# Mobile Air Quality Mapping in the District

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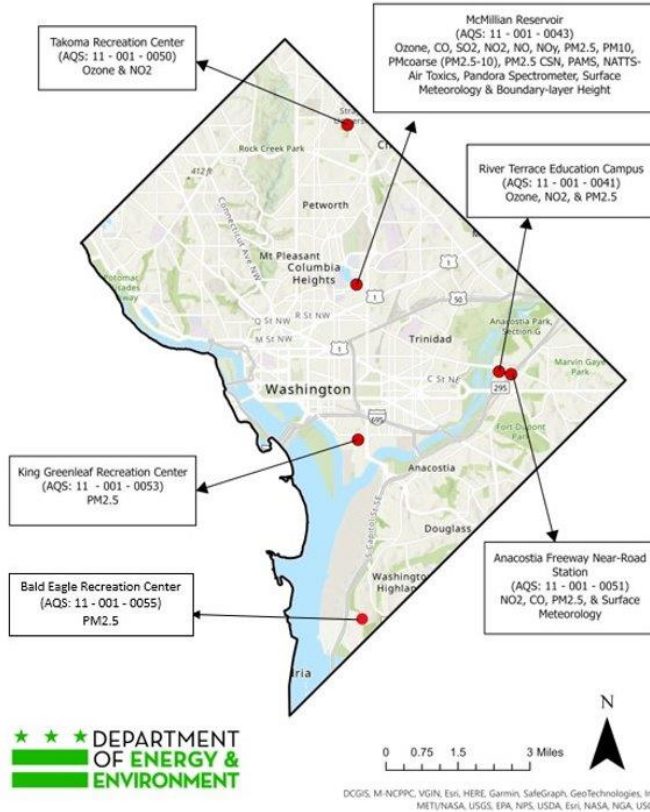ACPAC
September 2024

DEPARTMENT OF ENERGY & ENVIRONMENT

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GOVERNMENT OF THE DISTRICT OF COLUMBIA
MURIEL BOWSER, MAYOR

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Washington DC's Ambient Air Monitoring Network

| Site Location | Address | Location Setting* |
|---|---|---|
| Takoma Rec Center | 301 Van Buren St NW | |
| McMillan Reservoir | 2500 First St NW | |
| River Terrace Education Campus | 405 Anacostia Ave NE | Historically overburdened community |
| Anacostia Freeway Near-Road Station | Benning Rd NE @ I-295 On-ramp | Historically overburdened community |
| King Greenleaf Rec Center | 201 N St SW | Historically overburdened community |
| Ward 8 Site | 100 Joliet Street, SW | Historically overburdened community |

*All stations considered urban

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# What is DOEE doing to Assess Air Quality in Overburdened Communities?

Reorienting and expanding the regulatory network
- Currently 4 (of 6) stations in overburdened communities
- Network compliant with PM NAAQS EJ requirements

Community-scale hyperlocal air monitoring to identify hot-spots
- Hyperlocal mobile monitoring with Aclima
- Emerging technology low-cost sensors
- 3 park-bench emerging technology air monitoring stations
- Mobile monitoring van program

Community Involvement
- Stakeholder engagement on Ward 8 location
- Shared governance for 3 park-bench monitor
- Trained "Air Ambassadors" to understand local air quality issues
- Examining Air Ambassadors as an avenue for low-cost-sensor network hosting

# Communities of Focus

**Disadvantaged Census Tracts According to the Climate and Economic Justice Screening Tool**



**Legend**

DC Wards

Climate and Econmic Justice Screening Tool

Disadvantaged

Not Disadvantaged

DC GIS
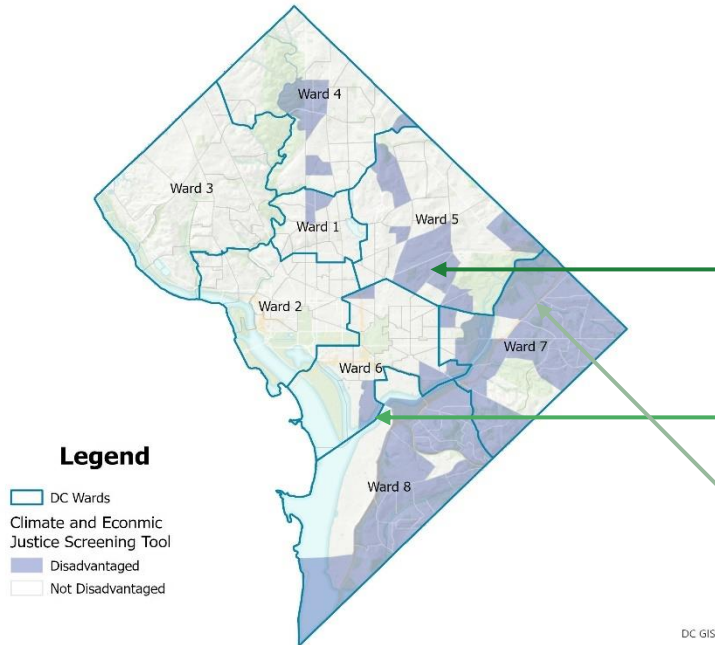
## Communities with residential areas next to industrial areas are disproportionately exposed, including:

**Ivy City and Brentwood**
Located near industrial facilities and are on either side of the Ivy City railyard, as well as traffic from New York Avenue.

**Buzzard Point**
Has historically had multiple facilities such as concrete plants that result in increased levels of particulate pollution, as well as a now-demolished power plant.

**Mayfair**
Next door to the old Kenilworth Landfill, which used to receive waste and ash from several District municipal waste incinerators and a now demolished oil-fueled power plant, Pepco Benning Road.

# Introduction to Aclima Mobile Monitoring

Aclima uses mobile mapping and analysis to generate maps that show typical pollution concentrations with high spatial resolution (**hyperlocal maps**)

These maps highlight typical concentrations over a defined measurement period, in this case two weeks for the DC Pilot, illustrating high and low pollution concentrations at the street level.

All 1-second measurements are assigned to a ~100m **road segment** based on the location (latitude and longitude) of the data point.
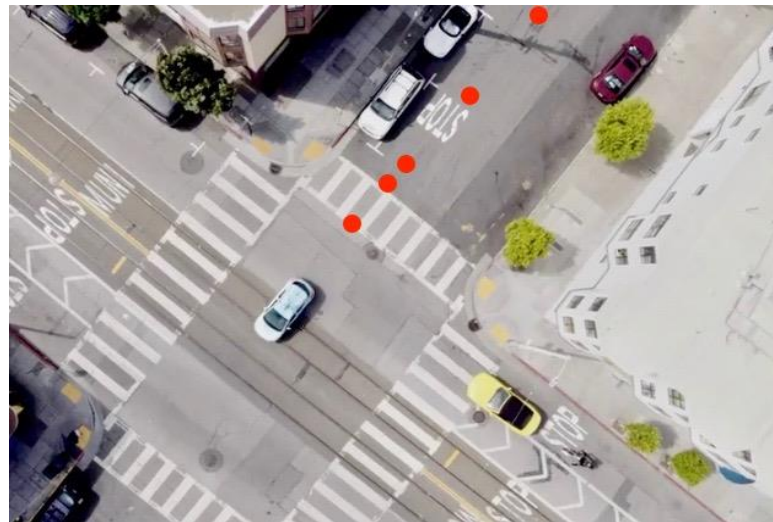


1 second data points as red dots aligned to the route of the car.

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△aclima

Ivy City / Brentwood
Buzzard Point
Mayfair

PILOT OVERVIEW

In June 2023, Aclima conducted two weeks of hyperlocal mobile air quality measurement across 3 neighborhoods specified by DC-DOEE:

Mayfair, Ivy City/Brentwood, and Buzzard Point (5 census tracts total).

Measurement included:
Carbon dioxide, fine particulate matter, nitrogen dioxide, carbon monoxide, ozone, black carbon, methane, and TVOCs.

# EPA's National Ambient Air Quality Standards (NAAQS)

Criteria Air Pollutants (in **bold** are pollutants measured by Aclima)

☑ **Ozone ($O_3$)** — 70 ppb (8 hour)

☑ **Nitrogen dioxide ($NO_2$)** — 100 ppb (1 hour); 53 ppb (annual average)

☑ **Fine particulate matter ($PM_{2.5}$)** — 35 $\mu g/m^3$ (24 hour); 9 ug/m3 (annual average)*

☑ Coarse particulate matter ($PM_{10}$) — 150 $\mu g/m^3$ (24 hour)

☑ **Carbon monoxide (CO)** — 35 ppm (1 hour), 9 ppm (8 hour)

☑ Sulfur dioxide ($SO_2$) — 75 ppb (1 hour)

☑ Lead (Pb) — 0.15 $\mu g/m3$ (3 month average)

*EPA recently strengthened annual $PM_{2.5}$ NAAQS*

# How to interpret the following maps:

Measurements collected June 15 – 28, 2023



Pollutant and units

CO [ppm]

0.31 - 0.36 ← Bottom 20th percentile
0.36 - 0.38
0.38 - 0.43
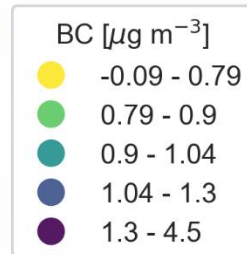0.43 - 0.48
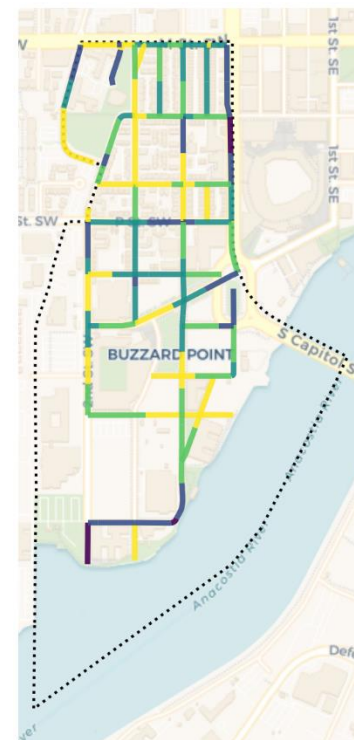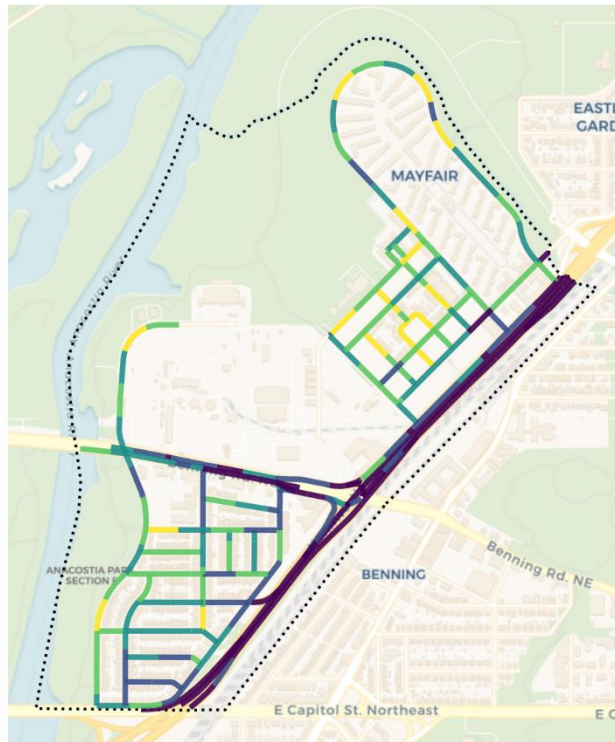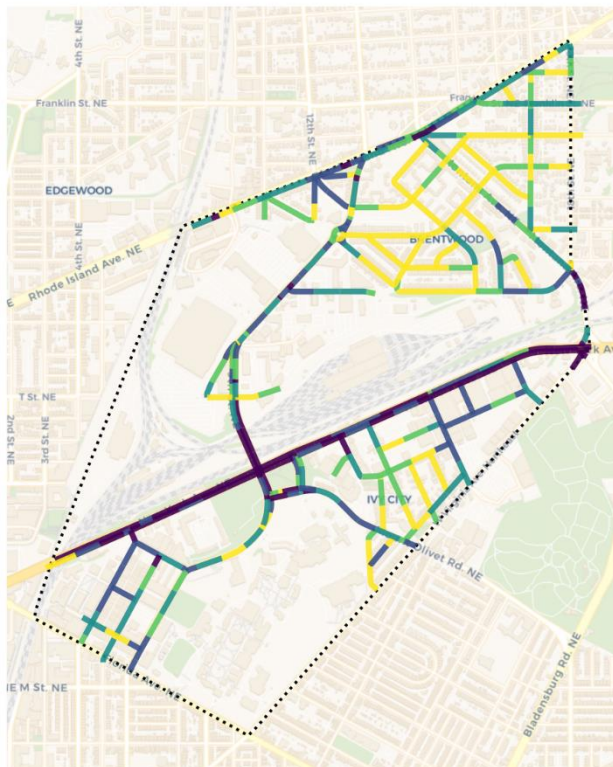0.48 - 0.89 ← Top 20th percentile

Measurement area bounds
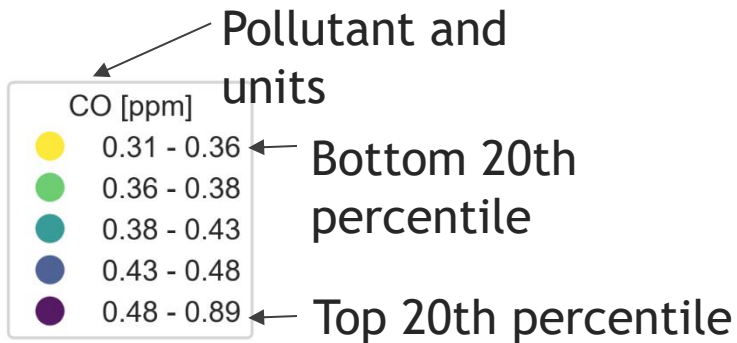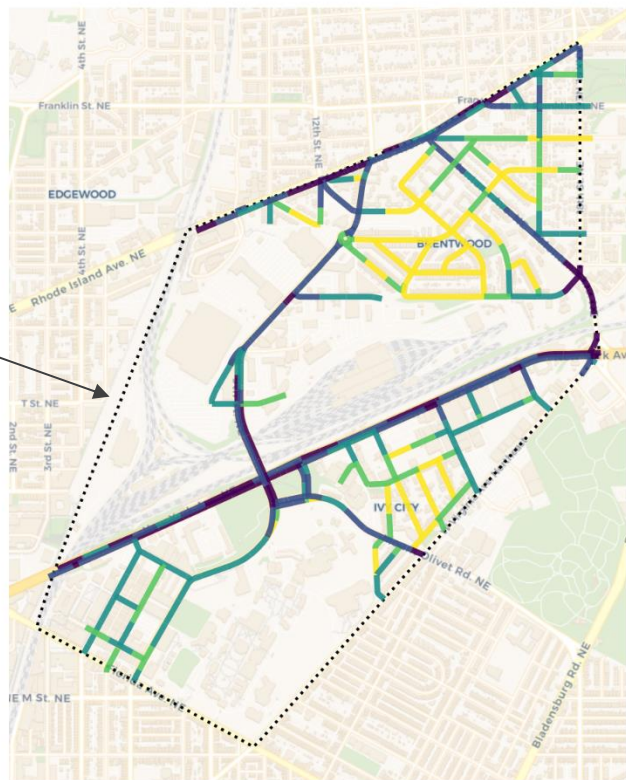
Median concentration color scale grouped by 20th percentile intervals

# PM$_{2.5}$ (Fine particulate matter)

Standard: 35 $\mu$g/m$^3$ (24 hr); 12 $\mu$g/m$^3$ (annual)



PM$_{2.5}$ [$\mu$g m$^{-3}$]
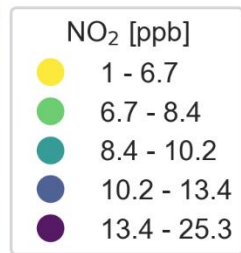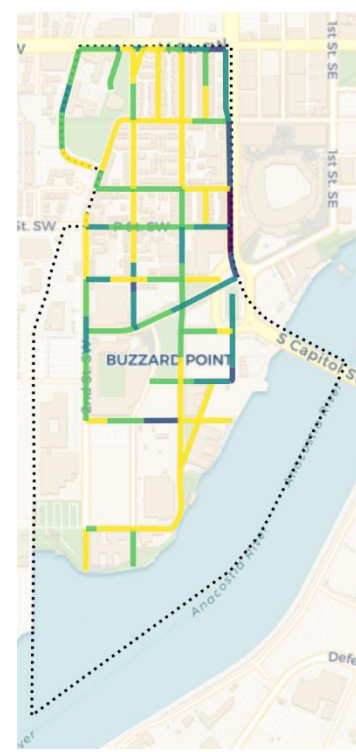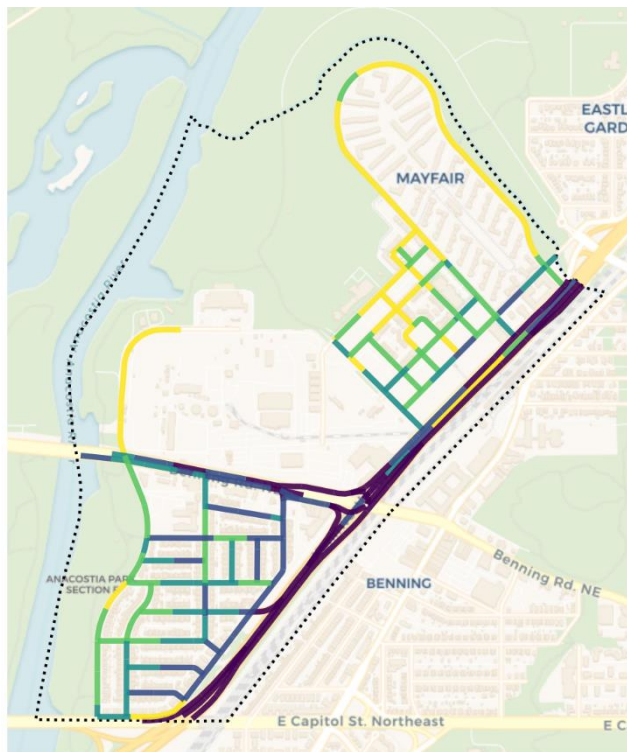- 2 - 6
- 6 - 7
- 7 - 8
- 8 - 10
- 10 - 24

# Black Carbon (BC)



BC [$\mu g\ m^{-3}$]
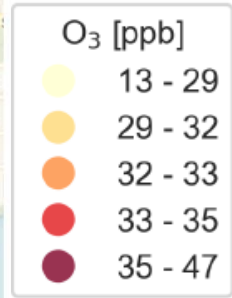- -0.09 - 0.79
- 0.79 - 0.9
- 0.9 - 1.04
- 1.04 - 1.3
- 1.3 - 4.5
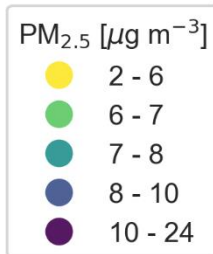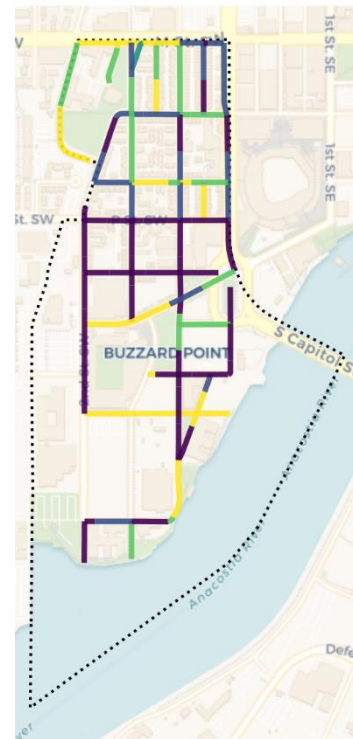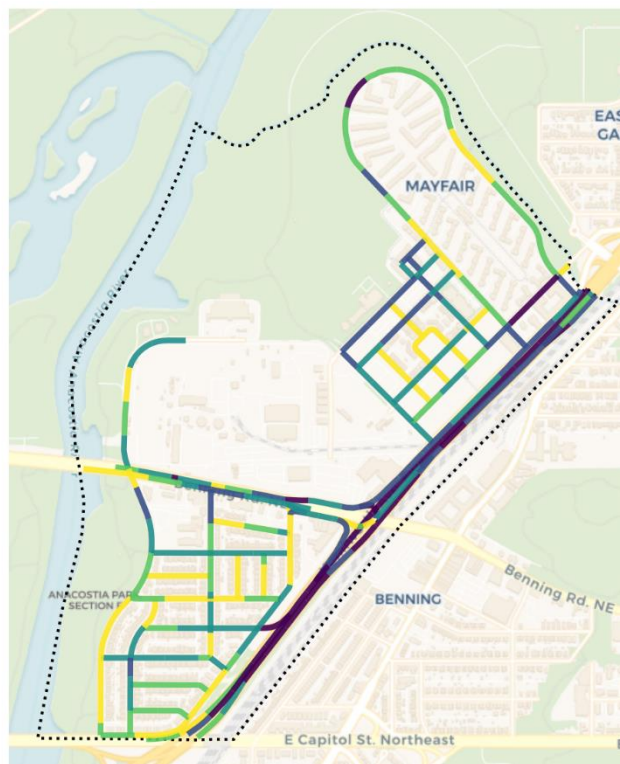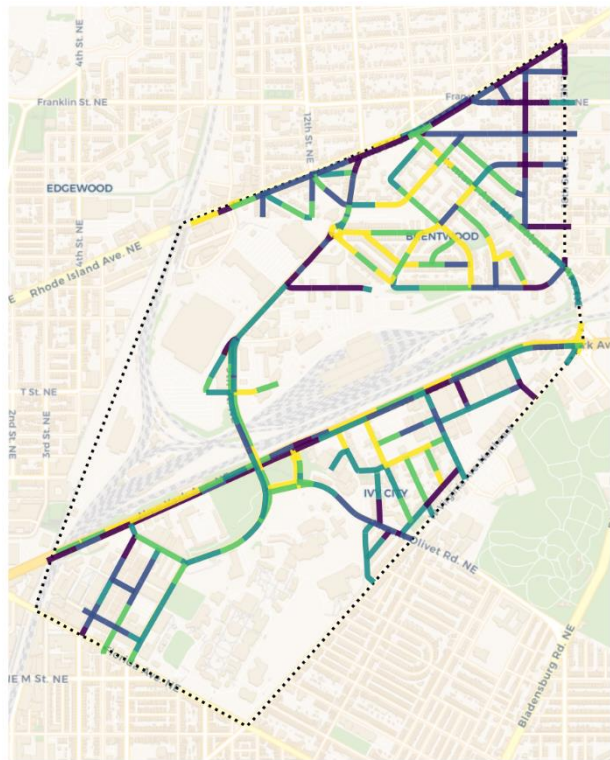
# Nitrogen Dioxide (NO₂)

Standard: 100 ppb (1 hr); 53 ppb (annual)



NO₂ [ppb]
- 1 - 6.7
- 6.7 - 8.4
- 8.4 - 10.2
- 10.2 - 13.4
- 13.4 - 25.3
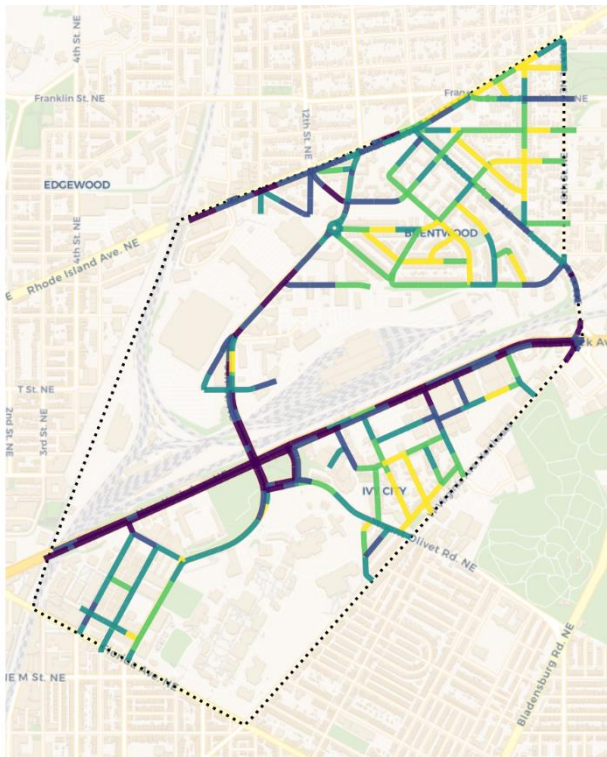
# Ozone

Standard: 70 ppb
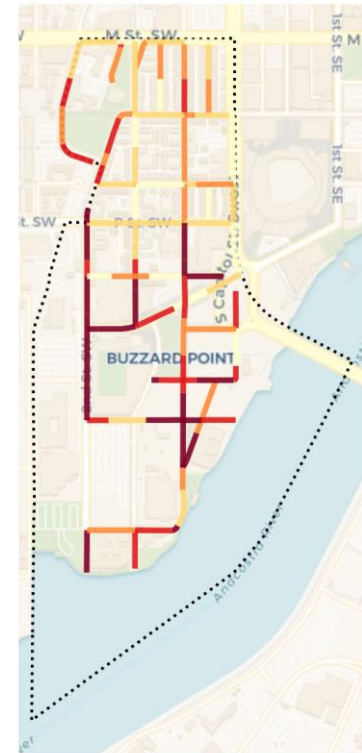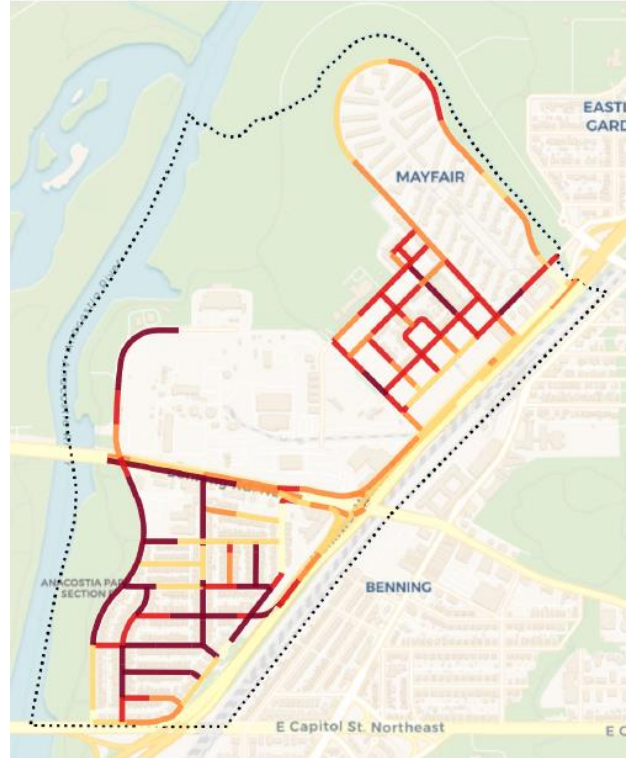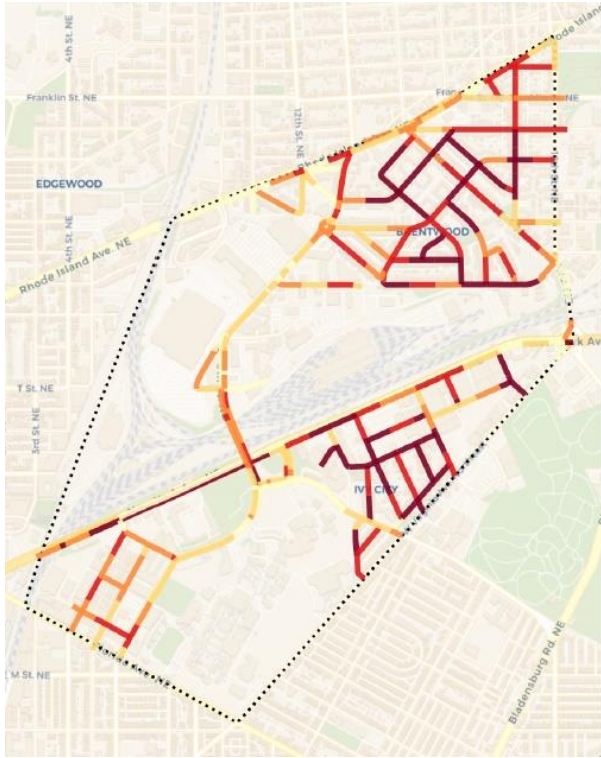
# Comparision Statistics



Figure A1: Comparison of hourly (left) and daily (right) mean Aclima mobile sensor measurements within a 250 m radius circle centered at all available stationary regulatory sites to the corresponding collocated data at those regulatory sites for $PM_{2.5}$ [µg/m3], including comparison metrics (including R2, slope error, intercept error, MAE, MBE, and precision) that represent Aclima AMN 1-hr or 24-hr device-level performance.
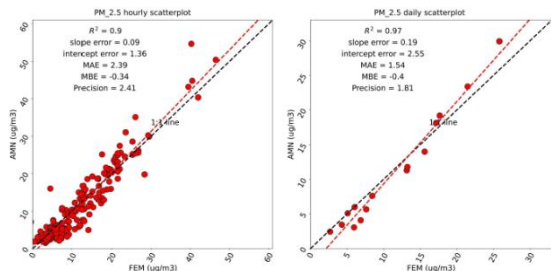
Figure A2: Comparison of hourly (left) and daily (right) mean Aclima mobile sensor measurements within a 250 m radius circle centered at all available stationary regulatory sites to the corresponding collocated data at those regulatory sites for $NO_2$ [ppb], including comparison metrics (including R2, slope error, intercept error, MAE, MBE, and precision) that represent Aclima AMN 1-hr or 24-hr device-level performance.
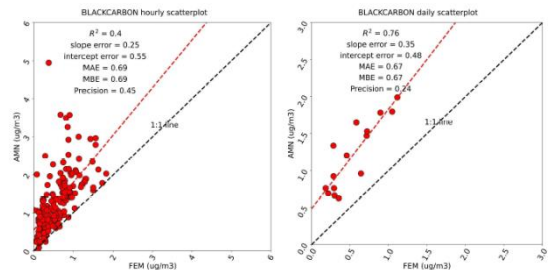
Figure A5: Comparison of hourly (left) and daily (right) mean Aclima mobile sensor measurements within a 250 m radius circle centered at all available stationary regulatory sites to the corresponding collocated data at those regulatory sites for Black Carbon [µg/m3], including comparison metrics (including R2, slope error, intercept error, MAE, MBE, and precision) that represent Aclima AMN 1-hr or 24-hr device-level performance.
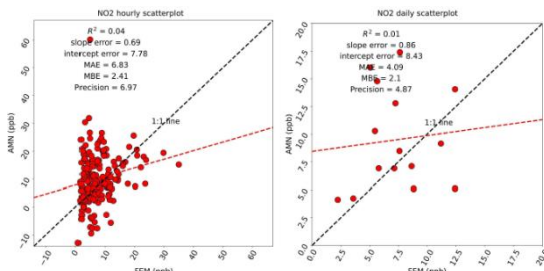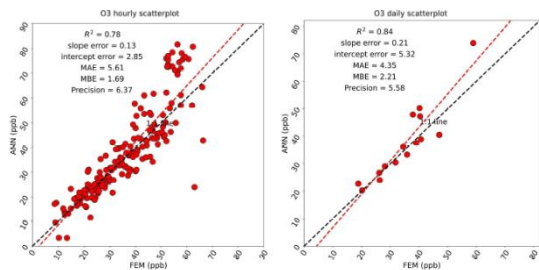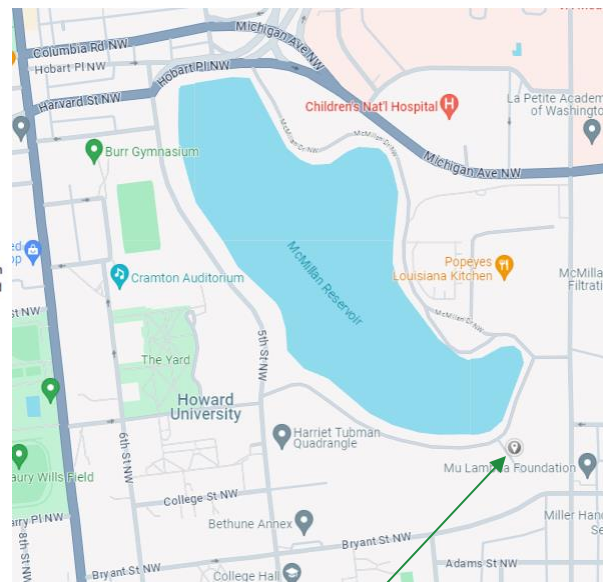
Figure A3: Comparison of hourly (left) and daily (right) mean Aclima mobile sensor measurements within a 250 m radius circle centered at all available stationary regulatory sites to the corresponding collocated data at those regulatory sites for $O_3$ [ppb], including comparison metrics (including R2, slope error, intercept error, MAE, MBE, and precision) that represent Aclima AMN 1-hr or 24-hr device-level performance.
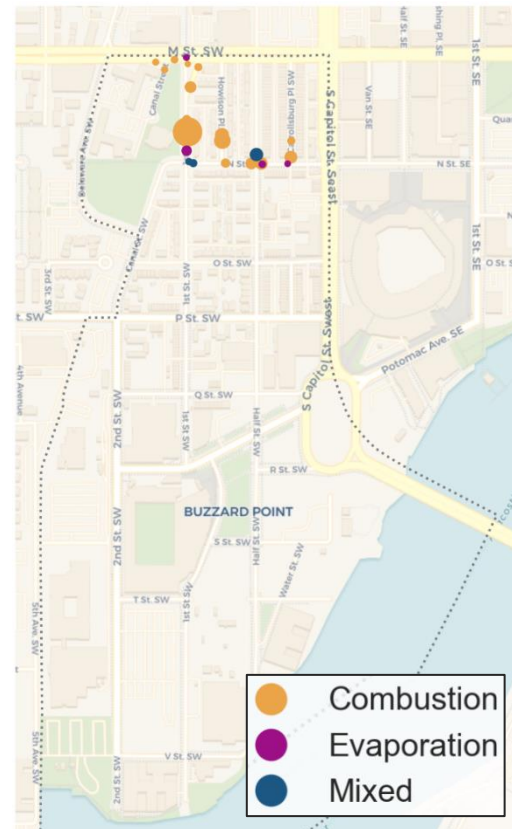
McMillan Monitor

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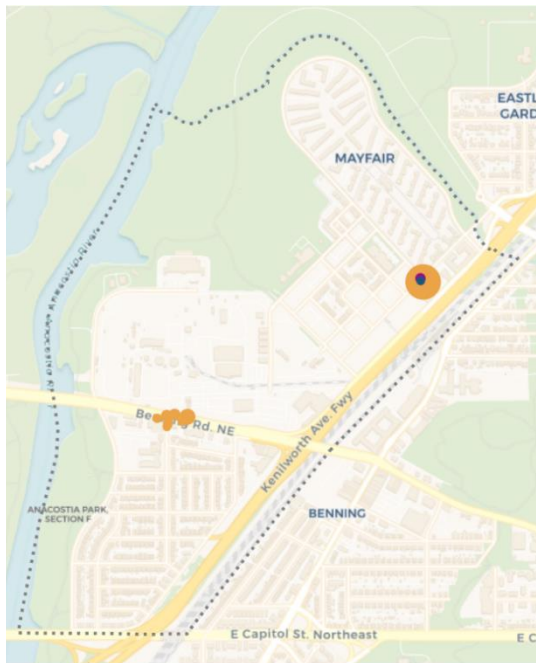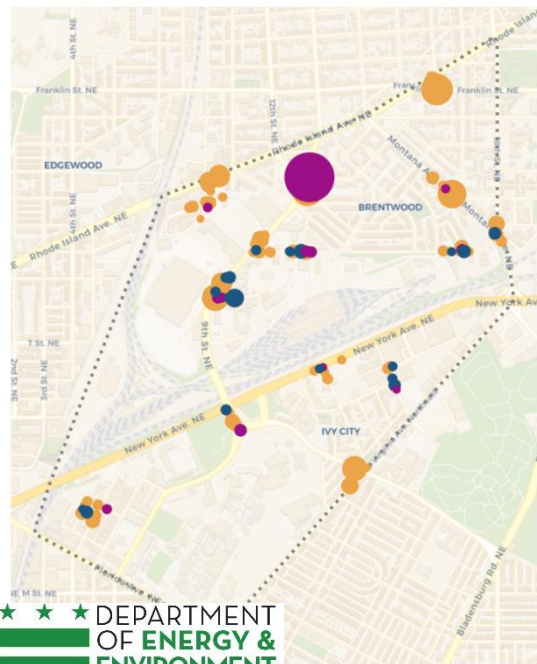
# Total Volatile Organic Compounds (TVOC) measurements
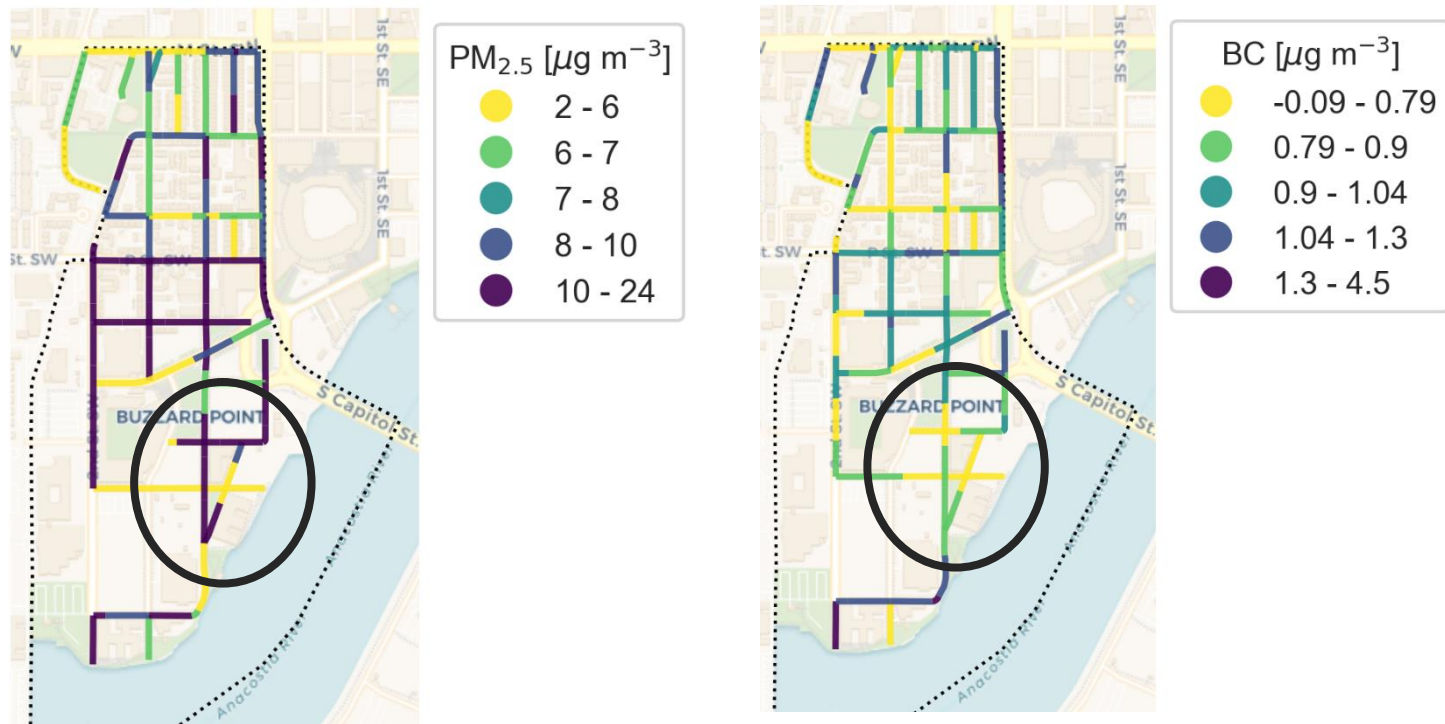
Combustion-related (orange), off-gassing-related (purple), and a combination of the two (blue) TVOC enhancements

Size of the circle increases with concentration

# Example of Area of Concern: Buzzard Point



Segment medians for PM$_{2.5}$ (left) and Black Carbon (right) in Buzzard Point, with black circles highlighting segments with **high** PM$_{2.5}$ and **low** BC.

# Aclima Phase Two

- Data collection Aug 12 to Sept 23
  (6 instead of 2 weeks)
- Geography expended from 2.26 to 30.33 sq mi
- Results expected winter 2024-2025

- Additional Questions to be answered:
  - How does collocation compare directly to McMillan
  - What pollution is seen in additional neighborhoods
  - Insights with longer time period
  - Year-on-year comparison (keeping in mind June v Aug-Sep)
  - Comparison with less overburdened community
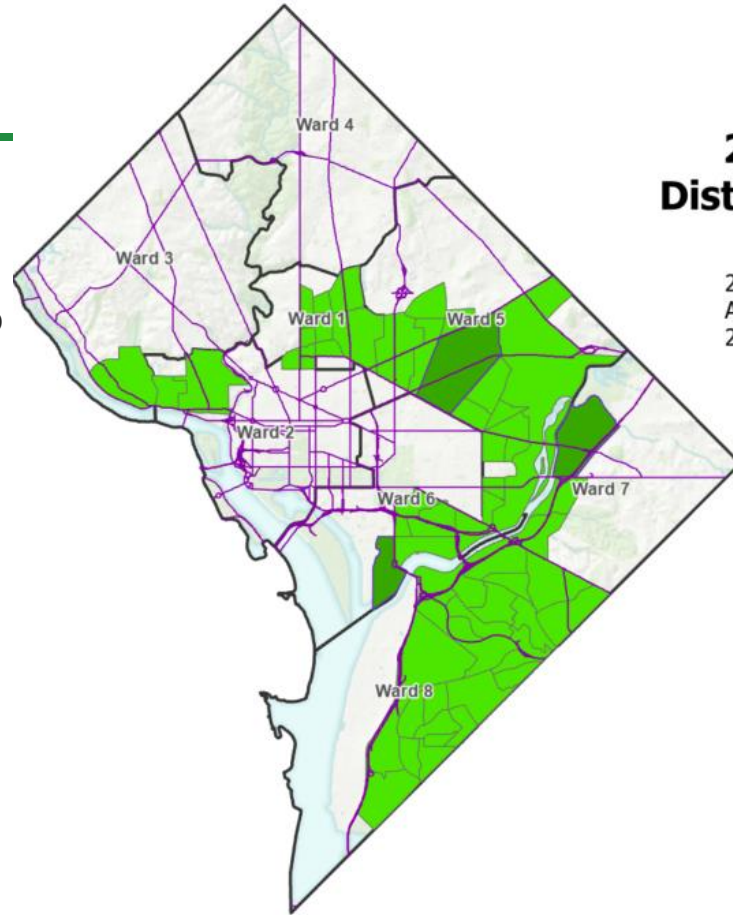


**Aclima**
**2024 Study Area**
**District of Columbia**

| 2023 Study Area | 2024 Study Area |
|---|---|
| 2.26 Sq Mi | 30.33 Sq Mi |

**Legend**
- Interstates and Major Roadways
- 2023 Measurement Area
- 2024 Measurement Area
- Ward Boundary - 2022

0   1   2   4 Miles

# Expanding Neighborhood Air Quality Monitoring with Low-Cost Sensors

1. Low-cost sensors provide a budget-friendly solution for widespread air quality monitoring.
2. Simple installation allows for quick setup in various locations.
3. Sensors offer continuous, real-time air quality measurements for timely insights.



*The image above is a purple air sensor. It measures particulate matter.*

# Deploying Sensors in Neighborhoods

1.  The sensors will be strategically placed in locations such as high-traffic and residential areas to ensure comprehensive coverage.
2.  Will use a combinations of less-expensive Purple Airs and more versatile LTE-enabled sensors.
3.  Aclima mapping will inform of potential locations that warrant further monitoring.
4.  A network of sensors will be deployed evenly to capture localized air quality.
5.  The sensors will continuously monitor and transmit real-time air quality data that will be used for analysis.

# Questions

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