Air Quality Chicago

Using Community Science to Reduce Particulate Pollution & Protect Public Health

ENVIRONMENTAL LAW & POLICY CENTER

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And all of the many volunteers, partners, and funders who made this work possible!

Introduction

Air pollution is a serious threat to public health. Across the country, 111 million Americans – 35% of the population – live in counties with unhealthy air.[i] That includes many in the Midwest, as the hub of our nation's transportation network and home to many old, polluting industrial facilities.

While there are a range of pollutants in the air, fine particulate matter is particularly harmful, which is largely fueled by industrial facilities and vehicles such as diesel trucks, locomotives, and buses. Also known as "soot" or PM2.5, fine particulate matter is the world's leading cause of environment-related mortality and is responsible for an estimated 5% of all premature deaths in Chicago.[ii]

The Environmental Law & Policy Center (ELPC) began air quality monitoring in 2013, working with community partners to better understand – and address – particulate pollution in the Chicago area. This community science, also known as citizen science, program grew and evolved as we built new partnerships, came to understand specific local concerns, and learned best practices for data collection. Since ELPC started mobile monitoring in 2017, we have worked with over 30 organizations, schools, and community groups gathering over 14 million data points. We helped people understand the particulate pollution in their neighborhoods and how they can make a difference in their communities, while building partnerships to expand monitoring across the city and working with scientists to analyze the data.

This program is now at a crossroads. Many of the partner organizations we trained and worked with are doing their own monitoring, and we are excited to see them take over. ELPC is now shifting away from direct monitoring and training but will continue to support our partners in their work by focusing on data analysis and policy advocacy. Climate change is also increasing many air pollution risks, such as wildfires, making air quality concerns top of mind for many Chicagoans in a new way. It is more important than ever to reduce local pollutants and help protect communities from growing threats.

This report explores why and how ELPC conducted this project, data analysis, and findings. We then offer recommendations for future monitoring and ways of seizing policy opportunities to achieve cleaner air for all.

What is Air Quality Monitoring & Why Did ELPC Get Involved?

AIR POLLUTION: SCIENCE & STANDARDS

Fine particulate matter (PM2.5) is a kind of air pollution defined by contaminants' microscopic size.[iii] It includes tiny particles in the air that measure less than 2.5 microns in diameter, such as such as soot from diesel engine combustion, gases, and other toxic dust. These particles are small enough to bypass the body's natural defenses to enter the lungs and blood stream; you would need to line up 20 of them side-by-side to equal the width of a human hair. Exposure to PM2.5 has been linked to an increased risk of asthma, cardiovascular disease, cancer, and premature death.[iv] In some Chicago neighborhoods, asthma affects 1 in 3 children.[v]

Studies show diesel exhaust is a major source of particulate matter pollution, especially in and around highways, rail yards, ports, intermodal facilities, and construction sites.[vi] Other sources of PM include cars, airplanes, restaurants, fireworks, industry, dust, agricultural burns, and forest fires. Chicago is a major hub for North American truck and rail transportation and multiple associated intermodal facilities, where freight is transferred between diesel trains and trucks. Reducing this pollution is important to protecting public health.

PM2.5 can move in a variety of ways, depending on the particulate makeup, weather conditions, and other factors. Particles may remain suspended in the air for some time during still and hot conditions, or they may dissipate quickly on the wind and be carried long distances to then settle on the ground or be brought down by rain.[vii] Many local pollution sources contribute to poor air quality, individually and in combination. Particulate matter can vary tremendously over short distances. Aclima (2020) findings demonstrated that from one block to another, air pollution can fluctuate by six to eight times.[viii] An air quality monitor will show a momentary spike in high particulate concentrations when it's near a direct emissions source such as a diesel truck tailpipe. But the greater the number of trucks driving on that street, or industrial facilities in the vicinity a neighborhood, the more they will contribute to the poor air quality in that area over time.

Figure 1: Map of federal regulatory PM2.5 monitors run by the Illinois Environmental Protection Agency in the Chicagoland area as of 2023, including only three in the city.

Fine particulate matter is one of the six "criteria pollutants" monitored by the U.S. Environmental Protection Agency (EPA) under the Clean Air Act's National Ambient Air Quality Standards (NAAQS). The EPA is required to regularly review its criteria pollutant standards to reflect the latest scientific research and protect the American people from health harms. The standards establish thresholds for unhealthy concentrations of PM2.5 measured in micrograms per cubic meter of air($\mu g/m^3$). Areas that exceed these standards must implement more stringent air protections.

Under the old standards, set in 2013, daily average readings above 35 $\mu g/m^3$ and annual averages above 12 $\mu g/m^3$ were considered unhealthy.[ix] After reviewing the most recent available scientific evidence and technical information, the U.S. Environmental Protection Agency issued a tighter regulatory standard for annual PM2.5 pollution in February 2024.

The new standard was reduced from 12 to 9 µg/m³ which will "prevent up to 4,500 premature deaths and 290,000 lost workdays, yielding up to $46 billion in net health benefits in 2032."[x]

The Illinois Environmental Protection Agency (IEPA) manages stationary monitors across the state. These large monitors (as big as boxcars) measure pollutant concentrations from fixed locations with high accuracy, offering the official big-picture perspective on the region's long-term air quality. Unfortunately, there are only 3 state PM2.5 monitors in Chicago, a city of over 200 square miles.[xi]

Chicago's air quality has improved over the past 20 years, but it still ranks among the nation's most polluted metropolitan areas, and the burden is not distributed equally throughout the city.[xii] Some communities have higher levels of pollutants than others due to heavier traffic, proximity to industrial areas, fewer parks and green spaces, and other disparities.

Figure 2: People from Sustainable Englewood Initiatives, ELPC, and other community residents gather around a stationary monitor before installation, 2013.

In the 2010s, ELPC and community groups called for more comprehensive air quality monitoring, to paint a fuller picture of the problem. Because of technological advances, mobile monitoring emerged as an alternative method. People can collect data in real-time using hand-held devices while moving by bike, foot, or sometimes vehicle. Mobile monitoring offers a reliable, low-cost way to acquire data at a high spatial resolution. As both stationary and mobile monitoring technology progressed, ELPC saw opportunities to increase understanding of local air quality and expand access to air quality data throughout Chicago and other communities.

Robust data could help create effective mitigation plans that accurately reflect the unequal distribution of pollution.

ELPC'S MOBILE MONITORING PROGRAM & PARTNERSHIPS

ELPC first started air quality monitoring in 2013, working with community groups to supplement the EPA's limited monitors with additional stationary monitoring equipment. Our first installation was in the South Side neighborhood of Englewood, where neighbors were concerned about an expanding Norfolk-Southern freight rail yard that threatened to displace neighbors and increase air pollution risks. This data contributed to negotiations and better community benefit agreements.[xiii] Norfolk Southern agreed to upgrade diesel equipment with better pollution controls, to reduce truck congestion and train idling that was causing avoidable pollution, contribute millions of dollars for local job training and local sustainability projects, and donate an abandoned rail line to become a new walking-biking trail for outdoor recreation in the community.[xiv]

We conducted additional monitoring with community organizations through 2016, but the devices available at the time were difficult to manage. At more than $4000 each, about the size of a heavy toaster, they also required a significant time commitment. Volunteers had to change filters every 24 hours and refrigerate them quickly. ELPC staff weighed the filters with sensitive equipment working in partnership with professors at Loyola University Chicago and Northwestern University. Ultimately, this style of monitor was impractical for a community science project, so we looked for better options.

Figure 3: ELPC intern Julian Green holds an AirBeam monitor, which he used for data collection on the Southeast Side in 2021.

Figure 4: Partners from Blackstone Bicycle Works in Hyde Park ride away, carrying bike-mounted air monitors.

In 2016, ELPC convened a day-long national strategy meeting of scientists, professors, tech developers, public interest attorneys, policy advocates, environmental justice activists, healthcare professionals, and others, to explore new air monitoring opportunities and technology. We learned about the AirBeam, created by HabitMap, a low-cost, open-source, handheld monitor that uses light scattering to take air samples at 1 HZ (1 per second intervals). The AirBeam monitors are small and light, inexpensive (just $250), and align with US EPA federal regulatory monitors. AirBeam monitors immediately transmit data to a mobile device via Bluetooth, so users can view particulate matter levels in real time as they move throughout the city.

Mobile Monitoring with AirBeam

In 2017, ELPC began building out a community science program using AirBeam monitors. Each year, ELPC worked with neighborhood organizations, student groups, interns, and others to track air pollution, identify neighborhood hotspots, and learn how to reduce PM2.5 exposure. Volunteers walked and biked around city neighborhoods in the summer holding the monitors, while looking for pollution sources and attempting to take notes on the surrounding context. We trained people how to use the monitors, planned routes, and convened groups to discuss observations.

Our partners included:

→ **MAPSCorps** – Youth development nonprofit on Chicago's South Side, focused on building skills through asset mapping and community data collection.

→ **Cut Cats Couriers** – Bike courier company, based on Chicago's North Side, that delivers food, liquor, and other packages throughout the city.

→ **Southeast Environmental Task Force** – Nonprofit organization on the city's industrial Southeast Side, comprised of neighbors affected by and fighting pollution, from garbage incinerators and petroleum coke storage to a recent metal shredder.

→ **The Plant Chicago** – A sustainability hub in the South Side's Back of the Yards neighborhood, which hosts green businesses and community programming.

→ **The Field Museum's Green Ambassadors Youth Program –** Chicago's natural history and science museum, located just south of downtown, hosts this program for youth to build connections between South Side communities and the environment.

→ **Neighbors for Environmental Justice (N4EJ)** – This Southwest Side community organization, based in McKinley Park has longstanding concerns about the MAT Asphalt plant located directly across the street from the neighborhood's namesake park. N4EJ partnered with ELPC to host our first day-long public air monitoring event in 2019.

In addition to these partners, and several others mentioned throughout the report, the comprehensive list of partners, funders, and interns is on page 25. While ELPC staff encouraged volunteers to observe their surroundings and note the conditions when monitors indicated a spike in air pollution, the reality of walking and biking around a dense and busy city street made note taking difficult on many occasions. It was important for volunteers to be able to review the data, reflect on their experiences, and discuss observations afterwards in order to make the most of their monitoring experience. To make that reflection process easier, ELPC staff provided data maps in understandable visual formats.

HabitatMap provides a good website, where AirBeam data is collected and mapped over time, but it uses uneven units of measuring distance.[xv] For ELPC, this made it difficult to determine conditions on a block-by-block basis, and the raw data was even harder to read. So, we worked with JustDesign Cooperative to build an additional digital dashboard at airqualitychicago.org, which displayed the data in a consistent and easy-to-understand map format. This

allowed each person who monitored to log in and view the results along their personal routes. Each hexagon represents about half a city block and shows averages of all the data collected in that area throughout the multi-year program.

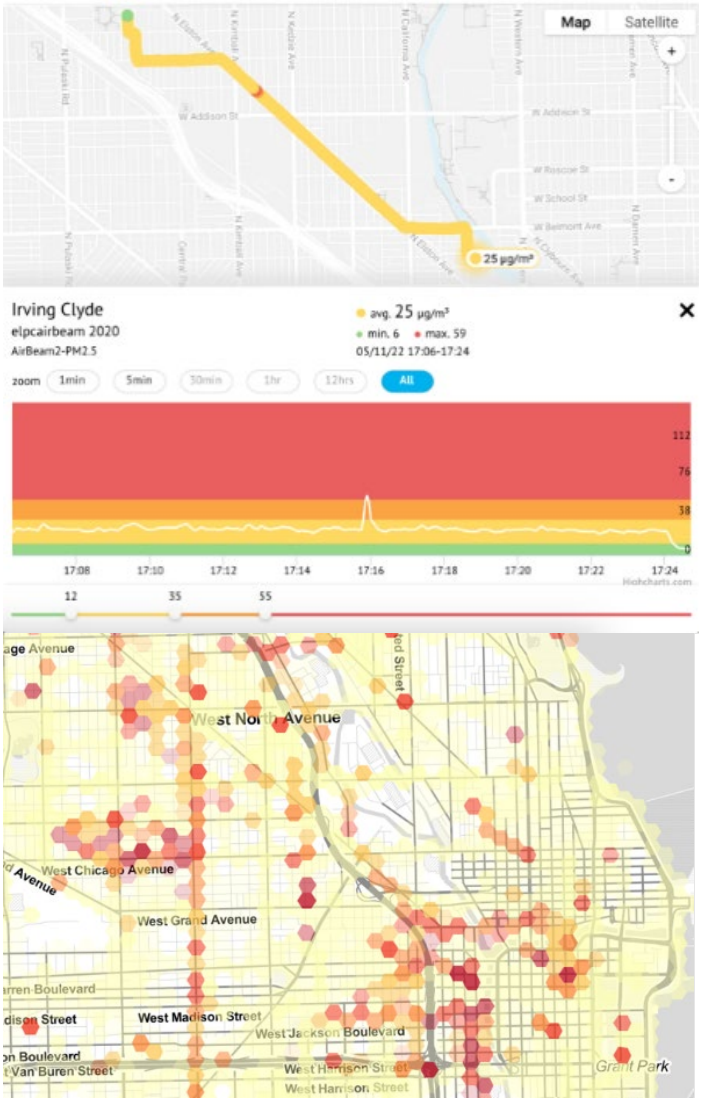

Figure 5: AirBeam maps – Screenshot on top shows the HabitatMap website view for an AirBeam session. Map on the bottom shows ELPC's digital dashboard, with data compiled over time into consistent hexagon format.

Where did we monitor and why?

Overall, ELPC's air quality monitoring program volunteers collected more than 14 million AirBeam data points between 2017 and 2021. Within Chicago city limits, we gathered nearly 10.5 million data points, reaching 74 of the city's 77 official community areas and portions of nearby suburbs Berwyn, Cicero, and Evanston. We also collaborated with local organizations in Milwaukee and Cleveland, supplying monitors and training materials to conduct air monitoring there.

Most of our data was collected in warmer months, especially July, largely due to student availability in the summer months. Volunteers were usually out between 9am and 4pm, and they conducted the most monitoring in 2019 and 2020. See for additional data. Our volunteers came from all over the city, but as the program went along and we noticed the data begin to weigh more heavily towards North Side communities, ELPC shifted focus to prioritize South and West side neighborhoods with our own monitoring, interns, and growing partnerships. In each of the 26 neighborhoods with the most coverage, volunteers gathered more than 100,000 data points, accounting for 76% of the total data set. Here are a few of the neighborhoods where ELPC and volunteers collected the most data:

1) Lincoln Park –
Residents of this near North Side community reached out to ELPC for help in 2018. Neighbors were fighting to shut down a local metal shredding facility, General Iron, after years of air pollution, water concerns, and explosions.

The Clean the North Branch community organization and Alderman Brian Hopkins' office galvanized volunteer power to collect over 3 million air quality data points, more than ELPC and community partners had the capacity to gather in other parts of the city. However, instead of shutting down General Iron, the city coordinated with the company to propose a relocation to the Southeast Side in 2020, a largely Latino community with an overabundance of industrial polluters already. ELPC and Clean the North Branch joined a coalition of Chicago community advocates, led by the Southeast Environmental Task Force, which successfully encouraged the city to reverse course and block General Iron's move in 2022.[xvi] Unfortunately, an administrative law judge overruled the city in June 2023, saying the facility met permit requirements; Mayor Johnson has since filed an appeal and advocates have vowed to keep fighting.[xvii]

2) Little Village –
In our second most documented neighborhood, Little Village, ELPC worked with Latinos Progresando, MAPSCorps, and other volunteers to collect 631,724

data points. This predominantly Latino community on Chicago's Southwest Side is along an industrial corridor with longstanding air quality concerns. As the neighborhood is bordered by rail yards to the north, east, and west, the Sanitary Shipping Canal and I-55 expressway to the south, and crossed by inner-city arterial truck routes, Little Village already has more than its fair share of diesel traffic.

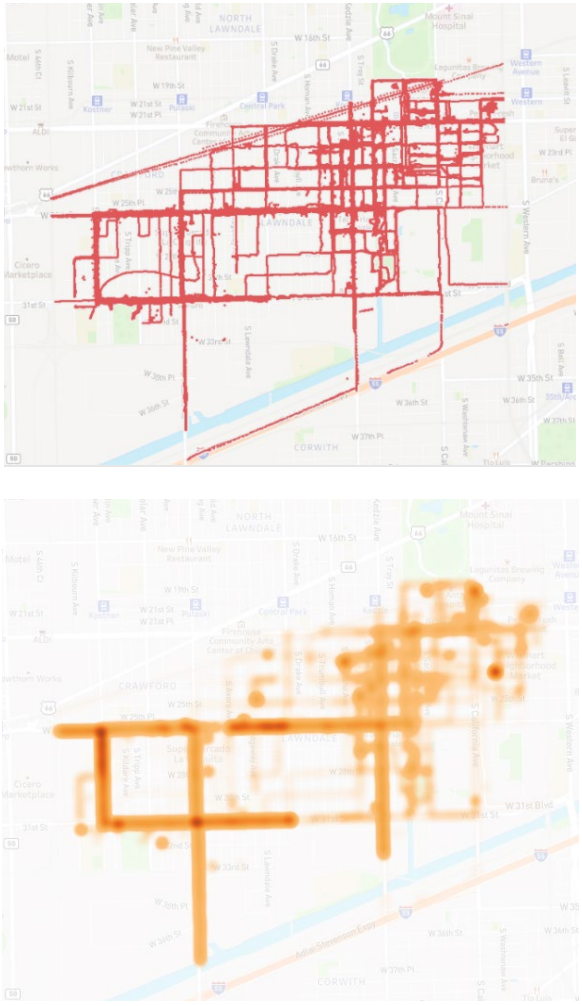

Figure 6: Little village data maps – The top map shows the geographic spread of Airbeam data collected in Little Village, while the density map on the bottom shows where the most data was collected.

3) Hyde Park –
This South Side lakefront neighborhood was our third most documented, thanks to several partnerships in the area. Several ELPC interns called Hyde Park home while attending the University of Chicago, so it was easy for them to monitor nearby. We also collaborated with a physician at the University's hospital who worked with pediatric asthma patients to track their own exposure; their data was not compiled with the rest to protect patient privacy. We partnered with educators at the Museum of Science and Industry and community groups at the Experimental Station, such as Blackstone Bicycle Works and the 61st Street Farmers Market. Altogether, monitors gathered 401,204 data points, particularly along major thoroughfares including Lake Shore Drive, Cornell Dr., 55th Street, Stony Island, and Cottage Grove.

4) West Town & Humboldt Park –
The fourth and fifth most documented neighborhoods are next to one another on the near Northwest Side, where ELPC directed volunteers to explore high-traffic and diesel corridors. In addition to the green space of Humboldt Park and its connected boulevards, this Puerto Rican neighborhood includes large industrial areas and a freight rail corridor. We partnered with West Town Bikes during the early pandemic in 2020, because their workers could carry monitors on their bikes while commuting to work. We also shared West Town data with the Chicago Transit Authority after early monitoring indicated that the Chicago Avenue route (66 bus) had high levels of PM2.5. We encouraged CTA to consider this type of data when selecting routes on which to first deploy cleaner electric buses. The CTA initially piloted electric buses along Chicago Avenue in 2021 and since then has continued adding more electric buses there and on other routes as well.[xviii]

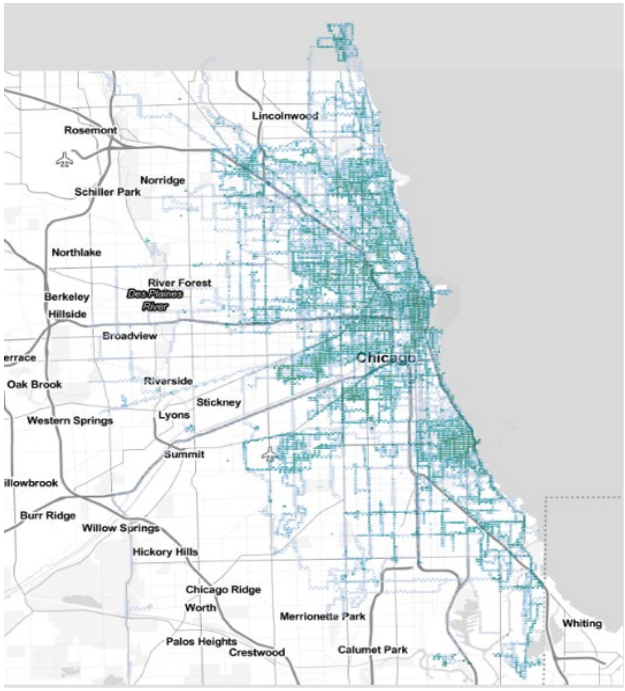

Figure 7: Blue dots on this Chicago map indicate broad geographic coverage. Every spot indicates where ELPC mobile monitors captured at least one data point.

STATIONARY MONITORING WITH MICROSOFT RESEARCH

While mobile monitoring can play an important role in community education, organizing, and data collection, it is limited by coverage time, volunteer capacity, and labor intensiveness. Continuous stationary monitors offer another approach, capable of gathering data during all seasons and times of the day, unhindered by these limitations. While mobile monitoring offers geographic flexibility, stationary monitoring offers more comprehensive coverage over time.

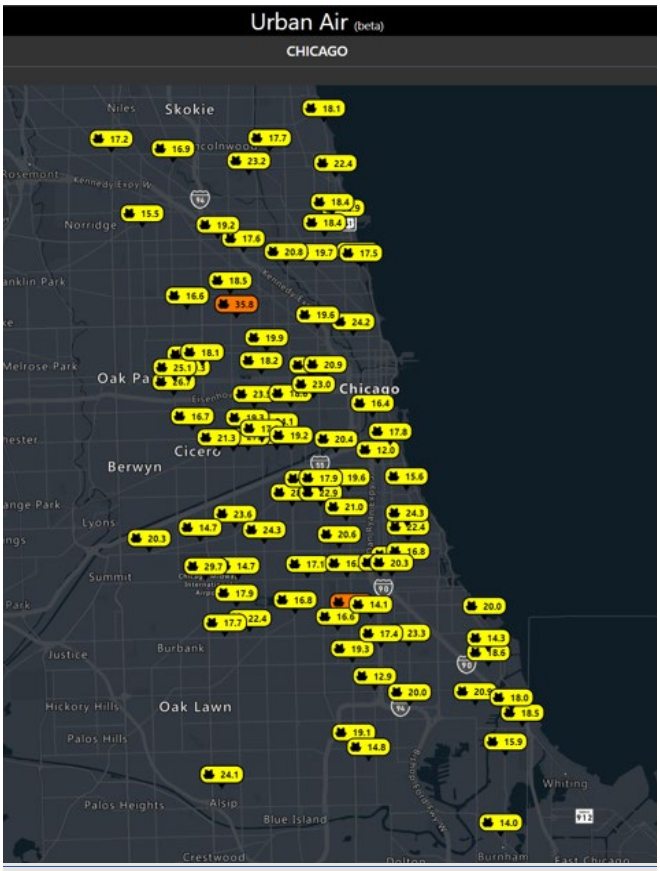

Figure 8: Stationary monitoring network, managed by Microsoft Research's Project Eclipse, in partnership with the City of Chicago, the Array of Things Project, JCDecaux Chicago, and local environmental organizations. Screenshot captured March 30, 2022, at 6:57pm.

Combining stationary and mobile monitoring offers the best of both worlds for understanding urban air quality. That's why, starting in July 2021, ELPC partnered with Microsoft Research's Project Eclipse along with the City of Chicago, the Array of Things Project, JCDecaux Chicago, and local environmental organizations.[xix] The Microsoft Research team installed over 100 low-cost stationary monitors on bus stops throughout the city, to continuously monitor for three pollutants: PM2.5, ozone, and nitrogen dioxide, and hosted the live data on a website map. See Figure 8 for a map showing the stations air quality readings.

As part of the planning process, ELPC connected the Microsoft Research team with community organizations. Local air advocates helped determine where the stationary monitors would be located, in light of community pollution concerns. Three of the stations were strategically positioned alongside EPA's regulatory monitors to validate the data's consistency and accuracy. As the data began to roll in, ELPC continued gathering with environmental justice groups to discuss findings and brainstorm advocacy ideas. ELPC also helped make sure that community organizations involved received mini grants for their work on the project.

Over the past two years, ELPC seized the opportunity to compare AirBeam mobile monitoring results with Project Eclipse data to confirm accuracy, highlight additional hotspots, and make other observations. Unfortunately, Microsoft Research abruptly ended its project in April 2023, so ELPC strongly urges the City of Chicago to set up a permanent public stationary monitoring network in Chicago as soon as possible.[xx]

SUMMARY OF ANALYSIS

As of December 31, 2022, the Microsoft Research Project Eclipse Network of stationary monitors collected over 15 million data points. This is the most robust air quality data set ever collected in Chicago, offering more granular coverage than the official Illinois EPA regulatory monitors and a shorter, but more continuous, timespan than ELPC's mobile monitoring work. ELPC analyzed the 10.23 million data points collected by Project Eclipse in 2022 to get a sense of how air quality changed over the course of one year.

Although there were 122 stations installed throughout the city, not all stations were operational 100% of the time, as is also the case with federal monitors. To minimize bias, we analyzed only data from the 67 stations that operated more than 90% of hours in 2022. We divided the data into daily, monthly, and annual periods to see if there were any time periods or locations that stood out (see Findings Section).

Comparing Mobile & Stationary Data

Each individual mobile reading is an accurate reflection of short-term pollution at the specific sampling location, and acute exposure to extremely high pollution levels can be a serious health issue. But one momentary spike in pollution will not have the same long-term health impact as frequent exposure to high PM2.5 can have over time. Stationary sensors are ideal for measuring the temporal variability and long-term patterns of air pollution where they are located. Once the Microsoft Research stationary monitor network was installed, ELPC gained a longer-term continuous source of data to compare with our mobile monitoring results. Learning from that, we could develop an efficient and effective approach for understanding long-term lessons from short-term mobile monitoring as well.

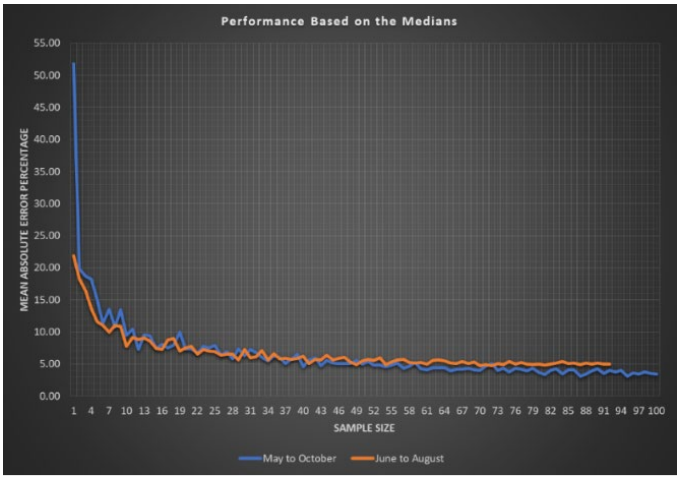

Figure 9: Chart shows that with more monitoring repetitions, we can be more confident that the data collected represents the consistent air quality in that location over time.

We used Microsoft's data to develop a method to calculate how many repetitions of mobile monitoring are needed to reliably estimate a particular location's long-term air quality. We learned that by repeating our mobile monitoring visits to each spot on the map, we can get a better sense of overall PM2.5 level there and reduce the potential for unusual values to influence the results. In other words, repeated visits can help us determine whether pollution is a recurring long-term problem for this community location.

We treated each monitoring station as if it represented the air quality of an average city block size of 420 by 680 feet. For each station, we looked at data from up to 100 different hours, but never two hours from the same day. We took a sample every day for up to 100 days and then studied how the data evolved over time. ELPC often conducted mobile monitoring during the day, in warmer months, because of volunteer schedules and equipment limitations. So, we split our data checks into two separate yearly subsets: May-October and June-August, only between 8 AM and 8 PM, to mirror the timing of mobile monitoring. We then pinpointed how many repeats are needed in these periods for reliable data. The performance assessment results are illustrated in Figure 9.

There can be anomalies at any location, such as a house fire which one day causes poor air quality in a neighborhood that is usually healthy. One day of bad air pollution can also be harmful to local health, but it is less reflective of a neighborhood pattern. If there are very few air quality readings in an area, any single data point might be farther from the norm, giving us less confidence that the data represents a long-term problem. But the difference begins to decline after five samples. At 15 or more repeats, the difference stays below 7.5%, and after 30 sampling days, the difference is consistently less than 6%. After 30 visits to the same location over the course of a year, the recorded PM2.5 value is likely to be an accurate representation of that location's annual PM2.5, deviating by no more than 6% from the actual annual value.

Confusing? Think of it like weather: a single temperature reading in January in Chicago might be 60 degrees. That's not "wrong," but rather a reflection on our unpredictable winters. If you read the temperature on 15 or even 30 days in January, your average reading is much more likely to be what you'd expect: a brisk 20 degrees. Air quality monitoring works the same way: the more readings you average together, the more reflective they are of the overall long-term air quality.

Following this analysis, ELPC reviewed all our and partners' monitoring data gathered since 2017. We created a new interactive map, indicating the level of long-term confidence in the measured PM2.5 value, based on the number of repeat visits.[xxi]

We broke these down into the following categories:

→ Between 5 and 9: **Unconfident** – Good start, but additional sampling days are needed.
→ Between 10 and 14: **Relatively Confident** – Almost enough, but a few more sampling days are needed.
→ Between 15 and 29: **Confident** - Does not necessarily need more sampling, but if more is done, it will be very confident.
→ 30 and above: **Very Confident** – No need to do any more sampling.

Just to clarify, when we use the term 'confidence' here, it's in a qualitative context and doesn't indicate a statistical assessment of risk. Future monitoring volunteers can gain confidence in the likelihood that their results accurately reflect the norm/usual air quality as they get closer to 30 repeat visits at each location. The more visits, the more confidence that the data represents the long-term air quality there.
In the maps below, each rectangle (or gridcell) is 420 x 680 ft, about the size of a city block. Red indicates a consistent problem with unhealthy air quality at that location, while green indicates healthier air. In the interactive map, you can set search criteria to filter the map or hover over each grid cell to see additional information. See next section for our findings from this analysis.

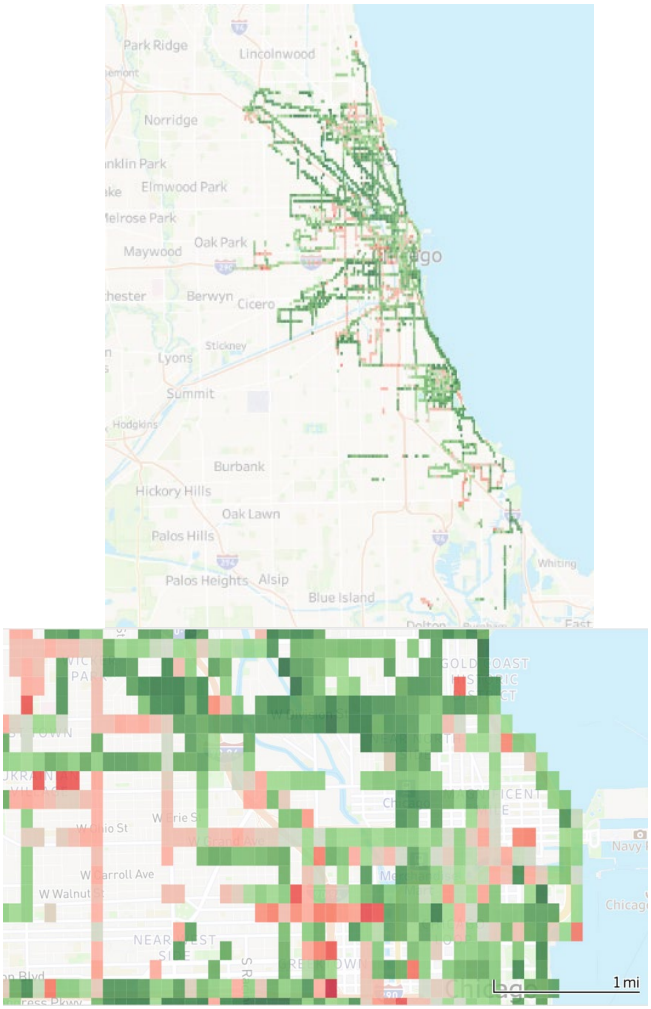

Figure 10: On top is a screenshot of the ELPC confidence map, showing the areas of sampling in Chicago. On the bottom is a closeup of the near north and near west sides. Red indicates unhealthy air; green indicates healthier air. Click here to explore in detail or visit elpc.org/AirQualityChicagoReport2024.

Findings About Monitoring

MOBILE MONITORING IS VALID

Mobile monitoring is very valuable for education, observation, and data collection, especially for providing geographic detail and spatial distribution of particulate matter. As other analyses have shown, air pollution can fluctuate by six to eight times from one block to another, and mobile monitoring can track significant fluctuations within 100-300 meters.[xxii] Comparing ELPC's mobile monitoring data with the stationary data from Microsoft Research and EPA federal regulatory monitors confirms that we can have confidence in the accuracy of these sensors, especially with repeated samplings. Handheld monitors complement stationary monitors by finding hotspots where additional monitoring and mitigation efforts are needed.

Monitoring is also a great way for people to learn about particulate matter and air pollution in their communities. Students and volunteers can watch the numbers light up in their hands when they pass by emissions sources, making these invisible environmental threats visible for them. Chicago Public Schools teachers, museum educators, MAPSCorps leaders, and other educational partners leaned into these educational benefits to learn about air science, asset-mapping, and problem-solving. For that reason, in future air quality monitoring programs, educational partnerships are a great place to start.

DETERMINING POLLUTION SOURCES IS COMPLICATED

Most air monitors measure particulate matter concentrations based on the size of particle in the air, not by what the particles are made of. That means isolating the source of the pollution is much less certain. There is some technology that can target black soot (associated with diesel engines), for example, but more discerning monitors are much more expensive and difficult to obtain. ELPC largely relies on locational data, observational notes, and more rigorous scientific analysis from EPA and university scientists to discern the most likely pollution sources whenever possible.

Tips on Taking Observational Notes – Safely walking and biking around a busy city takes a lot of attention. Trying to navigate while watching numbers change on a phone screen, looking for potential air pollution sources, and taking contemporaneous notes and photos was a lot to do all at once.

- → We found that it was very important to give volunteers the opportunity to review the data afterwards and reflect on their experience. Volunteers who kept shorthand notes of pollution sources or took photos while walking appreciated taking time after to flesh out their descriptions while the memories were fresh in their minds.
- → Gathering volunteers into small groups improved safety and task-sharing, so each person could focus their attention and provide more comprehensive observations.
- → Providing volunteers with a clear and simple route made it easier to multitask and replicate for accuracy.
- → While biking is a great way to move quickly around the city and gather a lot of air quality data, monitoring by bike is not for everyone, especially in communities with sparse bike lanes or dangerous infrastructure. We had the most success with experienced cyclists in partnerships with shops like Blackstone Bikes, Cut Cats Couriers, and West Town Bikes.
- → For youth and infrequent bike riders, it is possible to set them up with monitors, but it is most important to focus on riding safely in the moment and reflect on any observations afterwards when reviewing the data.

REPETITION MAKES STRONGER LONG-TERM DATA

As discussed in the previous section, repeatedly visiting each location to capture mobile monitoring readings can reduce outliers in the data and provide a better sense of air quality in that spot over time. Based on this analysis, for future mobile monitoring we recommend at least 30 repeat samples during distinct hours within a year to ensure a strong data set. The more data points at a single location, the better for finding hotspots that face consistent challenges with air pollution.

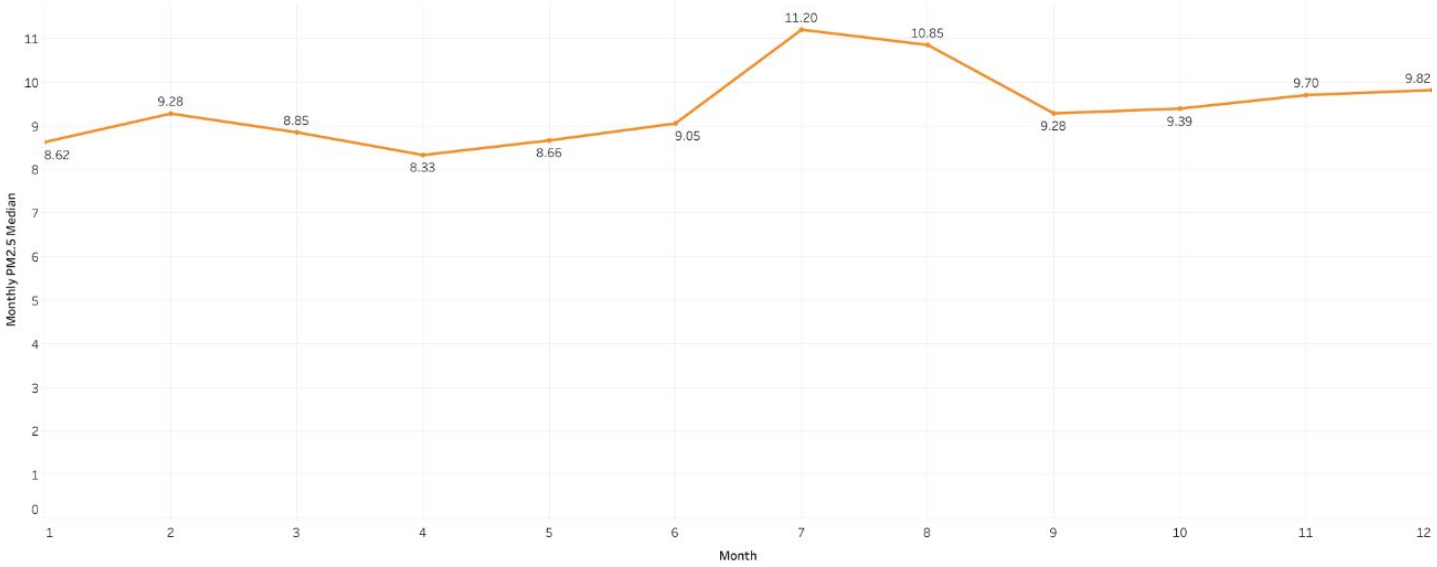

Figure 11: Monthly PM2.5 median from 2022 stationary monitor network. Shows higher levels of pollution in July and August.

WHEN YOU MONITOR CAN MATTER

We analyzed the stationary monitoring data from 2022 to see if there were any time periods that stood out. We found little difference in the time of day or day of the week, but there were notably higher PM2.5 rates during the summer.

→ **Time of day** – We found no substantial distinction in the median values across different hours; however, the period from 12:00 noon to 2:00 p.m. exhibits slightly elevated pollution levels. Therefore, sampling can be conducted at any hour, but to avoid outliers, it should not be limited to a single hour of the day and should include samples from the morning, early afternoon, and later in the day.

→ **Day of week** – Again, we observed no significant distinctions in the values; however, Tuesdays and Wednesdays tend to experience slightly higher pollution levels. Therefore, sampling can be conducted any day of the week, but should not be limited to any single day to avoid outliers.

→ **Months of the year** – To obtain the most accurate results, spread your monitoring out across the May to October timeframe. Notably, the two months of the year with the highest pollution levels are July and August (see Figure 11). This finding is not surprising, given the many studies showing the impacts of heat and humidity on air quality, both generally and in Chicago specifically. Lake Michigan stays cooler than the rest of the city during the summer, so when cooler air blows in from the lake, it can get trapped under a layer of warm air above, causing particulate pollution to accumulate in the city.[xxiii] Heat and humidity can also contribute to particle formation, although the relationship is more complex than with other pollutants such as ozone.[xxiv]

VOLUNTEER AVAILABILITY CAN VARY GEOGRAPHICALLY

Community science programs are shaped by the people who have the ability, time, and flexibility to do the needed activities. This is both a blessing and challenge: people give their time, contribute first-hand perspectives of their neighborhoods, and create knowledge together, but there are more people with free time in some neighborhoods than others. It became clear to ELPC staff that we needed to focus our own time and resources on underrepresented communities on the South and West Sides, while other volunteers continued to collect data downtown and on the more affluent North Side. Collectively, our citywide data helps to illustrate the disparities across communities. More city-wide air quality monitoring resources that could complement volunteer efforts and provide a more holistic, balanced, and consistent perspective across communities.

Citizen monitoring isn't as simple as handing a volunteer a device. It requires trained individuals to coordinate the program, train volunteers, and evaluate the data. ELPC is a Midwest organization, but our air quality monitoring staff is based in Chicago. We had mixed results beyond Chicago because community science needs community organizers with connections to local resources. Our work in Milwaukee was more successful than in Cleveland because of our partnership with a community group on the ground, the Urban Ecology Center, that was well organized and had strong leadership. These are important considerations to keep in mind for future air quality monitoring programs.

SHARING DATA PUBLICLY IS VALUABLE

Air pollution is usually invisible, so it can be hard for most people to understand their risk or avoid exposure, especially in communities lacking time, financial resources, or healthcare access. Local air quality data and public awareness can help overcome these barriers. It is also important to ensure that long-term data sets are available for analysis, not just daily or hourly results. Scientists and city leaders can utilize such data to identify problems or target stronger enforcement. Conversely, local advocates can hold public officials accountable if they do not take action. Overall, making air quality data publicly available allows for more analysis, transparency, and accountability.

Figure 12: Volunteers and community partners with Neighbors for Environmental Justice at a community air quality monitoring day in the McKinley Park neighborhood, 2019

Findings About Pollution

Our data shows that there is widespread disparity in particulate levels around Chicago. Accordingly, some people are more exposed to unhealthy air than others, especially in communities facing economic and health stresses. This issue was visualized in a 2020 analysis by the City of Chicago that layered air quality data with social determinants of health to identify South and West Side neighborhoods most impacted by bad air quality, see Figure 12.[xxv] The more we can learn about pollution sources and hotspots in our city, the better those most affected can be protected.

In this section, we present some of our findings about air pollution in Chicago, including short-term observations and long-term analysis. Throughout this section, diesel vehicles and industrial polluters feature among the worst polluters, fueling PM2.5 hotspots near highways and railyards across the city. On the other hand, parks may have the opposite effect, as we found better air quality in their surrounding communities.

MOBILE MONITORING OBSERVATIONS

ELPC interns, partners, and volunteers recorded notes while reviewing data & maps after monitoring, in addition to many contemporaneous notes. AirBeam monitors read temporary pollution spikes from many sources. Observations include:

Busy arterial roads

"On July 4th, 14th, and 26th, I recorded spikes after high levels of car traffic passed through two different areas of Washington Park. The spikes from July 26th and the 4th occurred at the same hotspot, along Cottage Grove Ave. between 53rd and 54th Streets." – ELPC intern Jonathan Garcia[xxvi]

"Monitors showed peaks between 9 and 10 am (rush hour) at intersections and bus stops – suggesting traffic is a major driver of momentary harmful PM peaks. Other areas with elevated PM levels include: 79th Street at the intersections of Ashland, Racine, and Halsted, Halsted between 75th & 79th, Ashland between 83rd and 87th, and various locations along 87th." – Auburn Gresham volunteer summary, MAPSCorps[xxvii]

Figure 13: "83rd and Cottage Grove intersection. I always get the worst spikes at this intersection (always in the red). This is because there is a restaurant whose smoke is blowing in the air, a gas station, and a bus stop. Also, 83rd and Cottage is a busy intersection." – ELPC intern Julian Green[xxviii]

Diesel trucks & buses

"No matter what neighborhood we walked through, we saw many of the same polluters causing spikes in the PM 2.5 levels. Diesel vehicles like trucks and buses were a huge culprit. We often find high PM 2.5 levels on busy streets, especially streets with CTA bus routes. This was especially clear on the corner of Halsted & Fullerton in Lincoln Park." – ELPC intern Meghan Ward[xxix]

"Volunteers found a greater prevalence of commercial vehicles in the late morning and early afternoon, an observation that lines up with the elevated PM levels documented during those times." – South Chicago volunteer, Claretian Associates[xxx]

Construction

"Construction can sometimes cause PM 2.5 spikes, especially when old vehicles and equipment are used. In West Town, an area with rapid development, we noticed unhealthy levels of PM 2.5 throughout the neighborhood." – ELPC intern Meghan Ward

"Portions of Rush University Medical Center were under construction throughout my time monitoring this summer from the beginning of July to mid-August." – ELPC intern Tess Madden[xxxi]

Industrial facilities & factories

"General Iron is not a good neighbor. A fine layer of dust can be seen on everything from cars to windowsills to playground equipment. People have reported smells as far away as the 606 and Sedgwick L station and fluff as far away as the Lincoln Park Zoo." - Lara Compton, Lincoln Park resident & monitoring volunteer, calling to stop the metal-shredding facility's move to the Southeast Side.[xxxii]

"We walked through McKinley Park and Back of the Yards, two neighborhoods that have historically housed many factories. The air quality was poorer than average, and we observed a massive pollution spike outside the Wheatland Tube Co. building on 45th and Western. Observed levels of PM 2.5 jumped to the absurd level of 117." – ELPC intern Meghan Ward

Figure 14: ELPC interns walk by idling diesel trucks in McKinley Park

Heat & Humidity

"On hotter days, the PM readings hovered around 20 µg/m³, far worse than on cooler days when PM readings remained below 5 µg/m³ consistently throughout my routes." – ELPC intern Anna Kenig-Ziesler[xxxiii]

"I found that hot and humid days tend to have worse air quality overall. On days with heat indices above 100 degrees, I measured higher than average particulate matter concentrations, with PM2.5 levels consistently rising above 20 µg/m³." – ELPC intern Jonathan Garcia

Fireworks

"One possible influence could be the increase in fireworks leading up to and following the Fourth of July. Living near Humboldt Park, fireworks are a regular occurrence, and they impact air quality in the neighborhood and around the park." – ELPC intern Devon Snyder.[xxxiv]

"Fireworks were another surprising source of high PM 2.5 readings. On July 3, readings surpassed 134 in Gompers Park, where kids were setting off small fireworks. We could see the haze in the air from celebrations all week." ELPC communications writer Lena G. Reynolds

Cigarette smoke

"The first high reading I recorded on my air monitor happened when I passed a person smoking a cigarette. My PM 2.5 reading shot up from the 10-15 range into the low 40s – a very unhealthy reading." – ELPC intern Meghan Ward

Restaurants and personal barbecues

"Although the neighborhood's (Hyde Park) green spaces often seemed to help the surrounding air quality, one exception to this was when there were people grilling in the parks.

PM2.5 levels spiked considerably near people grilling, which is consistent with recent research."[xxxv] – ELPC intern Anna Kenig-Ziesler

"Restaurants with woodfire and propane ovens caused a spike in PM 2.5. This unexpected source consistently raised pollution whenever we passed one. Burning wood raises PM 2.5 levels.[xxxvi] One PM 2.5 reading we observed when we passed a restaurant with a woodfire oven in Hyde Park measured 38 ppm." – ELPC intern Meghan Ward

Forest fires

"July (2021) forest fires throughout parts of Ontario and First Nation Communities in east-central Canada and the western United States impacted Chicago air quality as well.[xxxvii] Smoke from the wildfires created noticeable haze during the better part of the month and resulted in higher levels of fine particulate matter." – ELPC intern Devon Snyder

HOTSPOTS CONCENTRATE NEAR FAMILIAR SOURCES

Throughout our data analysis, several locations in the city stood out as having elevated PM2.5 readings, based on either Microsoft/Project Eclipse stationary monitoring or ELPC's mobile AirBeam monitoring. While we cannot say for certain what is causing pollution at these locations, several are near highways and roads with substantial truck traffic, railyards, and train tracks that carry both freight and passenger rail. These activities all produce significant pollution alone and in combination. Most of the sites in this list came from ELPC's mobile monitoring analysis, where we recorded a median pollution level of at least 20 µg/m³ in 10-30 repeat visits. The other sites noted here are pulled from the Microsoft/Project Eclipse data, where the daily median exceeded 25 µg/m³.

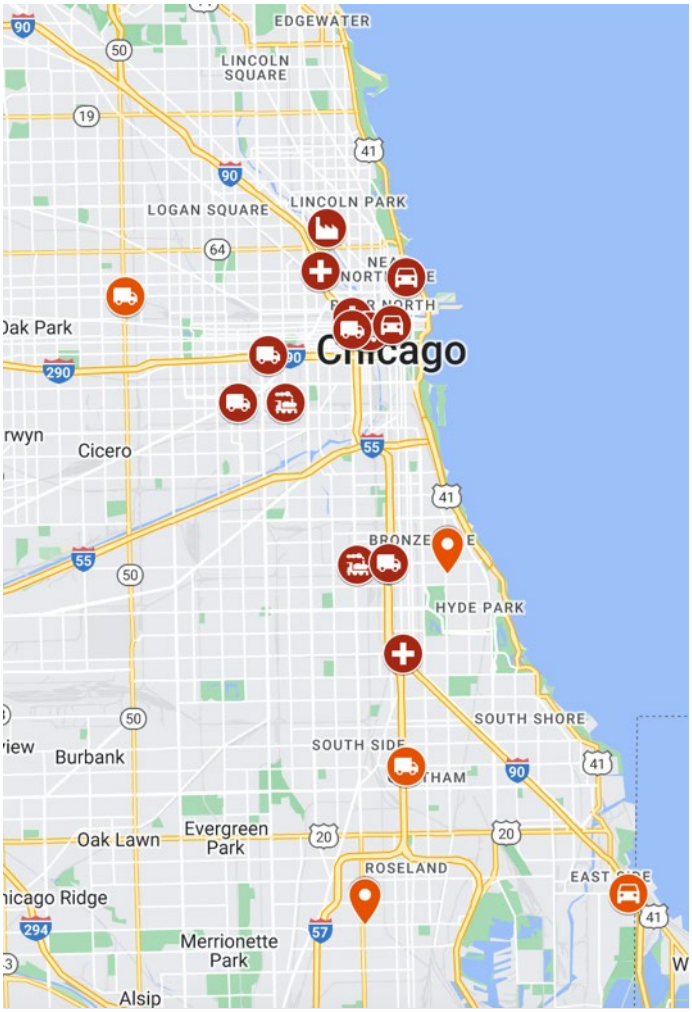

Figure 15: Map showing ELPC and Microsoft Research hotspots. Many are near transportation corridors, industrial facilities, and other sources. See interactive map here.

Near Highways & Trains

Given that diesel transportation is one of the leading sources of particulate matter pollution, it was no surprise to find hotspots near highways, freight and passenger rail lines, and railyards throughout the city. There are fewer diesel engines in the city than gas, but they are more likely to create air pollution hotspots, both because they are more polluting and because they tend to concentrate and idle for extended periods of time around freight facilities and distribution corridors. Gas engines are more common for personal passenger vehicles and are widely distributed throughout the city. Although gas cars are not as bad as diesel, they still rank highly among pollution sources, contributing anywhere from 35% to 45% of roadway particle pollution. These sites with high particulate levels are close to highways and/or diesel trains:

→ North Side
- *Kennedy Expressway (I-90/94) & Division near two Metra lines*
- *DuSable Lakeshore Drive (US-41) & Michigan Ave*
- *Kinzie & Halsted, over the Kennedy highway (I-90/94) near many Metra line*

→ West Side
- *Eisenhower Highway (I-290) & Oakley*
- *Damen & 15th under Union Pacific railyard*
- *Clinton & Randolph near Ogilvie Metra station*
- *Canal & Washington near Ogilvie Metra station*
- *Randolph & Halsted near Kennedy Highway (90/94)*

→ South Side
- *Halsted & 47th near Norfolk Southern railyard*
- *Wells & 47th over Dan Ryan highway (I-90/94)*
- *State & 63rd near Norfolk Southern railyard, Dan Ryan highway (I-90/94), & other industrial facilities – Microsoft data*
- *State & 83rd over Dan Ryan highway (I-94) – Microsoft data*
- *106th & Avenue D near the Chicago Skyway – Microsoft data*

Other Hotspots

The following sites were not particularly close to highways or diesel trains so there is probably a combination of other sources causing high pollution levels. The General Iron facility likely contributed to the hotspot recorded at Clybourn and Cortland, but for the rest of the sites it is difficult to determine a clear cause. Some spots are in or near light industrial areas, major arterial roads with bus and truck traffic, a concentration of restaurants, or other potential sources. Further examination is necessary.

- → North Side
  - *Clybourn & Cortland near the General Iron facility*
  - *Lake & Clark/Dearborn downtown in the loop*
- → West Side
  - *Chicago & Cicero – Microsoft data*
  - *Ogden & California by Douglass Park*
- → South Side
  - *Cottage Grove & 49th – Microsoft data*
  - *Halsted & 111th – Microsoft data*

Considering the unequal distribution of monitoring equipment across the city, this is by no means an exhaustive list of all hotspots. There were several locations where ELPC mobile monitoring showed elevated particulate matter, but there were insufficient repeat visits to gain long-term confidence in the results. ELPC recommends that the City of Chicago's Department of Public Health and the Illinois EPA conduct additional monitoring and observations at these and other locations to better understand the pollution levels and sources, and what can be done to mitigate the impacts on public health in the surrounding communities.

BETTER AIR QUALITY NEAR PARKS

ELPC investigated the variation in particulate matter levels across various city zoning types to see how land use correlated with air pollution. This study focused on the same 67 Microsoft/Project Eclipse stations with 90% or more operation time in 2022 as discussed in earlier sections. We drew buffer lines around each sensor station with radii of ¼ mile, ½ mile, and 2 miles, calculated the area of each zoning type, and compared zoning percentages with readings at that monitor. We examined the spatial distribution of nine zoning types: Business, Commercial, Downtown, Residential, Manufacturing, Planned Development (PD), Planned Manufacturing Development (PMD), Parks and Open Spaces (POS), and Transportation.

We found that annual PM2.5 levels were significantly correlated only with the Parks and open Spaces (POS) zoning type. The more park land around the air monitor, the better the air quality. At a ¼-mile radius, the correlation coefficient was -0.384, indicating a moderately negative relationship between PM2.5 levels and the percentage of park land nearby. Interestingly, this correlation became slightly stronger at a 1/2-mile radius, with a coefficient of -0.427, suggesting that parks have a more pronounced influence within this distance. However, as the radius increased to 1 mile, the correlation weakened to -0.358.

Although correlation does not equal causation, these findings imply that the presence of Parks and Open Space zoning might be a contributing factor in reducing PM2.5 concentrations especially within a half-mile radius. Beyond this distance, the correlation begins to weaken, suggesting that the benefits of parks in mitigating air pollution diminish as the radius expands. This observation highlights the important potential role of parks and open spaces for improving air quality in urban areas. In a park, away from many polluting sources and vehicles, you have a chance to

breathe cleaner air, and even beyond parks the air is cleaner nearby. If you lack parks, your opportunity to breathe cleaner air diminishes.

Although the idea that parks are good for air quality seems intuitively evident, this is a completely new kind of analysis, using the most robust urban air monitoring data set in Chicago yet available. It is nice to know that Chicago's "city in a garden" motto is proving beneficial to residents' health; however, we cannot rest on those laurels.

In the Chicago Metropolitan Agency for Planning's "On To 2050" plan, the agency's goal is for 65% of the population to have access to four or more acres of parkland per 1,000 residents but it noted, "this is an ambitious goal." Currently only 52.2% of the population has such access, and in historically disinvested areas the percentage drops even lower: only 24.5% of disadvantaged communities have access to 4+ acres of parkland per 1,000 residents. We cannot put a whole new Grant Park in every neighborhood to share the benefits of parkland more widely. Our analysis calculated the total area of park lands around each monitor, not the size of any particular park. Pocket parks, linear greenways like the 606 and Major Taylor Trail, and gardens like El Paseo Community Garden provide rich quality-of-life benefits to residents and bring to life abandoned or underutilized spaces in addition to air quality benefits.

Beyond its parks, Chicago has seen declining tree cover for the past decade, losing about 10,000 more trees per year than planted.[xxxviii] This decline can have impacts on stormwater absorption, summer heat protection, CO2 storage, and particulate matter too. In our vegetative buffer program, ELPC has been working with the Morton Arboretum, US EPA, the US Forest Service, University of Illinois, Illinois Department of Transportation, and Chicago Public Schools to explore how trees can protect students from air pollution.[xxxix] Studies show that a dense planting of evergreen trees, bushes, and other plants can physically block pollution-laden air, while filtering particles as they pass through and accumulate on leaf surfaces. ELPC identified dozens of schools near high traffic corridors to start a pilot project, many directly adjacent to highways. In 2023, ELPC helped plant a vegetative buffer on the city's South Side, to help protect a school directly adjacent to the Dan Ryan Interstate.[xl]

Continuing to expand Chicago's park system, while reducing pollution sources within parks, and expanding tree cover and vegetative buffers beyond parks could provide benefits to even more residents.

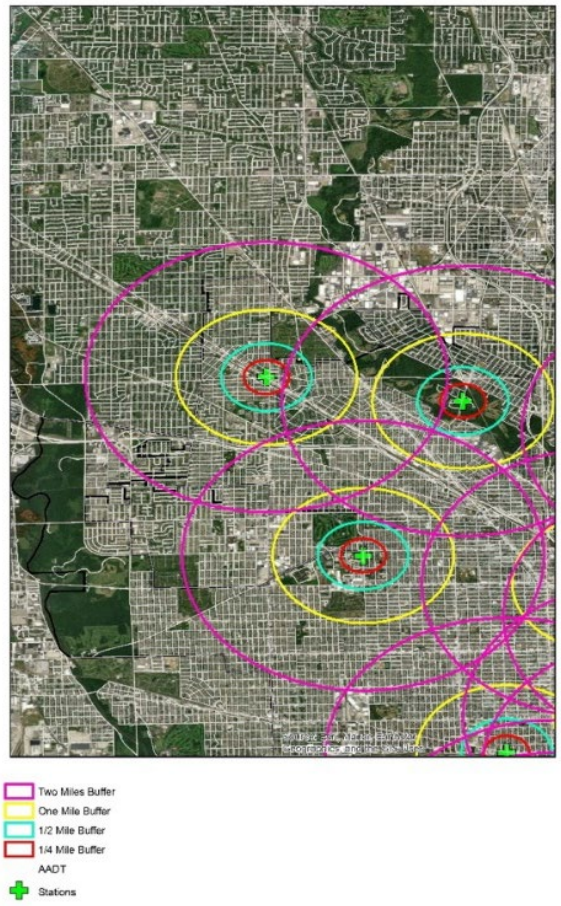

Figure 16: Park Proximity Analysis - Screenshot of a city map showing the Microsoft/Project Eclipse stations with buffer rings drawn around them. Within these rings, we calculated the proportion of each zoning type and measured the correlation with the air quality recorded at the station.

STRONGER STANDARDS WOULD PROTECT MORE PEOPLE

Every five years, the EPA is required to review the science on particulate matter and consider lowing the threshold for what is considered most harmful. Updating standards for pollutants like soot takes time, but the pace and result can depend on the administration. The Trump EPA left the standards alone in 2020, ignoring the advice of the agency's own scientific advisory committee. The Biden EPA reconsidered in 2021 and initiated a new review of the science. In January 2023, EPA proposed more stringent standards for soot pollution and issued a final rule in February 2024. The agency tightened the annual standard from 12 µg/m³ to 9 µg/m³ and left the daily standard in place at 35 µg/m³.

While EPA's rule was still under consideration, ELPC conducted an analysis of Chicago's air quality data, to illustrate how stronger standards might protect more people. ELPC joined a chorus of environmental and public health professionals, including the American Lung Association in calling on the EPA to issue the strongest possible standards.[xli] We included the following analysis in our testimony to EPA in March of 2023.

We analyzed the 2022 air quality data from Microsoft Research stationary monitors and found that many communities and places where high particulate matter levels commonly occur, were overlooked by the old standards (12 µg/m³ annual & 35 µg/m³ daily). Stronger standards would help bring attention to more such hotspots, so lawmakers and public health agencies could target mitigation and protect people from harm.

Daily Data/Comparison to EPA Standard

We calculated the median of all the recorded data points for each day, and looked for stations that exceeded 35ug/m3, the level considered especially unsafe according to the EPA's daily standards. Our analysis indicates that in 2022, three stations on the South Side exceeded this threshold for 20, 14, and 16 days, respectively, in September and October. Concentrations ranged from 68.9 to 226.4 µg/m³, with an average of 175.75 µg/m³, which is far above the daily threshold of 35 µg/m³. There was clearly something going on at these locations last fall. The City of Chicago should examine the areas around these stations to prevent air pollution from harming people there.

EPA defines its daily PM2.5 standard as the 98th percentile of 24-hour concentrations, averaged over a 3-year period, with a threshold of 35 µg/m³.[xlii] In this study, due to the availability of only one complete year of air quality data from Microsoft stations, we adopted a simplified approach. Instead of applying the 98th percentile method, each day's average daily PM2.5 concentration exceeding 35 µg/m³ was reported for each site. This part of the analysis was primarily aimed at raising awareness about the numerous instances of elevated daily PM2.5 levels during 2022.

We wondered what the map would look like if the US EPA adopts stronger standards, as advised by scientists, public health experts, and environmentalists. When we reexamined the data using a threshold of 25 µg/m³, we found six stations on the city's South and West Sides experienced frequent concentrations above this level, stretching from March to December 2022. People facing poverty often have fewer options to reduce exposure and less access to the healthcare needed to heal from the effects of air pollution. In some of the census tracts around these locations, up to 43% of the residents live below the federal poverty level, exacerbating the impacts of the air pollution they experience.

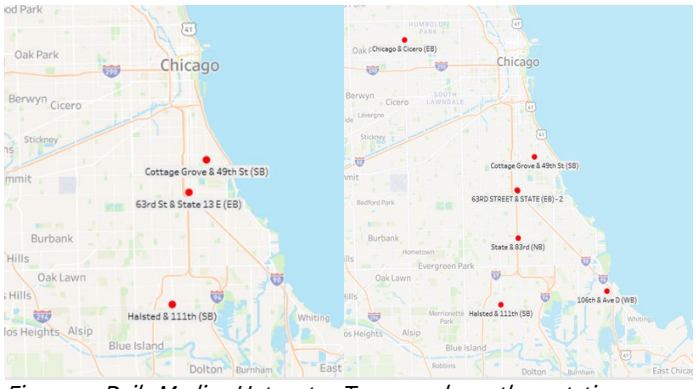

Figure 17: Daily Median Hotspots - Top map shows three stations exceeded the current EPA daily standard, 35 µg/m³. Bottom map shows six stations exceeded the recommended standard, 25 µg/m³.

Annual Data / Comparison to EPA Standard

For the annual analysis, we calculated the median PM2.5 levels for all 67 stations operating more than 90% of hours throughout 2022. We added up to 105,000 data points for each station, calculated the median, and looked for stations that exceeded 12 µg/m³, the level considered unsafe according to EPA's annual standards from 2012-2024. No stations exceeded that threshold. Again, we wondered what the map would look like with stronger standards and arrived at very different maps. We selected 10, 9, and 8 µg/m³ levels to analyze, based on the EPA announcement that the agency was considering a new annual standard within that range.

16 stations had annual PM2.5 levels exceeding 10 µg/m³ (see second map below). In the census tracts around these stations there are 76,100 people, with 19% living below the poverty level. When we set the threshold at 9 µg/m³, the new annual standard as of February 2024, 41 stations exceeded the limit (see third map below). These stations were in census tracts with 156,580 residents and a 20% average poverty rate. At 8 µg/m³, 66 of the 67 stations exceeded the threshold, including census tracts that encompass over a quarter million people, with an average of 19% living below the poverty line. In some of these census tracts as many as 68% of residents are living on less than the poverty level.

Census tracts are quite local, covering just a few square blocks within a neighborhood, so there were not nearly enough air monitors running throughout 2022 to monitor each census tract in the city closely, but the 67 monitors studied did track a wide variety of neighborhoods (see fourth map below). If 66 of those 67 showed particulate matter exceeded 8 µg/m³, it may well be that the majority of Chicagoans are affected by PM2.5 pollution. Stronger standards help show how pervasive this problem is and resulting changes will bring cleaner air to everyone and have the biggest impact on those who are most burdened.

Although ELPC agrees with the EPA's Clean Air Scientific Advisory Committee recommendation that standards no higher than 8 µg/m³ would be better, we welcome the new federal standard of 9 µg/m³ as an important step in the right direction.

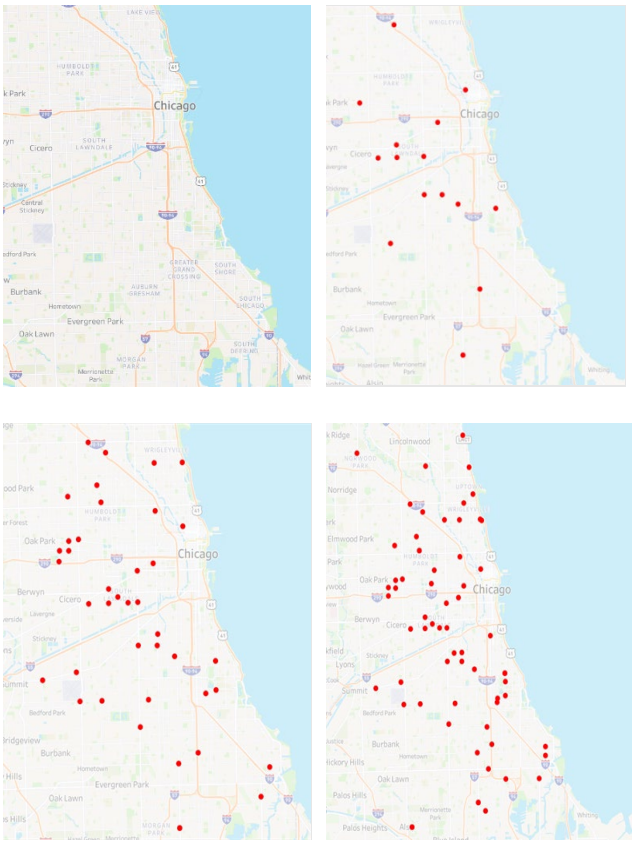

Figure 18: Annual Median Hotspots – Top left map shows no stations exceed the old current annual standard, 12 µg/m3. The three other maps show increasingly more stations in the dangerous category, if the threshold changed to 10, 9, or 8 µg/m3, respectively. The new annual standard of 9 µg/m3 will protect many more Chicagoans.

Final Thoughts & Recommendations

Air pollution has always been a multifaceted challenge, but ELPC's Air Quality Monitoring Project has taught us a great deal about how fine particulate matter (PM2.5) affects Chicago and how we can fight it. Here are some recommendations, based on our findings.

MORE MONITORING –
PM2.5 affects Chicago communities unevenly. Although many hotspots that emerged from the data had clear pollution sources, some were a bit mysterious. We need more air quality monitoring to better understand how PM2.5 clusters, where, and when.

→ **Establish a City Stationary Monitoring Network**: There should be a publicly-owned, reliable, comprehensive, and consistent source of accessible air quality data. While the Microsoft Research network provided valuable insights, strong community commitments, and good data transparency, a private corporation cannot be expected or relied upon to provide this data over the long run. Community-based mobile monitoring is also important, but the burden should not fall to residents alone. Relying on volunteers can create imbalanced data. The City of Chicago has committed to establishing a stationary monitoring network, and ELPC will continue to hold city leaders to that commitment and related implementation.[xliii]

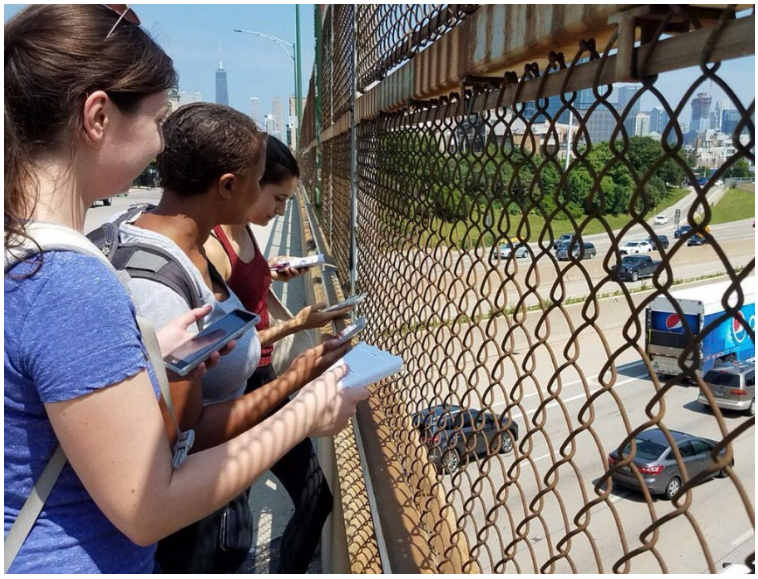

Figure 19: ELPC interns document air quality readings on an I-290 overpass

→ **Continue Community-based Mobile Monitoring:** ELPC's work shows that mobile monitoring is very valuable and important for public engagement, education, observation, and data collection, especially for providing granular geographic detail. The downsides are that mobile monitoring is labor intensive, does not offer documentation at all times, and is shaped by volunteer availability which can lead to data clusters in some neighborhoods more than others. These challenges can be mitigated by utilizing strong methodology and in combination with stationary monitoring. We recommend future mobile monitoring programs with the following approaches:

- *Walk* – Monitoring should be conducted on foot to maintain a consistent sampling rate over time and reduce safety risks. While biking is an option, it is much harder to take contemporaneous notes and photos at the same time for young children or inexperienced riders. We do not recommend monitoring while driving, as the risk of distraction could put both passengers and pedestrians in harm's way, and the monitor could pick up PM2.5 emitted by the vehicle itself.

- *Observe* – When visiting pollution hotspots, observe traffic patterns, local businesses, nearby green space, or other factors that might be affecting pollution rates. Air monitors determine pollution levels based on the size of pollutant, not its makeup, so observational data can help to discern the sources.

- *Repeat* – Any single sample could be an anomaly, so repeated visits ensure more confidence in the results over time. We recommend a minimum of 30 samples, during distinct hours, spread among 30 different days of the year. Monitoring can be conducted during any hour of the day or any day of the

week, however all sampling should not be done during a single hour or single day of the week. Make sure to include before, during, and after 12 noon to 2 p.m. in monitoring schedules. We also recommend including Tuesdays and Wednesdays in the monitoring days, since PM levels tend to be higher on those days. Spreading data collection between May and October increases the likelihood of obtaining the most accurate data. We also found that more data is needed on Chicago's South Side in September and October, as there were particularly high spikes in Washington Park and Roseland.

- *Follow Up* – Continue monitoring the Unconfident and Relatively Confident areas from ELPC's interactive map, where PM2.5 levels are above 12 μg/m³. Meeting the minimum repetition of 30 samples, during distinct hours and distinct days, will solidify the data and identify hotspots of persistent pollution issues.[xliv]

REDUCE CURRENT SOURCES OF POLLUTION –

PM2.5 tends to cluster around major pollution sources such as transportation corridors, industrial facilities, and construction sites, especially on Chicago's South and West Sides. While more monitoring should target the worst sources more directly, there are many things to do now to reduce pollution from well-known sources.

→ **Implement Stronger Federal PM 2.5 Standards**: ELPC's analysis shows that there are numerous communities facing air pollution risks that were overlooked by the old federal standards for years (35 μg/m³ daily, 12 μg/m³ annually). Now that the US EPA announced a stronger annual standard (9 μg/m³), based on the latest science, we hope to see swift and effective implementation.

→ **Clean Up Construction Equipment**: ELPC has worked with two construction companies on non-government projects, where each voluntarily limited idling and used cleaner equipment with good results. Leopardo chose to continue the cleaner practices on more recent projects. However, most construction projects continue to rely on heavy-duty diesel vehicles, which emit toxic compounds and particulate matter, posing a great threat to respiratory health. Changing construction practices can reduce street-level particulate matter levels, benefiting both the workers and community residents. Clean construction utilizes cleaner equipment and limits idling to lower pollution at and near work sites. Zero-emission electric equipment and trucks are available already, and new models are continually coming to market. Chicago has a clean construction ordinance that nominally applies to a subset of city projects, but neighborhoods could benefit from advocating for clean construction practices at all city and private developments.

→ **Target Hotspots at Industrial Facilities**: ELPC's data showed hotspots near industrial sites such as General Iron in Lincoln Park Wheatland Tube in McKinley Park, and other industrial corridors.

- *Stop General Iron* – After years of permit violations, explosions, and health impacts on Lincoln Park residents, General Iron is not a good neighbor, no matter the neighborhood. This facility should not be allowed to operate on the Southeast Side, a community that already has numerous industrial facilities and is facing disproportionate health impacts. After Southeast Side residents spoke out about this environmental injustice, the City made the right decision to deny the permit for General Iron. We hope this decision stands, and ELPC will continue to support city residents seeking cleaner air and environmental justice.

- *Better enforcement* – When businesses violate environmental regulations and permits, enforcement by city, state, and federal authorities should be swift and fair. Unfortunately, this is not always the case, as shown by ELPC's 2020 Region 5 report on lagging Clean Water Act enforcement under the Trump Administration, or in a recent report by McKinley Park-based Neighbors for Environmental Justice on City and State enforcement.[xlv]

→ **Reduce Pollution from Transportation Sources**: Fossil-fuel combustion is a leading source of particulate matter, contributing to many PM2.5 hotspots across Chicago. Shifting to zero-emissions electric vehicles, cleaning up combustion engines, and reducing the number of vehicles on the road can help to reduce pollution in these hotspots.

- *Idling enforcement* – Under city law, diesel buses and trucks are not allowed to idle for more than three minutes, but the current law is rarely enforced. The city should consider other approaches to enforce the law and protect public health.

- *Diesel Trucks* – Local, state, and federal authorities each have opportunities to reduce truck impacts on Chicago communities. The US EPA should adopt strong heavy-duty vehicle standards, which are expected to eliminate 650 tons of particulate matter by 2055. The heavy-duty NOX rule that the EPA finalized in December 2022 will also help to reduce particulate matter, starting in 2027. Illinois should follow other states in adopting two standards: the Heavy-Duty NOx rule to reduce pollution from combustion engine trucks and the Advanced Clean Truck Rule to speed up the shift in sales towards new electric models.

- *Freight trains* – Trains currently transport about 40% of the nation's long-distance freight, more efficiently and safely than trucks on our highways. Diesel trains contribute to hotspots such as those near the Norfolk Southern railyard at 63rd and State or the Union Pacific railyard at 15th and Damen. Federal and state programs to require cleaner models and increase the market share of electric trains and railyard equipment will help clean up this sector as will reducing train idling. The ongoing CREATE program will help to streamline train traffic through the city and reduce idling, although much more work is needed.

- *Passenger cars* – Gas-powered cars are cleaner than diesel, but they still make up the second-highest source of roadway particulate pollution, contributing to the hotspots we saw near highways and arterial roads. In addition to fossil fuel combustion in the engine, cars also create particulate matter from tires, brakes, and roadway wear. People will always need personal passenger vehicles for many trips and purposes, but we can reduce pollution from this sector by shifting to more fuel-efficient cleaner cars, hybrids, and all-electric vehicles. Policymakers can also reduce residents' dependence on cars by making streets safer for pedestrians and cyclists, increasing housing density in walkable transit-oriented communities, and ensuring safer and more reliable public transportation.

- *Passenger trains* – Chicago's famous "L" train has always been electric, but the suburban train network is mostly diesel. The hotspots near the Ogilvie transportation center were particularly noticeable in ELPC's data (Clinton & Randolph, Canal & Washington). The planned Union Station upgrades could help streamline train traffic and reduce idling. Metra is exploring opportunities to electrify, but they will need additional pressure and support from local, state, and federal authorities to do so quickly. Metra should also work with the city to reduce pollution impacts at Ogilvie.

- *Transit buses* – CTA has over 1,800 diesel buses operating on 129 routes throughout the city, serving millions of Chicagoans every year. Every person who rides the bus means one less car on the road, but diesel buses still contribute to air pollution along arterial roads, as ELPC monitoring volunteers frequently observed. CTA has committed to full electrification by 2040 and has already begun to roll out new emissions-free battery buses. ELPC began sharing our air monitoring data with CTA several years ago, in order to help the agency prioritize new buses on routes most affected by air pollution, such as Chicago Avenue and 63rd Street.

- *School buses* – Diesel school buses contribute a lot of particulate matter to our air. They are particularly dangerous for school children, whose lungs are still developing. Electric school buses provide a cleaner ride for kids and healthier communities too. ELPC has been a Midwest champion for electric school buses for many years, helping to connect school districts with state, federal, and utility funding sources across the region. After a formula flaw in the federal Clean School Bus Program failed to-prioritize Chicago Public Schools (the nation's 4th largest district) in the first round of funding applications, we galvanized Illinois' Congressional delegation and clean air advocates to adjust the formula for the second round. Electric school buses are now rolling out across the Midwest, including to Chicago Public Schools.

PROTECT AFFECTED COMMUNITIES –

We cannot stop pollution overnight, but stronger city ordinances and federal regulations, informed by local data, can help improve air quality in overburdened Chicago communities. More public awareness can also help residents to protect themselves and reduce their exposure.

→ **Data should inform public policy:** With a rich set of air quality data, city agencies can better target pollution reduction actions in the high-priority places that need them most. For example, ELPC shared our air quality data with the Chicago Transit Authority (CTA) as it was planning on rolling out new battery electric buses. The agency began running emissions-free buses on the Chicago Avenue #66 bus in 2021.[xlvi] Although buses account for just a fraction of the city's transportation emissions, they can have a concentrated

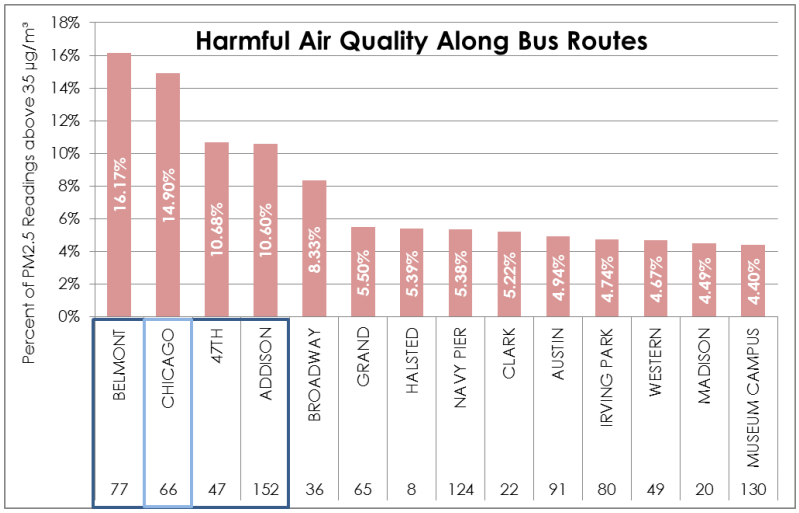

Figure 20: ELPC's 2019 analysis of CTA bus routes where data showed high particulate matter readings on high-frequency routes, often overlapping with truck routes and high-traffic arterials. We look forward to the CTA achieving full electrification of its bus fleet by 2040.

→ **Pass a Strong Cumulative Impacts Ordinance**: The City of Chicago recently completed an assessment to understand how environmental risks in Chicago communities may be compounded by multiple polluters and other socioeconomic challenges. ELPC's data confirms that air pollution affects some neighborhoods more than others, particularly on the South and West Sides and in communities with high poverty. ELPC worked with a coalition of community and environmental groups working with the City of Chicago to finalize its assessment. Now that it's complete, the city should adopt a cumulative impacts ordinance to protect community residents.

→ **Expand Vegetative Buffers:** ELPC analysis shows that Parks and Open Space zoning is correlated with lower PM2.5 concentrations within a half-mile radius. ELPC has been working with the Morton Arboretum, US EPA, and The University of Illinois on vegetative buffers, working to install dense evergreen trees and shrubs where schools are close to interstate highways and busy railyards. Public leaders and agencies should explore more opportunities to increase park space in communities lacking access and install additional vegetative buffers to protect vulnerable populations.

→ **Improve public awareness –** The city should explore opportunities to get the word out about high-risk times and locations where air quality is especially bad and harmful, in addition to advice for reducing emissions and exposure. Some cities post billboards with regular air quality updates, which are also found on weather apps. Text alerts could reach additional audiences.

On high pollution days, public health experts advise that residents reduce time outdoors, avoid strenuous exercise, and wear a mask to reduce exposure. Avoid driving, barbecuing, or other outdoor combustion activities like bonfires to reduce your personal emissions and protect your neighbors. Even on regular days, if you have any outdoor space, you can protect your home by planting trees and bushes to act as a vegetative buffer. To improve indoor air quality, bring in potted plants, ventilate your home with air purifiers, and use your hood vent when you cook. Take advantage of rebates and other incentives to switch to efficient and electric appliances whenever possible.

Whether particulate matter comes from near or far, it can be detrimental to your health, so please help advocate for change. Join a local environmental organization, volunteer for air quality monitoring, or reach out to your elected representatives to tell them that safe communities and healthy clean air matter to you.

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