How Does Particle Pollution vary in the City of Trenton?

A PurpleAir Study 2022-2024

New Jersey Department of Environmental Protection
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March 11, 2025

OVERVIEW

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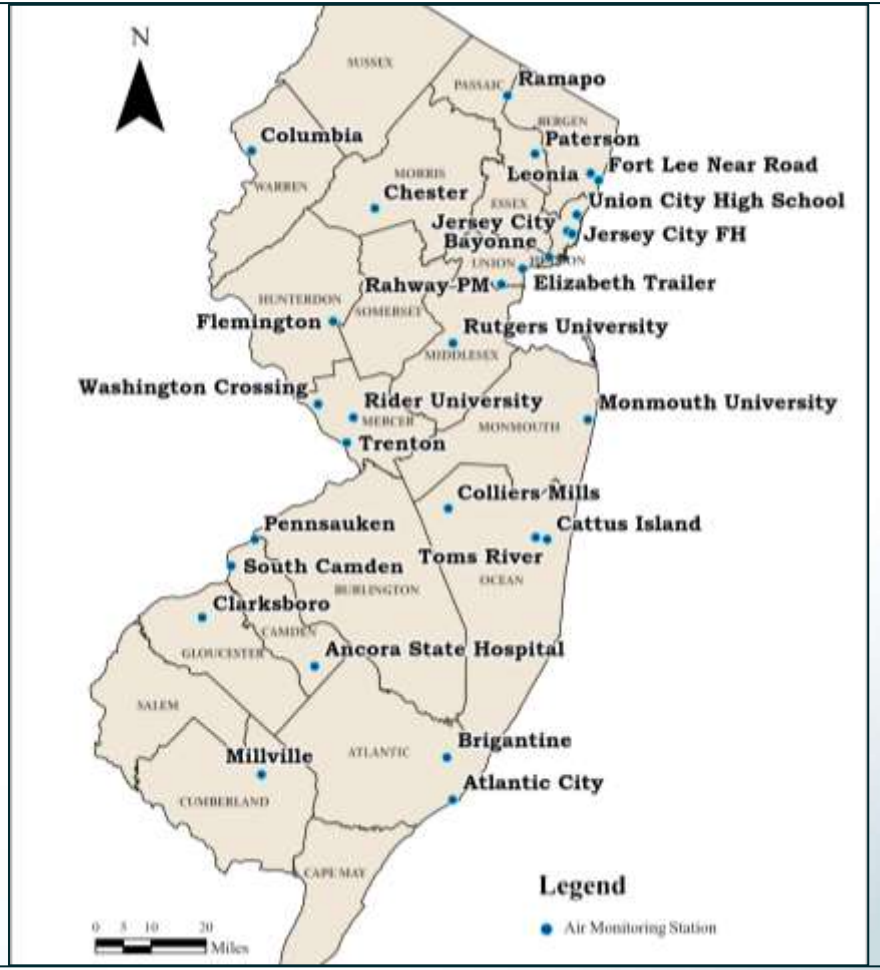
NJDEP Bureau of Air Monitoring

1. Monitor air pollutants & meteorological parameters
    a. Ozone
    b. Particulate Matter
    c. Nitrogen Dioxide
    d. Sulfur Dioxide
    e. Carbon Monoxide
    f. Lead
2. Manage & maintain 29 air monitoring stations
3. Review air quality data & submit to EPA

NJDEP Air Monitoring Website



Low-Cost Air Sensors vs. Regulatory Monitors

- Small, portable, lightweight
- Lower-cost compared to regulatory monitors ($200-$1,000)
- More user-friendly
- Provides information about air pollution

- Large, heavy, stationary
- ~$20,000
- Requires trained staff to maintain
- Not one in every neighborhood
- EPA-specific requirements

PurpleAir Sensor

Low-cost sensor we have the most experience with & widely used by government agencies, universities & more.

Advantages:

- Affordable (< $300)
- Smaller, easy to use and install
- Nationwide correction factor

Logistics:

- Measures $PM_{2.5}$, PM_{1}, PM_{10}, temperature, relative humidity
- Best to have a reliable Wi-Fi signal & power supply
- Data shown on PurpleAir map
- Has SD card for data storage

Trenton Project Timeline

Jan 2021:
City of Trenton Planning Board voted to adopt Trenton Community Health & Wellness Plan

Plan addresses air quality issues within "healthy housing": improve quality & safety of Trenton's housing stock including addressing asthma & respiratory illness

City of Trenton asked DVRPC to help city identify sources of air pollution & review available data on Trenton demographic, air quality, and health data

Sep 2021 – 2022:
Air monitoring advisory committee established & inquired NJDEP about a short-term air monitoring project in Trenton for more information

May 2022:
NJDEP began installing PurpleAir monitors in Trenton

Oct 2022:
Trenton monitoring sites established; all PurpleAir sensors installed & collecting data

Spring 2024:
NJDEP ends monitoring and begins to take down PurpleAir sensors.

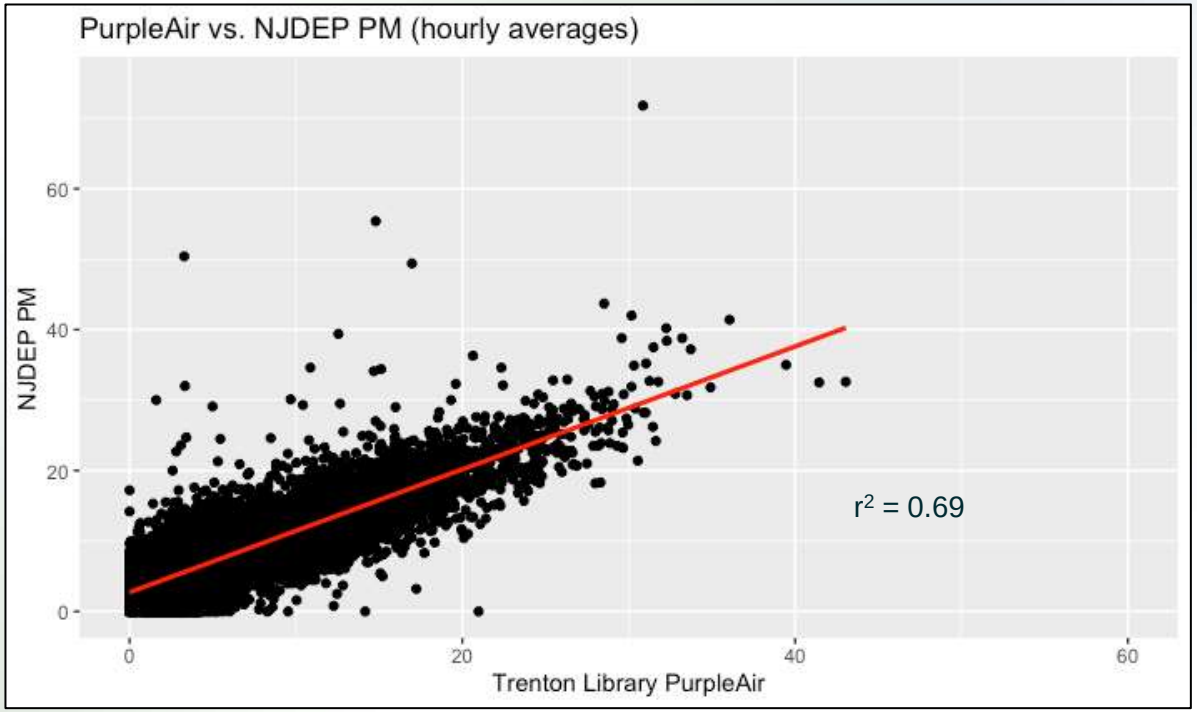
Monitoring Process

Monthly data retrieval from SD card from each monitor in Trenton

Cleaned & organized data using PurpleAir Data Merger tool.

Completed data analysis & generated figures using RStudio

Collocated PurpleAir sensors with NJDEP $PM_{2.5}$ monitor at Trenton Library

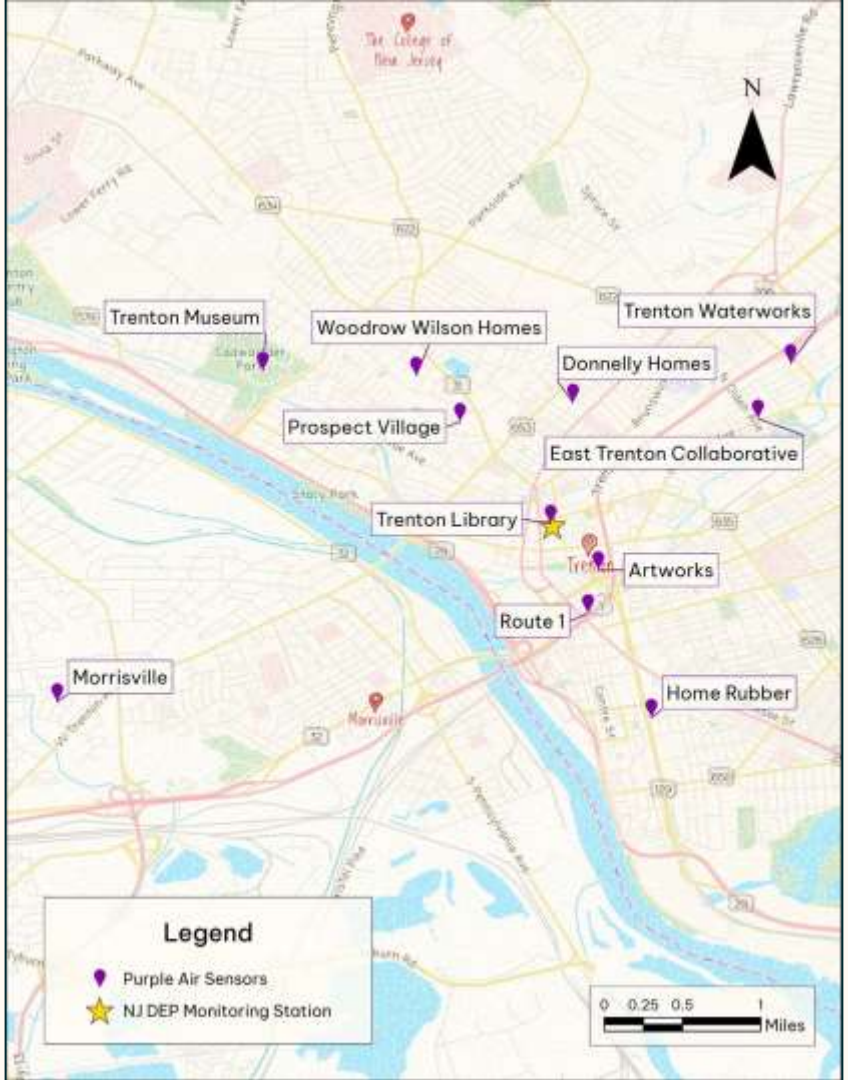


Home Rubber

Artworks

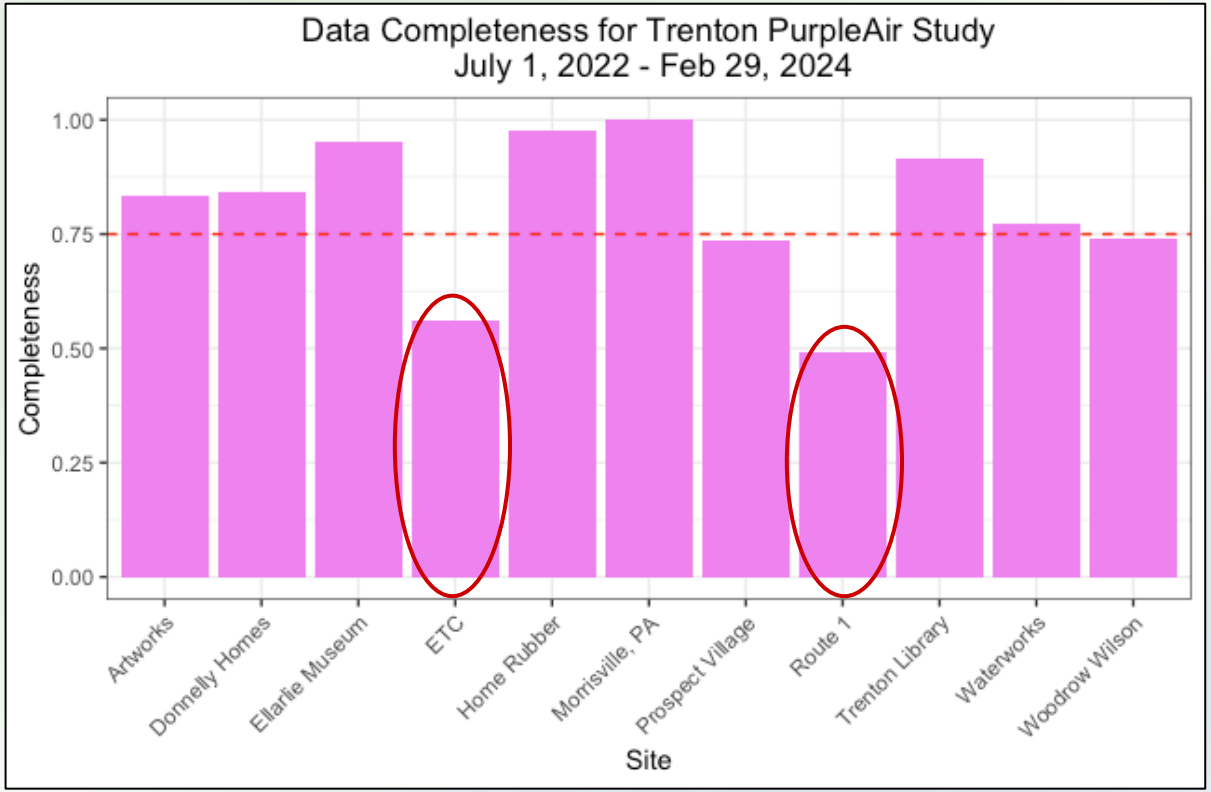
Trenton Museum

Initial PurpleAir Sensor Locations



How much data were the PurpleAir sensors able to collect?

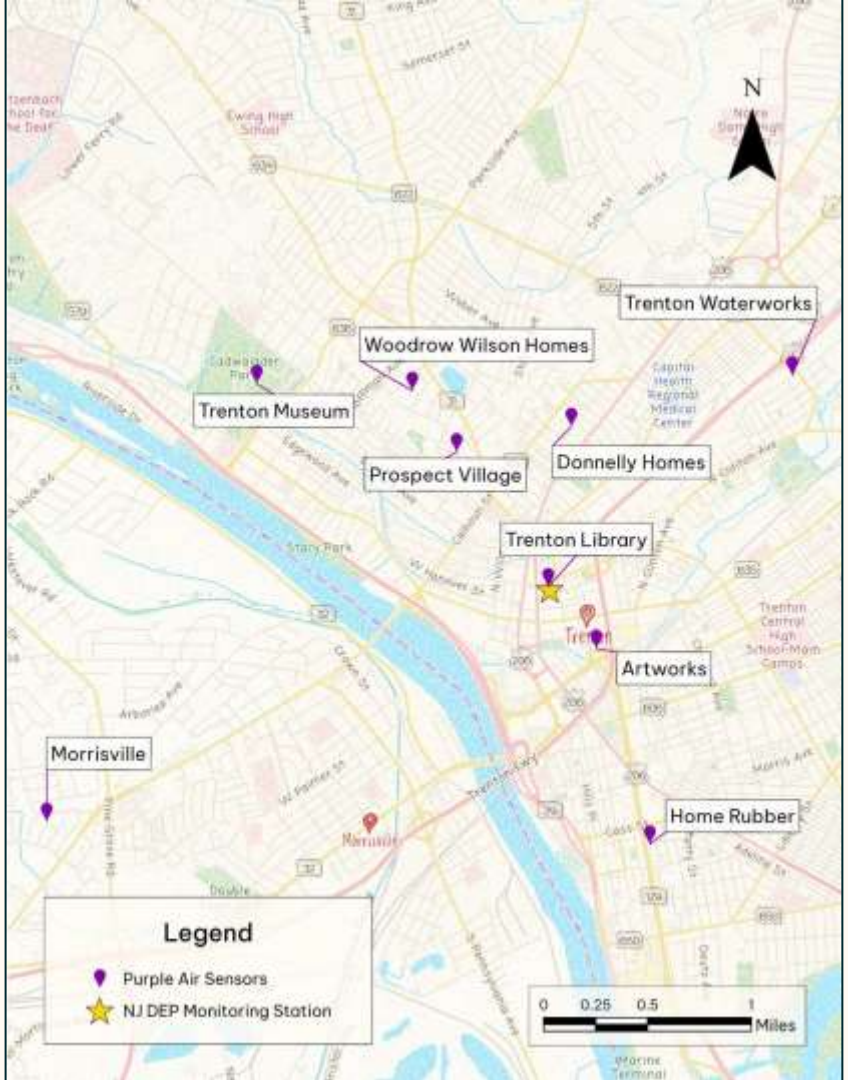
Removed ETC and Route 1 from analysis due to <75% of valid data.

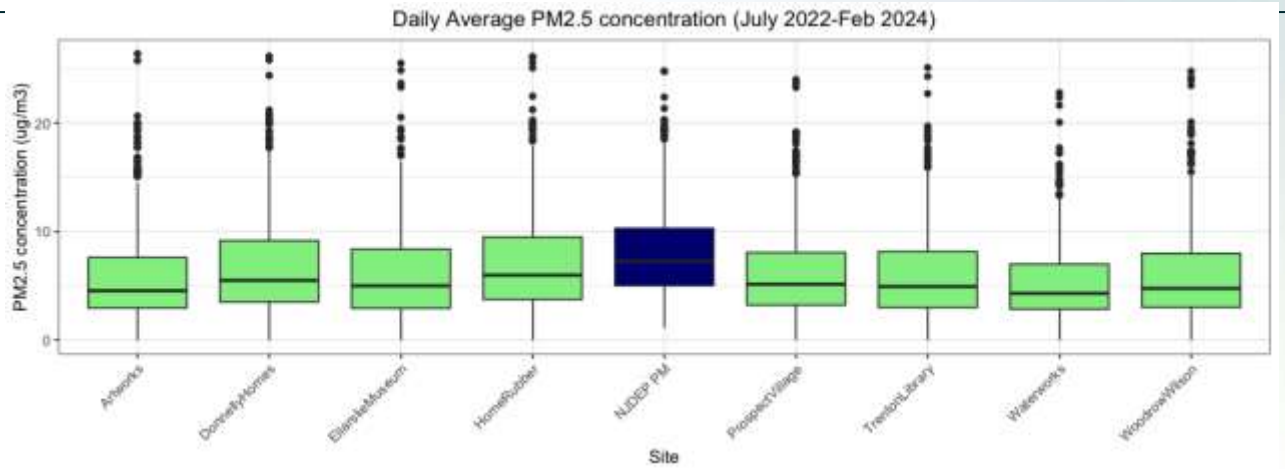


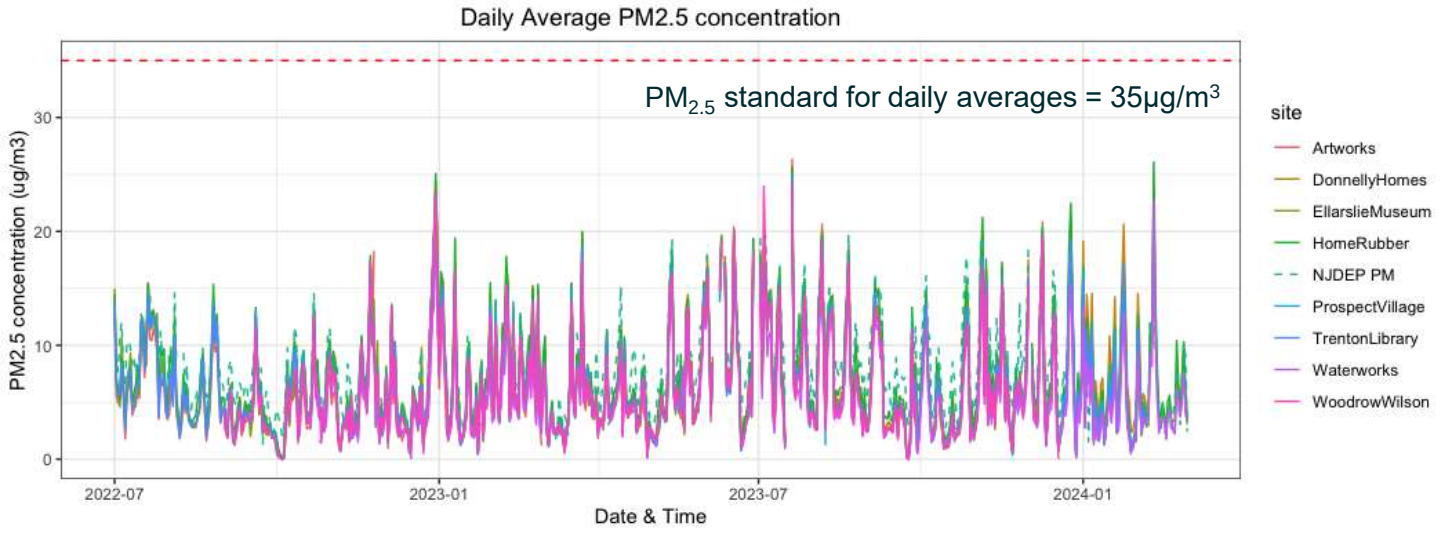
Removed Canadian wildfire smoke event days in 2023 (6/6 – 6/9) then removed outliers.

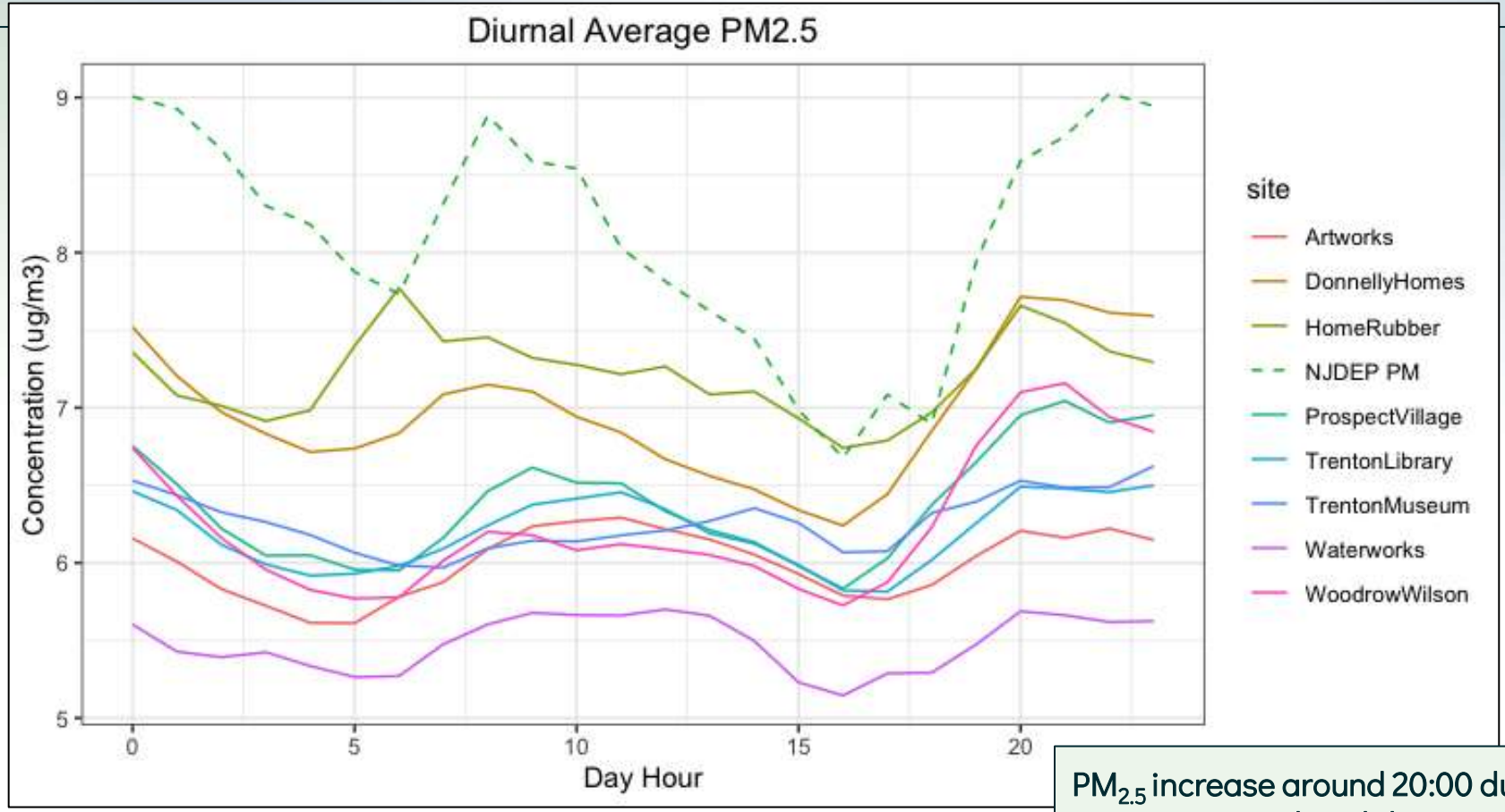
Outliers were considered any daily averages that were greater than the 99th percentile.

PurpleAir Sensor Locations

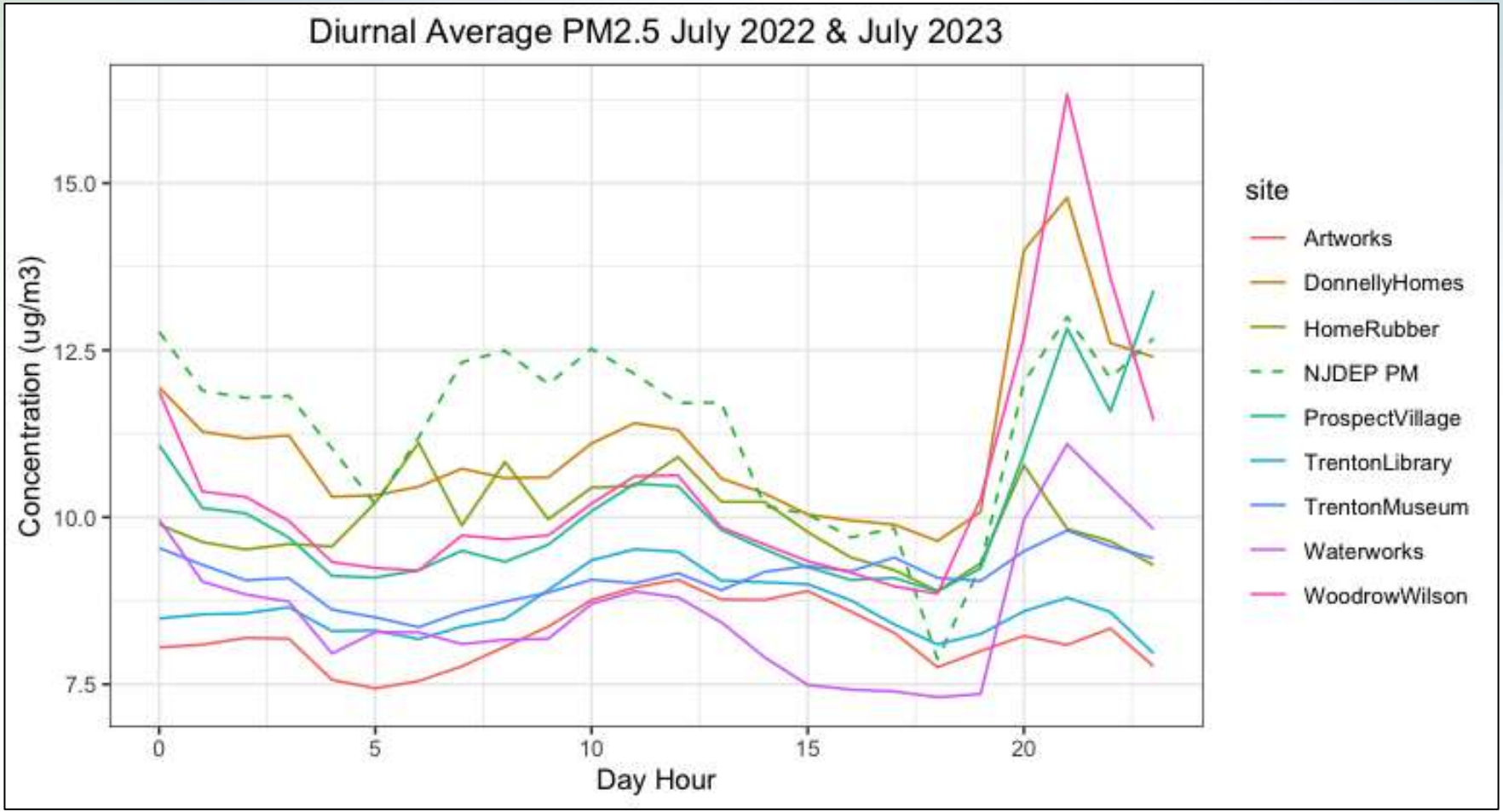


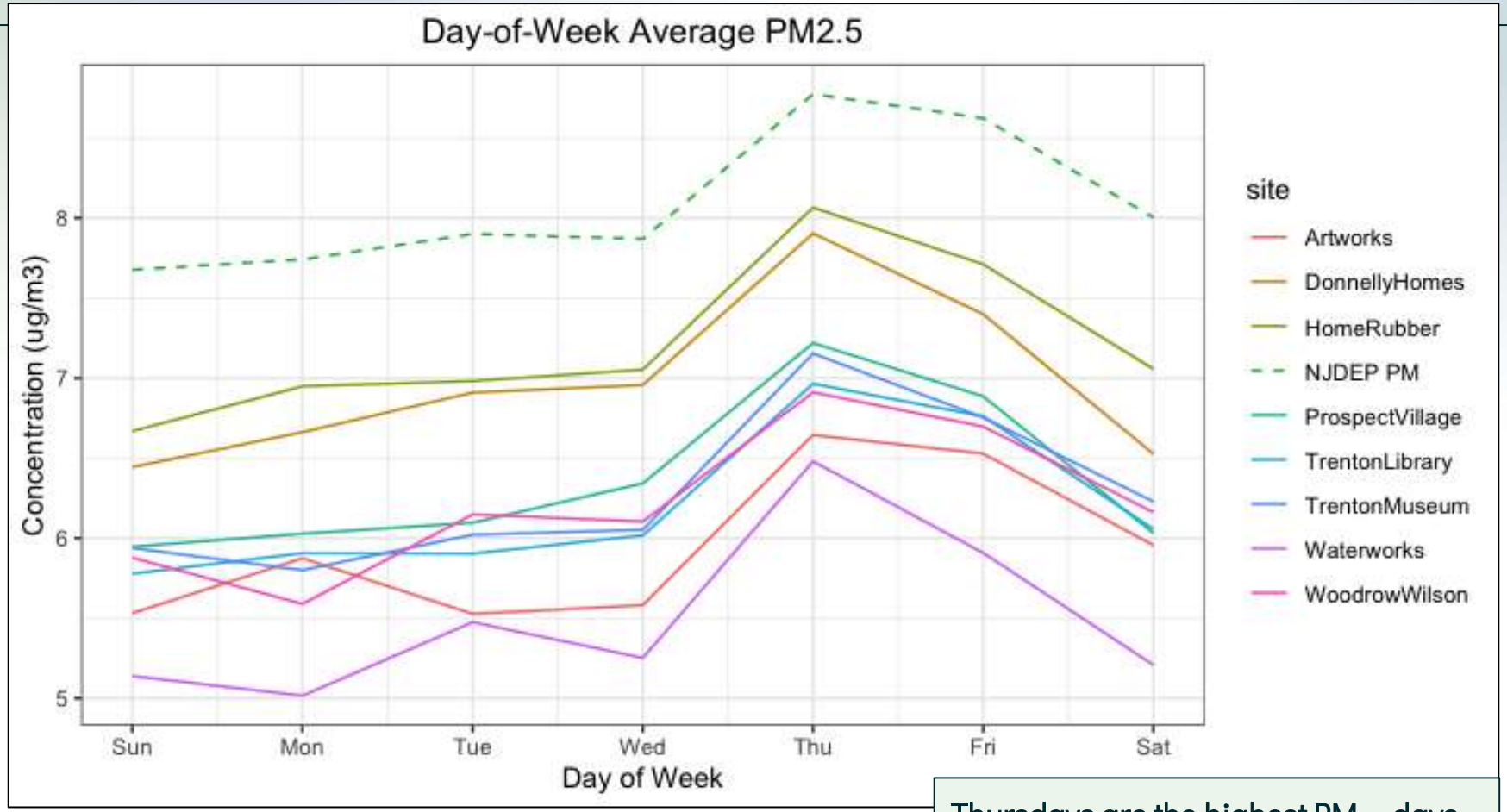

Daily Average PM2.5 concentration (July 2022-Feb 2024)
PM2.5 concentration (ug/m3)
0
10
20
Artworks
DonnellyHomes
EllarslieMuseum
HomeRubber
NJDEP PM
ProspectVillage
TrentonLibrary
Waterworks
WoodrowWilson
Site


Daily Average PM2.5 concentration
PM2.5 standard for daily averages = 35µg/m3
PM2.5 concentration (ug/m3)
0
10
20
30
2022-07
2023-01
2023-07
2024-01
Date & Time
site
Artworks
DonnellyHomes
EllarslieMuseum
HomeRubber
NJDEP PM
ProspectVillage
TrentonLibrary
Waterworks
WoodrowWilson

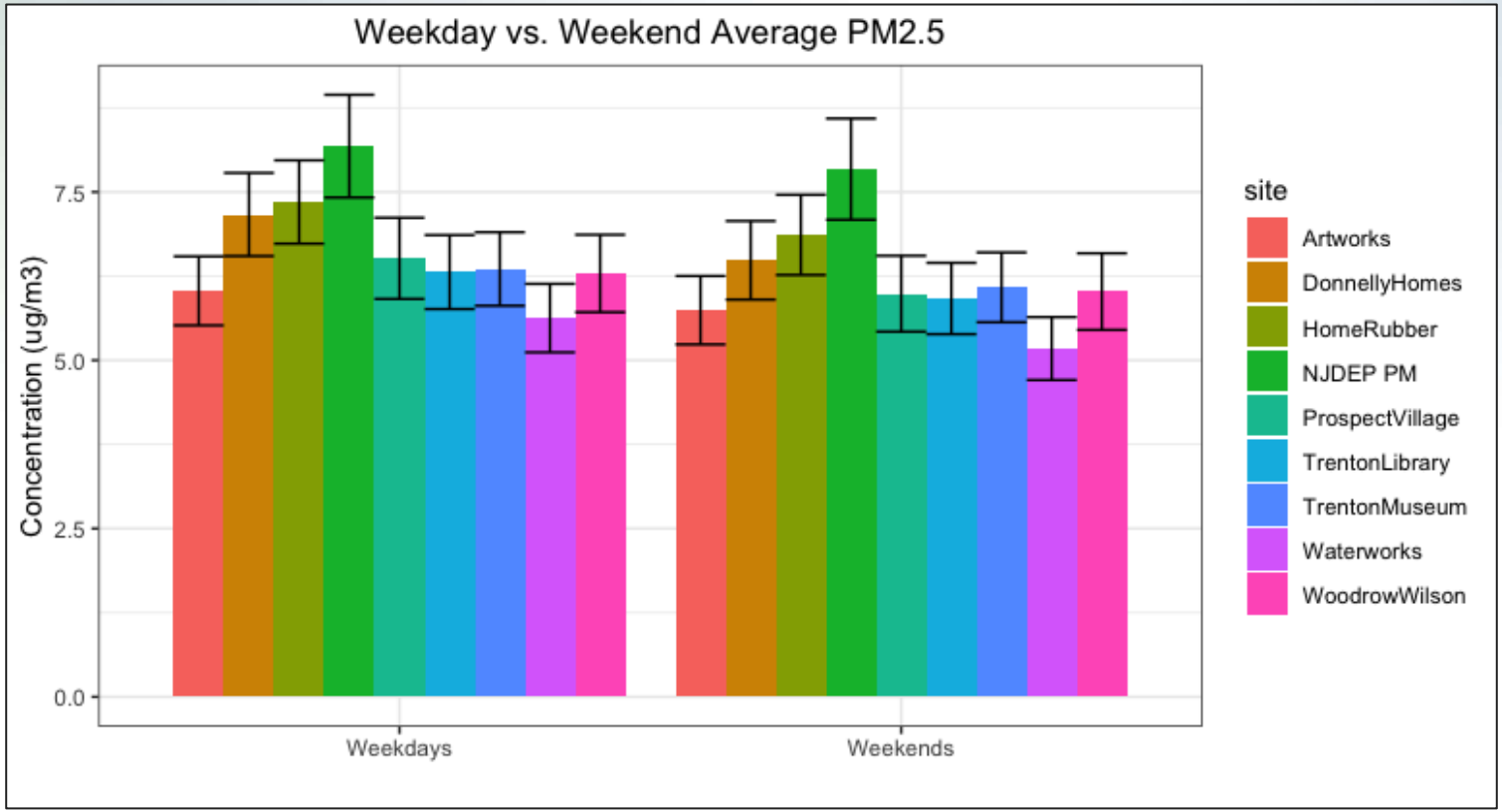


$PM_{2.5}$ increase around 20:00 due to sunset & ABL breakdown

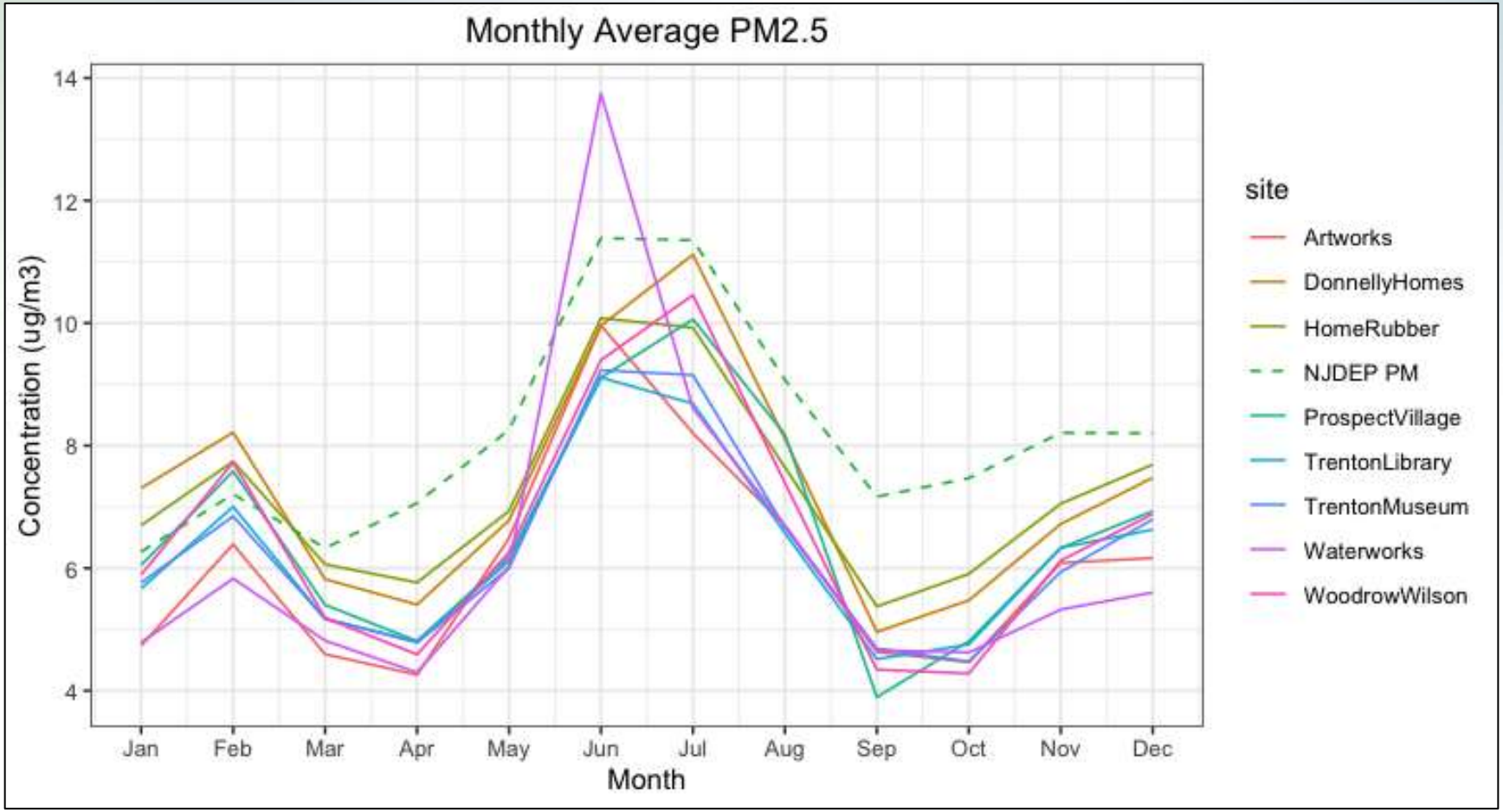

Diurnal Average PM2.5 July 2022 & July 2023
Concentration (ug/m3)
15.0
12.5
10.0
7.5
0
5
10
15
20
Day Hour
site
Artworks
DonnellyHomes
HomeRubber
NJDEP PM
ProspectVillage
TrentonLibrary
TrentonMuseum
Waterworks
WoodrowWilson

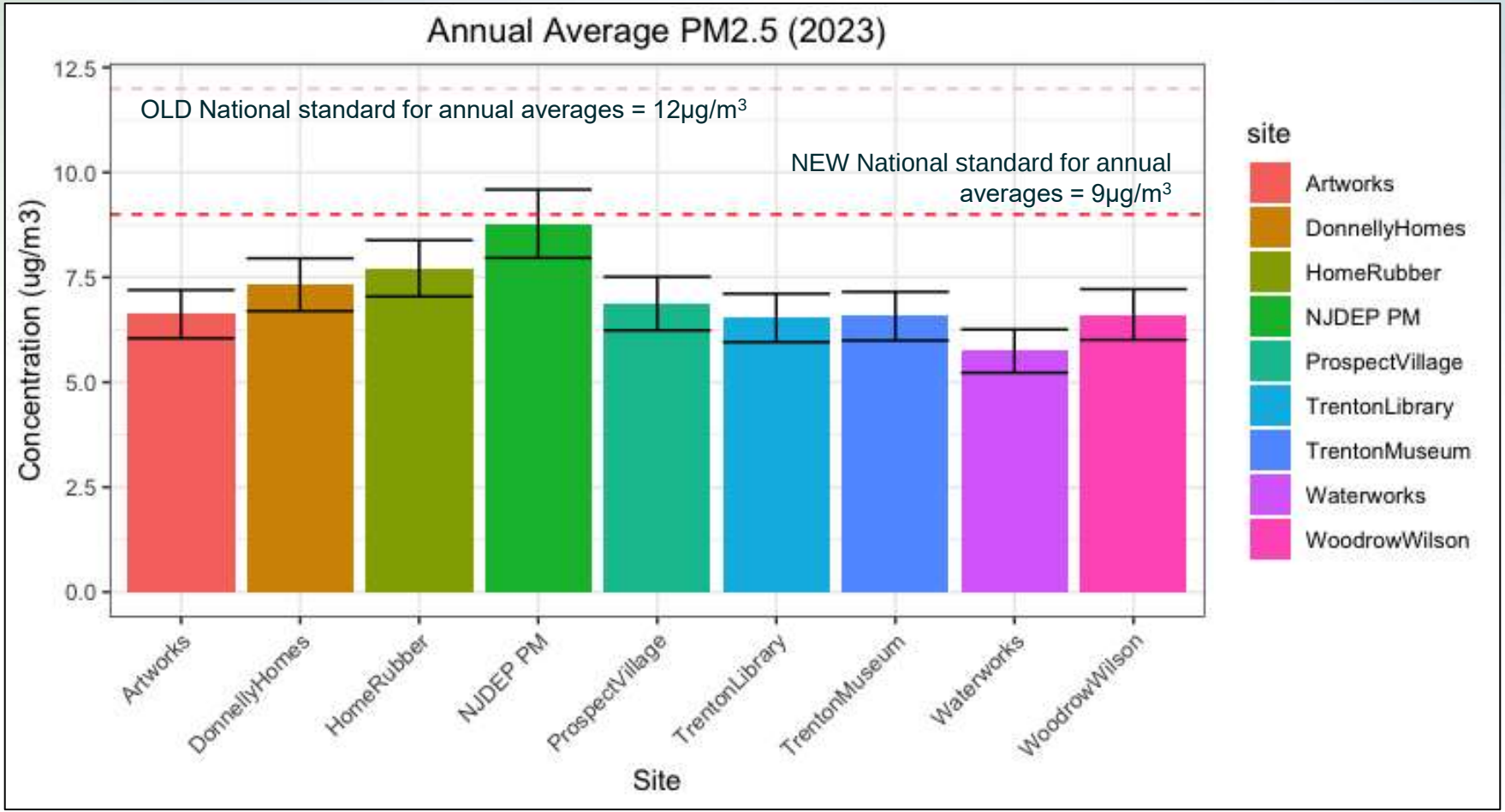


Thursdays are the highest $PM_{2.5}$ days



Statistical analysis revealed that there is NO significant difference between weekday and weekend daily $PM_{2.5}$ concentrations.


Monthly Average PM2.5
Concentration (ug/m3)
14
12
10
8
6
4
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
site
Artworks
DonnellyHomes
HomeRubber
NJDEP PM
ProspectVillage
TrentonLibrary
TrentonMuseum
Waterworks
WoodrowWilson


Annual Average PM2.5 (2023)
OLD National standard for annual averages = 12µg/m3
NEW National standard for annual averages = 9µg/m3
Concentration (ug/m3)
12.5
10.0
7.5
5.0
2.5
0.0
Artworks
DonnellyHomes
HomeRubber
NJDEP PM
ProspectVillage
TrentonLibrary
TrentonMuseum
Waterworks
WoodrowWilson
Site
site
Artworks
DonnellyHomes
HomeRubber
NJDEP PM
ProspectVillage
TrentonLibrary
TrentonMuseum
Waterworks
WoodrowWilson

Is there a difference in daily average $PM_{2.5}$ concentrations between the PurpleAir sites?

Yes

Statistical analysis showed there IS a significant difference between the daily average $PM_{2.5}$ concentrations between the 8 PurpleAir sites. Further analysis showed which sites were significantly different from one another.

Which sites had the highest $PM_{2.5}$ daily averages?

Home Rubber

Daily average $PM_{2.5}$ is significantly larger than Artworks, Trenton Museum, Morrisville, Prospect Village ,Trenton Library, & Woodrow Wilson (p-value < 0.001)

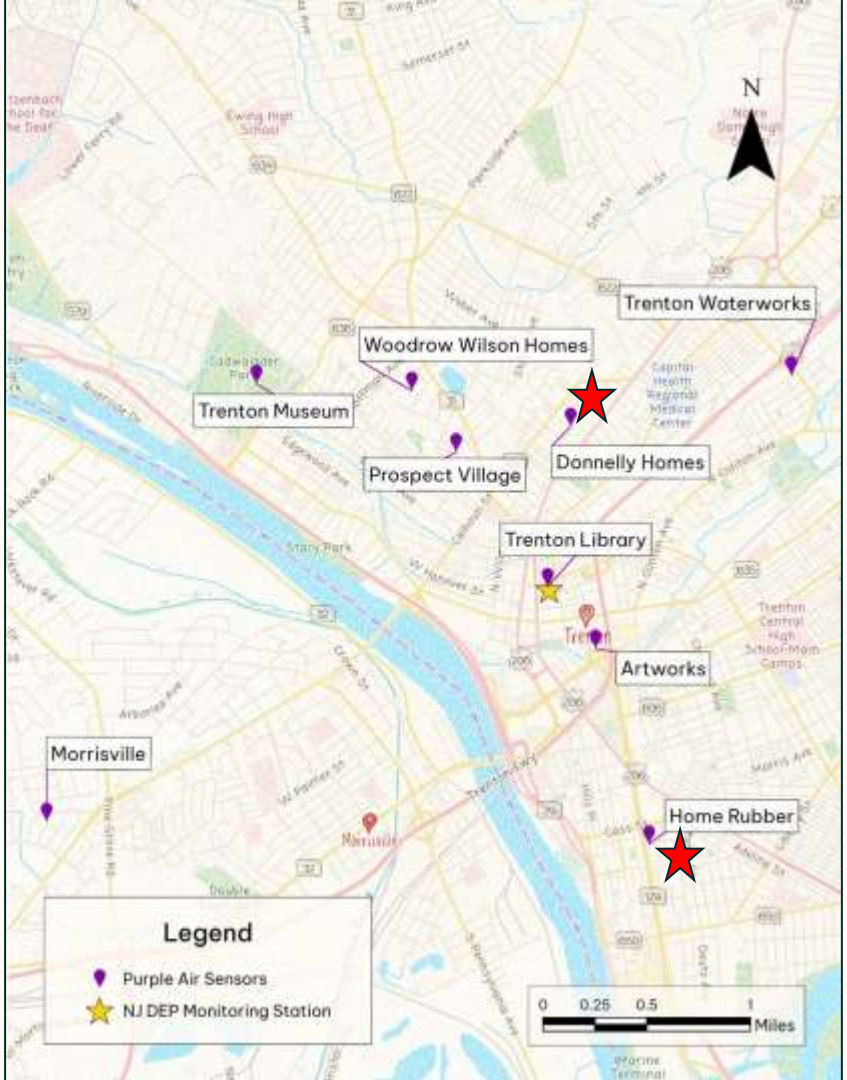
Donnelly Homes

Daily average $PM_{2.5}$ is significantly greater than Artworks, Morrisville, & Waterworks (p-value < 0.05)

PurpleAir sites with the highest $PM_{2.5}$ daily averages:

★ Home Rubber

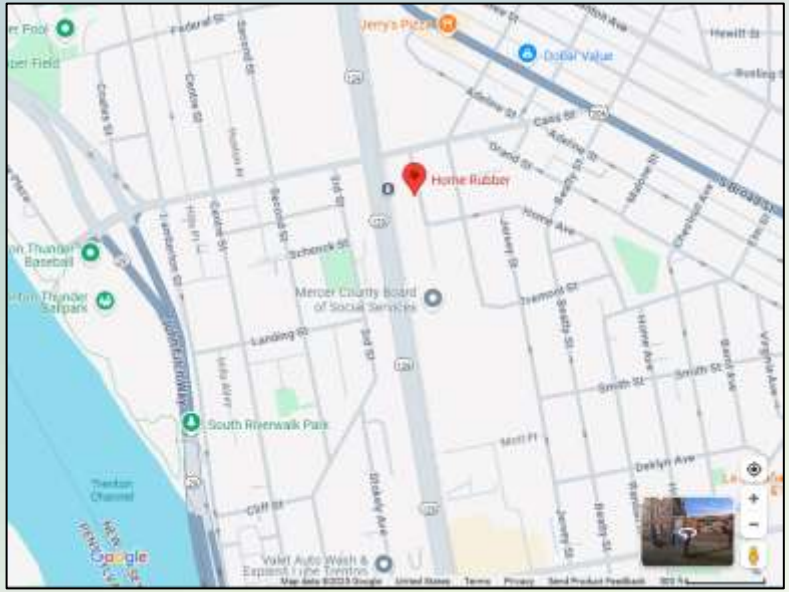
★ Donnelly Homes



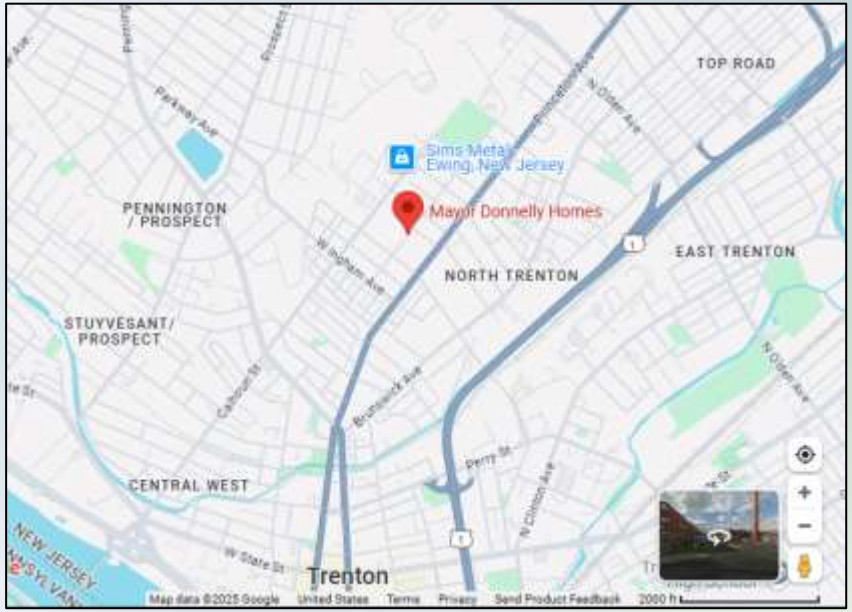
What could be causing these differences?

Home Rubber daily averages were higher than 6 of the other PurpleAir sites. It is situated only a few hundred feet away from a major artery Route 129, where many cars and trucks commute into Trenton & idle at the intersection of 129 & Cass St.

There is a NJ Transit Riverline stop at this intersection, also, which is a diesel light rail and there is a McDonald's adjacent to Home Rubber.

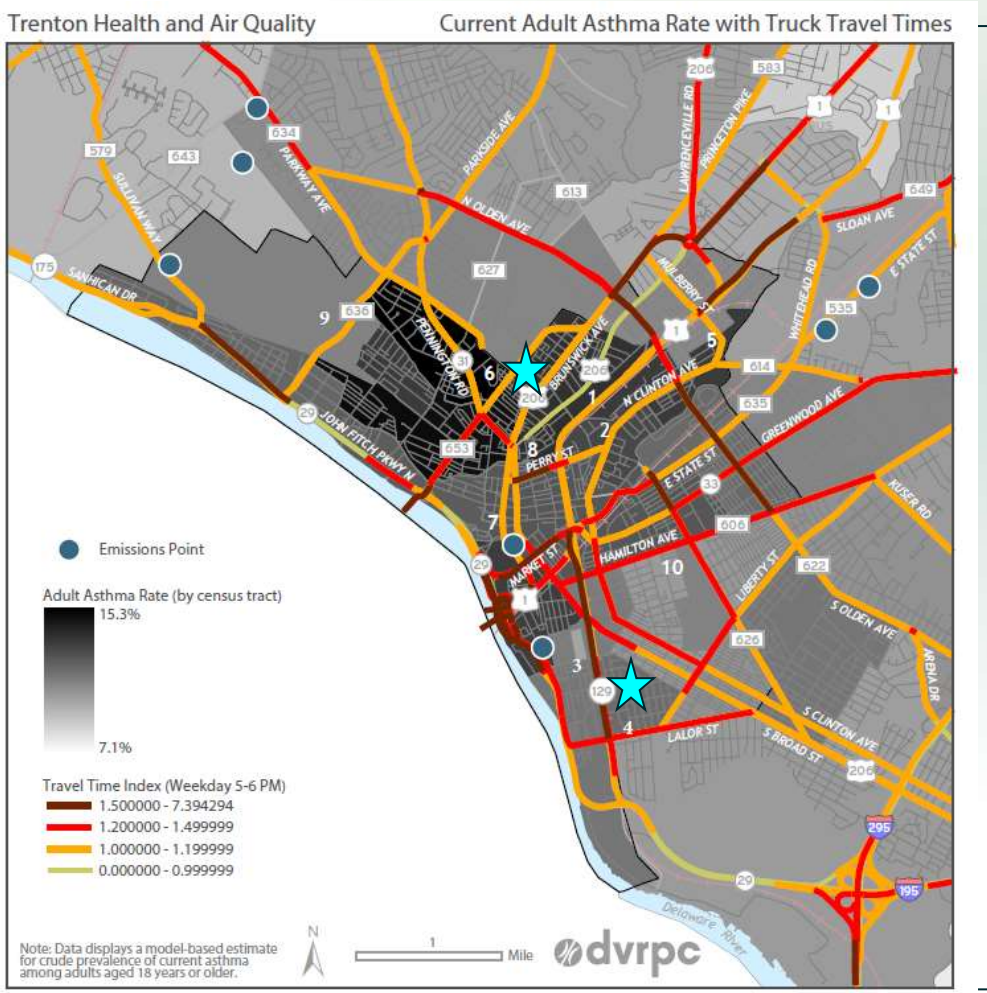


What could be causing these differences?



Donnelly Homes is a block away from Martin Luther King Blvd (Route 206) which is also a high-trafficked roadway by many cars and trucks, especially during rush hour.

Since Donnelly Homes and Home Rubber are not very close to any known stationary sources, but they are both near highly trafficked roadways, which could be the major source of $PM_{2.5}$ pollution



MPH Internship Project

Cardiovascular health impacts of $PM_{2.5}$ pollution in Trenton, NJ

History & Current Challenges

Trenton's status as a post-industrial city has made the city a place with great history. A lot of the problems followed this post-industrial era as factory workers struggled to find new jobs. Many of the problems the city faced because of it are still present today.

Community Needs

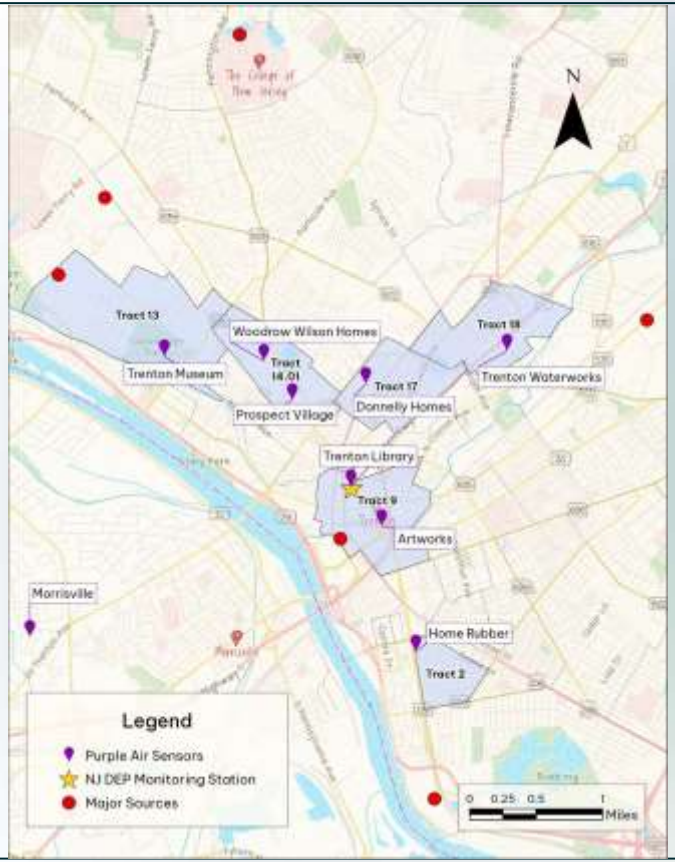
Trenton residents, especially Black and/or Latino and low-income residents are in need of:

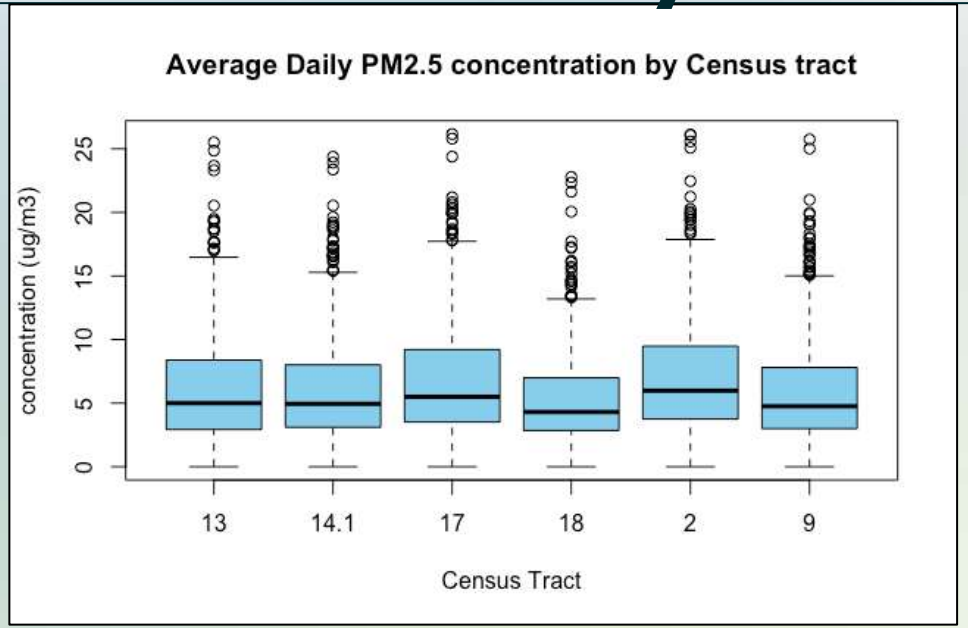
- Better Social Determinants of Health
- Better jobs & wages
- Improved cardiovascular & chronic health outcomes

Cardiovascular disease increases with $PM_{2.5}$ exposure

Many studies assessing health effects of $PM_{2.5}$ exposure focus on asthma & other lung diseases, but it's well described in the literature that cardiovascular disease (CVD) and mortality due to CVD increase with increased $PM_{2.5}$, even in short-term exposures.

Research Questions & Data Analysis





1. Is there a significant difference in daily average $PM_{2.5}$ concentrations in Trenton by Census Tract?

2. Is increased $PM_{2.5}$ concentrations associated with increased coronary heart disease or stroke prevalence in Trenton by Census Tract?

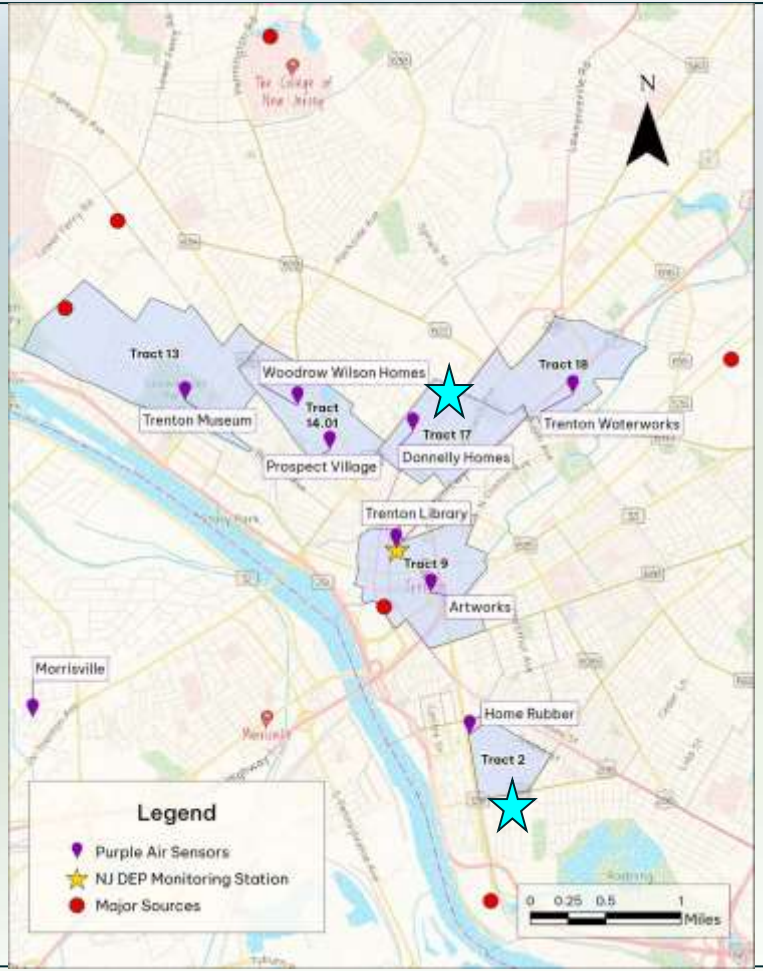
Yes, daily $PM_{2.5}$ is significantly different between the Census Tracts

CT 2 $PM_{2.5}$ was significantly greater than CT 13, 14.1, 18, & 9

CT 17 $PM_{2.5}$ was significantly greater than CT 18 & 9

$PM_{2.5}$ daily average concentration is a predictor of Coronary Heart Disease

$PM_{2.5}$ daily average concentrations are correlated with Coronary Heart Disease prevalence & stroke prevalence. But $PM_{2.5}$ is not a predictor of stroke



What's Next?

- Analysis of wildfire days – are there areas in Trenton that will be more impacted by smoke events?
  - Likely more wildfires with climate change
- More air monitoring
  - Recommend a near-roadway study?
- Completion of internship project:
  - Hosting virtual educational event for Trenton Community members
  - Handing out educational materials on $PM_{2.5}$, air quality, how to protect themselves, etc.
  - Capstone paper & graduate May 2025

Thank You

Our academic partners from Rider University Dr. JJ Stratton & Dr. Dan Druckenbrod, and from TCNJ Dr. Alexis Mraz & Karen Gordon.

NJDEP staff Luis Lim, Yuliza Cruz, Sebastian Meledina, Kevin Zolea, Tracie Kalman, Geoff Magaram, and Josh Ray for your help with collecting data, maintaining air sensors, and processing data.

Thank you to my internship advisor Dr. Alec Ayers, and TCNJ professors Dr. Mraz, Dr. Seals, and Mei Zhao

A special thank you to our Trenton City partners that allowed us to host air sensors at their locations: Trenton Free Library, Artworks, Donnelly Homes, Trenton (Ellarslie) Museum, East Trenton Collaborative, Home Rubber, Prospect Village, Waterworks, Woodrow Wilson, and all the residents that hosted PurpleAir sensors at their homes.

DO YOU HAVE ANY QUESTIONS?

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