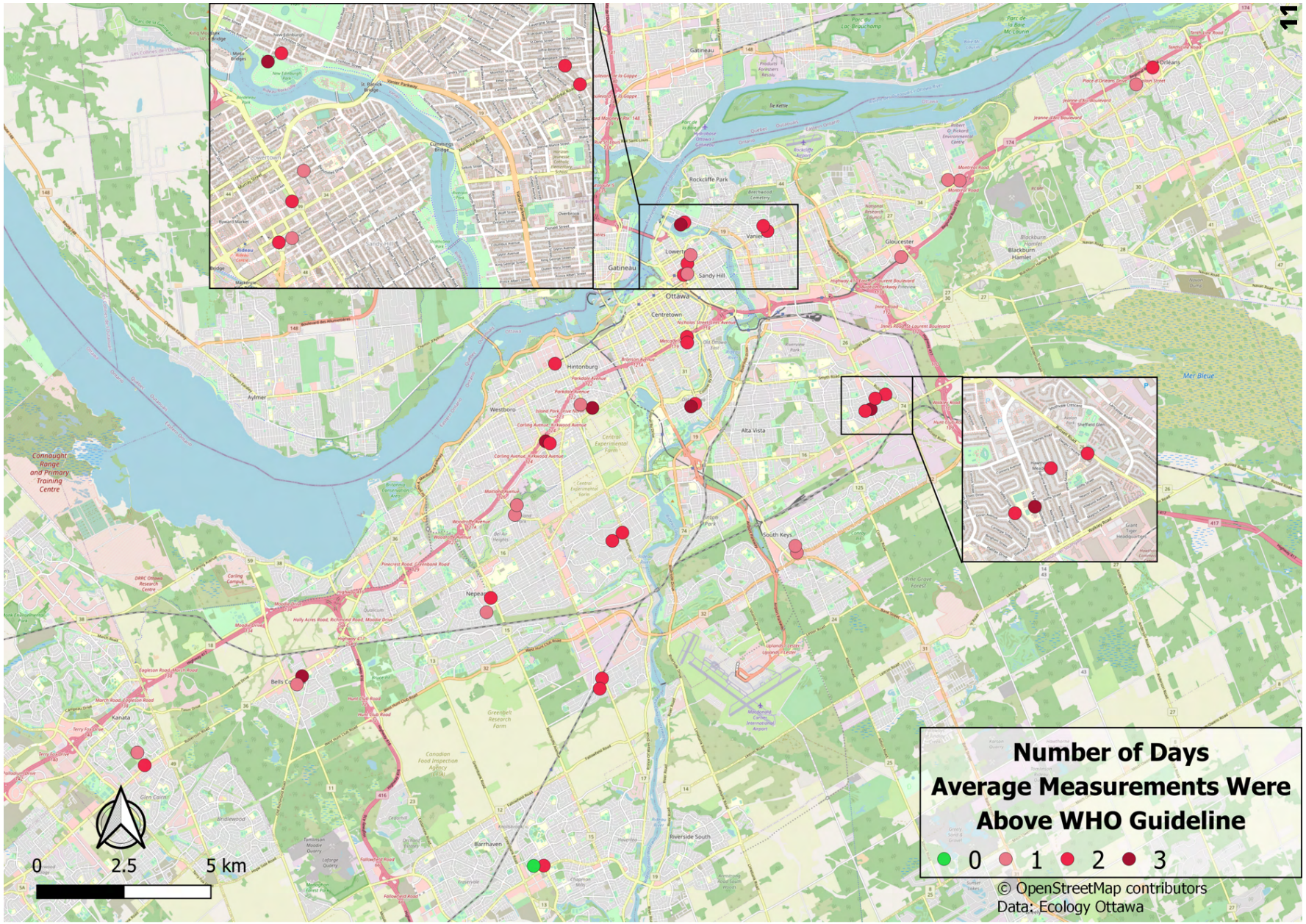
PM2.5: particulate matter 2.5 micrometers or less in diameter (more likely to travel into and deposit on the surface of the deeper parts of the lung)

PM10: particulate matter 10 micrometers or less in diameter (more likely to deposit on the surfaces of the larger airways of the upper region of the lung)

ug/m3: micrograms (one-millionth of a gram) per cubic meter of air

On average, the Arboretum proved to have significantly lower pollutant concentrations than either Site As or Site Bs across the city for all contaminants, though Site As and Bs were not significantly different from each other in any case. The standard deviations of the Arboretum measurements were also approximately equivalent to those of Site As and Bs for ozone, though significantly lower than their standard deviations for both NO_2 and particulate matter. In terms of ozone contamination, this data shows that air quality in the Arboretum varied just as much as the rest of the city (even rising above the World Health Organization threshold for presenting public health concern), but was still lower overall. For NO_2 and PM, however, the Arboretum pollutant concentrations were both lower, and remained lower more often. Together, these observations prove that overall air quality in the Arboretum is better than the rest of the city, which based on Site A and B observations, is believed to result from the significant tree canopy in the Arboretum relative to the rest of the city. The Arboretum is, however, still vulnerable to spikes in pollution (particularly from ozone), suggesting greater tree canopy can improve air quality but cannot protect against pollution spikes observed across the city. Efforts to reduce source emissions are therefore still required.

Number of days the average concentration of at least one contaminant was above the WHO guideline for short-term injestion



Policy proposals

1 Commit to regular and accurate air quality monitoring throughout the city

The city's air quality needs to be monitored on a regular basis, at a scale and level of detail that allows for specific identification of issues related to spikes in pollutant levels. As said above, it is only by studying the issues that we may begin to find solutions.

Further research could be directed to linking air quality levels with proximity to parks, diesel bus routes, highways, busy intersections, construction activities and active transportation infrastructure.

2 Ensure senior residences, hospitals, daycares and primary schools are located in air quality *safe zones*.

The data collected through this study is conclusive: there are significant spikes in poor air quality at major roadways and intersections near sensitive groups. Although the air is not always problematic, the highest levels measured do rise well above what is considered safe, even for non-sensitive people.

Half of the Site As monitored were located in Minor or Major Institutional zones. This zoning is meant to accommodate community services such as daycares, schools, parks and museums. Yet, this means that the locations are very close to major roadways. Following a continuous, rigorous and robust air quality data monitoring project, the City of Ottawa could apply a safeguard for all development projects for sensitive groups. Re-zoning the areas in which the worst air quality is found could help ensure these sensitive groups are located in safer areas.

3 Limit the emissions from vehicular traffic and fossil fuel combustion

Transportation is responsible for 50% of nitrogen dioxide emissions, followed by the petroleum industry (22%) and electricity generation (10%). [3]

- Set and enact policy to attain a target of 60% of total trips by sustainable mode share – walking, cycling and transit – by 2031, with escalating targets and annual reporting leading to 75% in 2046
- Transition the City of Ottawa fleet to all electric vehicles, including buses and light rail by 2050 at the latest.
- Enact a Road Diet Policy of systematically converting existing parking and car lanes to other uses, including transit-only lanes, wider sidewalks or protected bike lanes
- Reallocate a growing proportion of the city's annual budget from road widening and extension to transit and active transportation
- Ban gas-powered leaf blowers and other two-stroke engines
- Enforce idling control bylaw (By-law No. 2007-266)

4 Attain tree canopy target of 40% per neighbourhood city-wide and ensure green infrastructure is systematically incorporated into road developments

City-wide targets hide under-preforming neighbourhoods that are in serious need of tree cover. As shown in the results of the data analysis, the Arboretum's pollutant levels reached the WHO threshold less often than in other locations, and maintained an average far below those across the rest of the city.

[4] SDG Knowledge Hub

5 Commit to building safe streets for all active transportation users

The Cycling Infrastructure Plan and the Pedestrian Infrastructure Plan outline the many cycling and pedestrian improvements the City plans to make over the coming years. These changes could have a transformative impact on the city and leave a lasting legacy for current and future generations. However, their funding is currently spread out and delayed. Additional funding could accelerate investments in infrastructure such as bike lanes, walkways, signage, pedestrian bridges and transit integration measures. The City has done the hard work of identifying priority projects; but with greater ambition and funding, Ottawa can move into a leadership position on active transportation and away from a dated planning model oriented primarily around the car.

"The evidence of air pollution's harm [is] now strong enough that people should ask their elected representatives for more action."

Dr Ioannis Bakolis — lecturer at King's College London

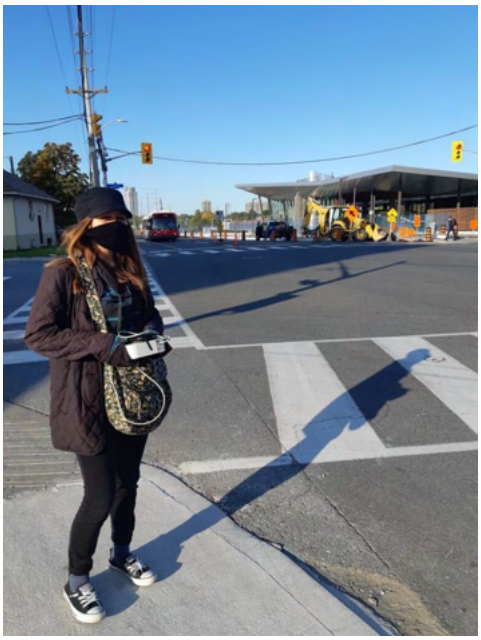
[5] Clean Air Cities Declaration: www.C40.org

Conclusion

Community-driven air quality monitoring engages local communities but has its limitations. To improve our air quality, policy makers must be the ones to ensure pollutants and particles are being accurately and systematically monitored.

Precautionary steps must be taken — let's protect the vulnerable members of our community through deeper awareness of air pollution's effects and through planning that considers their health. The recommendations above can and should be implemented as soon as possible.

Let's continue the conversation within our communities and with our elected officials. If you are concerned about the air quality in your neighbourhood, please reach out to your councillor and express your concern.



"[...] the ubiquitous exposure to air pollution is likely to damage the health of almost everyone in some way, even if it doesn't lead to a visit to the doctor."

Joshua Graff Zivin & Mathew Neidell — Authors of *Air pollution's hidden impacts* in Science, Vol. 359 Issue 6371, January 2018, pp. 39-40.

Annex 1: Data analysis

All data were evaluated by comparisons to international guidelines for ozone, nitrogen dioxide, and particulate matter established by the World Health Organization for average contaminant level intake over one hour. This is to say that usually, a location is monitored for one entire hour, and the average of this hour is analyzed. Considering the scope of the study, we did not ask volunteers to remain at each location for an hour. As such, data were not collected for long enough time periods to establish a truly comparable average. This analysis cannot be understood as compliant or non-compliant. Rather, the analysis should be read as suggestive of the air quality at a given location during our "snapshot" readings.

Air quality data collected from the volunteers at every site was consolidated into a single file before analysis. Two steps of cleaning transpired thereafter: site cleaning and calibration cleaning.

Site Cleaning

A 100 m buffer was created around each of the site locations shown on page 3, and any data that lay outside those buffers were excluded from the analysis. In some cases, however, volunteers did not go near the specified Site Bs, but simply walked away from the specified Site A until in a more residential, or less vehicle-traffic-heavy location. As such, some data points collected for Site Bs were outside the buffers yet were still included in the analysis due to compliance with the definition of what differentiates the sites A from B, as described above.

Calibration Cleaning

In this phase, O_3 and NO_2 concentration data was evaluated to determine if it was more than one standard deviation (specific to the measurements of that site at that date) different from that of three minutes prior. Data that was different by this measure was deleted, and the process was completed iteratively until all data was relatively equivalent, or a minimum of two measurements per site were left, for each monitoring day.

Data Uncertainties

As with any citizen-science initiative, uncertainties regarding data reliability and validity inherently emerge. Such uncertainties can be sub-categorized as endogenous or exogenous.

Endogenous Uncertainty

Endogenous uncertainty refers to uncertainty that arises by virtue of the study design. In the present study, sources of endogenous uncertainty are:

1. Monitors were calibrated in different locations before every measurement

Three different air quality monitors were used for the collection of data, each housed at a unique location for the majority of the study. Further, the monitors require between 1-2 hours to calibrate before measurements may be considered accurate (the monitor is considered calibrated when measured values do not change with time at a single location). Given these conditions, it is likely that monitors were not calibrated identically before each measurement, creating uncertainty as differences in calibration may lead to differences in results. This uncertainty was primarily mitigated by ensuring that monitors were calibrated outdoors for at least one hour before being given to a volunteer for data collection, and cleaning the data as described above

2. Sites were only evaluated four distinct times, each at a different time of day and day of the week

Due to the sheer number of sites that were evaluated, and the fact that this initiative was volunteer driven, this study was limited in the number of samples that could be taken. Uncertainty therefore emerges, as it remains unclear if low-chance events coincided with measurements. However, results presented in the next section illustrate consistencies in measurements with few severely outlying data points for any site.

3. Actions of volunteers are unclear

Though volunteers were trained before engaging in data collection, uncertainty remains regarding what indeed they did when on site. Ecology Ottawa used GPS coordinates to determine when volunteers were when taking measurements. This raises uncertainty primarily because it is unclear if monitors were exposed to environmental air or within a closed space (for example, in the volunteer's car or backpack).

Exogenous Uncertainty

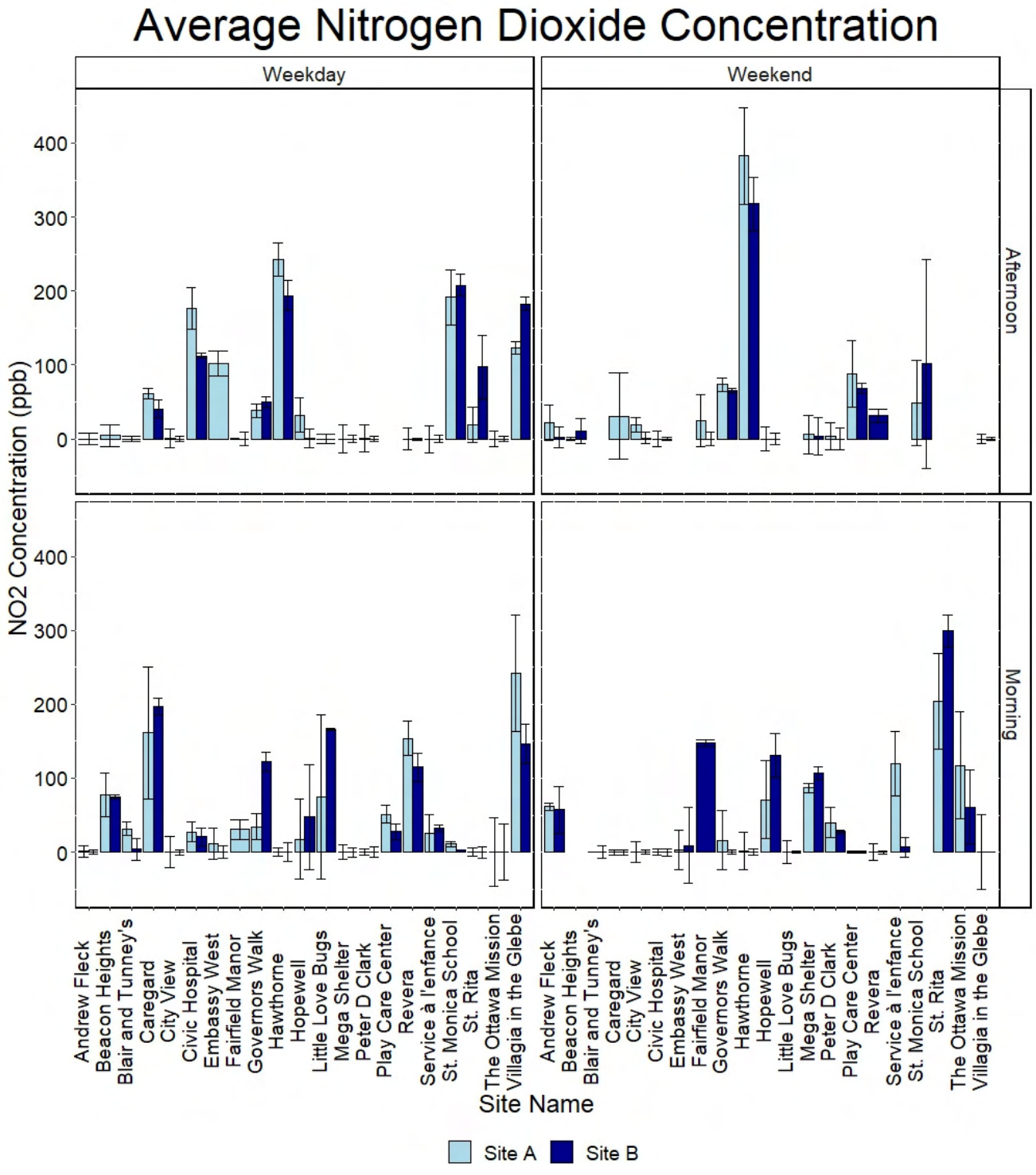
Exogenous uncertainty is uncertainty that arises by factors outside the control of the experimenters. In this study, the main factors are:

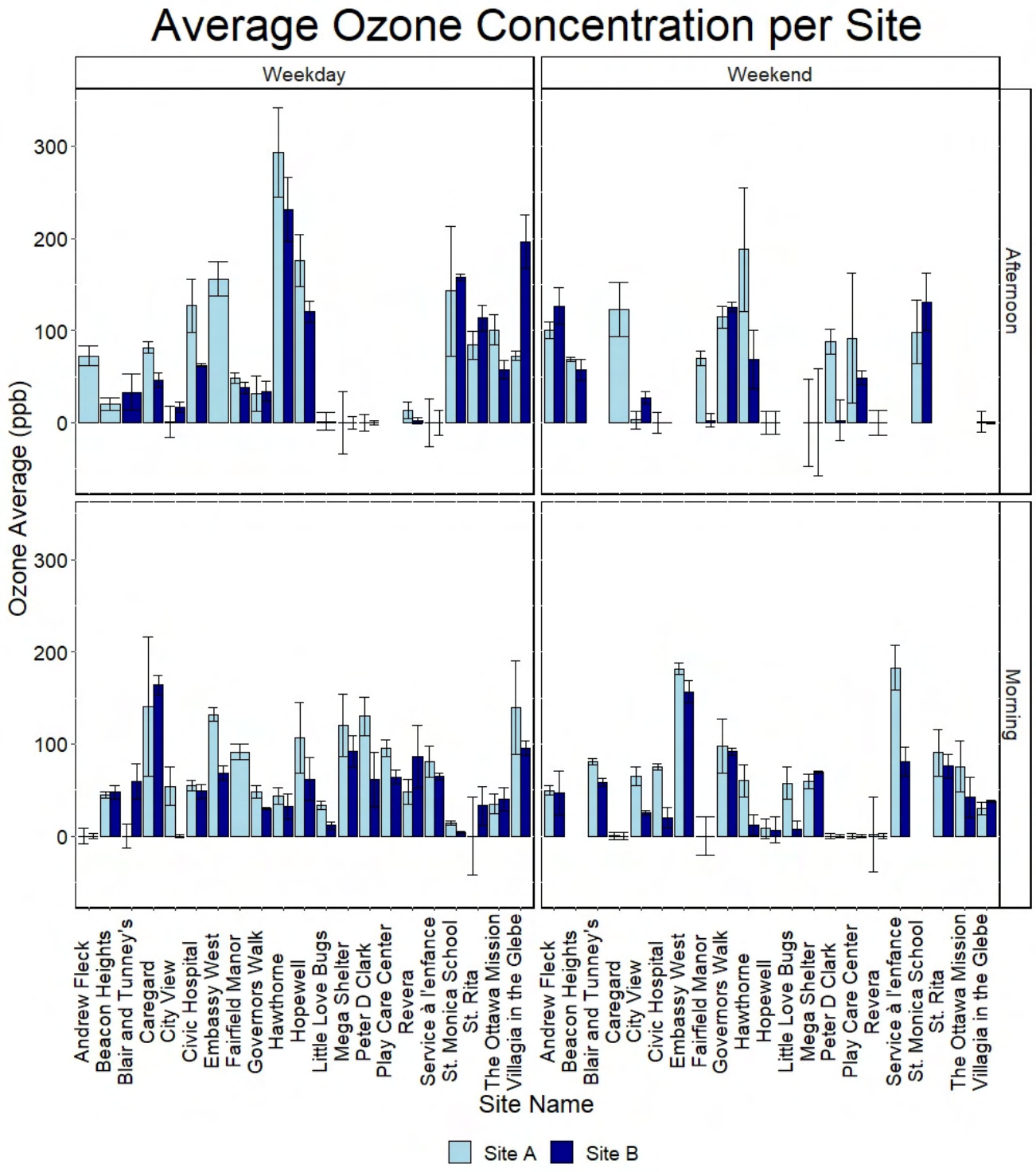
1. Drastic changes in weather leading to spikes or drops in air quality

Previous research has demonstrated that temperature changes of more than 7C from one day to another can lead to spikes or drops in air quality, particularly ozone concentrations. As temperature was not controlled in this study, and the temperatures of the day preceding monitoring was not recorded, it is unclear if such changes impacted our results.

2. Data was collected by more than 150 volunteers from across the city

Volunteers who collected data for this study were demographically, geographically, and educationally diverse, meaning no specialized knowledge of air quality or data collection practices could be assumed. Therefore, though all did participate in mandatory training before collecting data, there remains a notable likelihood that some measurements were taken incorrectly.


Average Nitrogen Dioxide Concentration
Weekday
Weekend
Afternoon
Morning
NO2 Concentration (ppb)
0
100
200
300
400
Andrew Fleck
Beacon Heights
Blair and Tunney's
Caregard
City View
Civic Hospital
Embassy West
Fairfield Manor
Governors Walk
Hawthorne
Hopewell
Little Love Bugs
Mega Shelter
Peter D Clark
Play Care Center
Revera
Service à l'enfance
St. Monica School
St. Rita
The Ottawa Mission
Villagia in the Glebe
Site Name
Site A
Site B


Average Ozone Concentration per Site
Weekday
Weekend
Afternoon
Morning
Ozone Average (ppb)
300
200
100
0
Andrew Fleck
Beacon Heights
Blair and Tunney's
Caregard
City View
Civic Hospital
Embassy West
Fairfield Manor
Governors Walk
Hawthorne
Hopewell
Little Love Bugs
Mega Shelter
Peter D Clark
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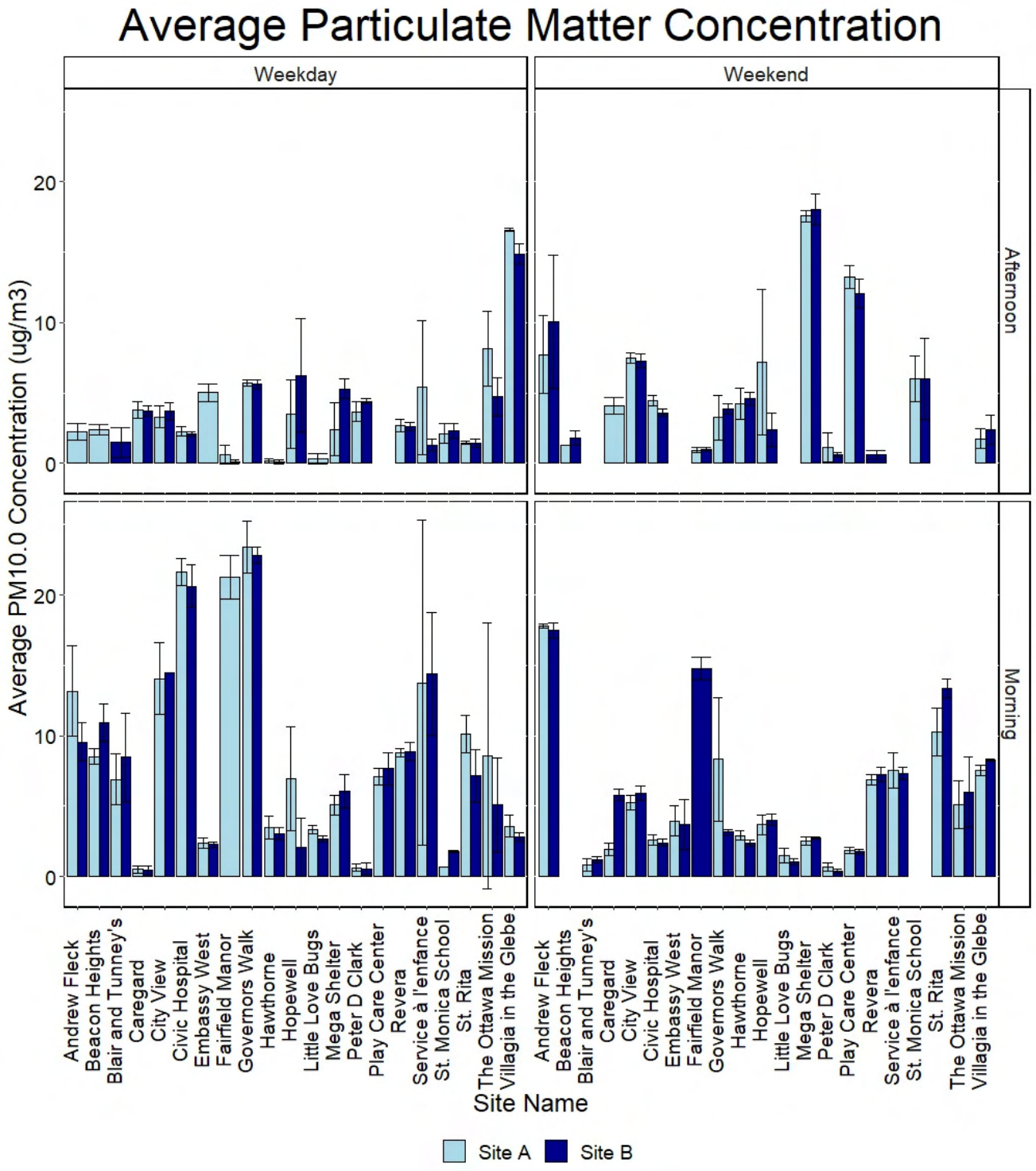
Service à l'enfance
St. Monica School
St. Rita
The Ottawa Mission
Villagia in the Glebe
Site Name
Site A
Site B


Average Particulate Matter Concentration
Weekday
Weekend
Afternoon
Morning
Average PM10.0 Concentration (ug/m3)
0
10
20
Andrew Fleck
Beacon Heights
Blair and Tunney's
Caregard
City View
Civic Hospital
Embassy West
Fairfield Manor
Governors Walk
Hawthorne
Hopewell
Little Love Bugs
Mega Shelter
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