Project Quarter 3

Upper South and Appalachia Citizen Air Monitoring Project (USACAMP)

Appalachian Voices

Upper South and Appalachia Citizen Air Monitoring Project (USACAMP)

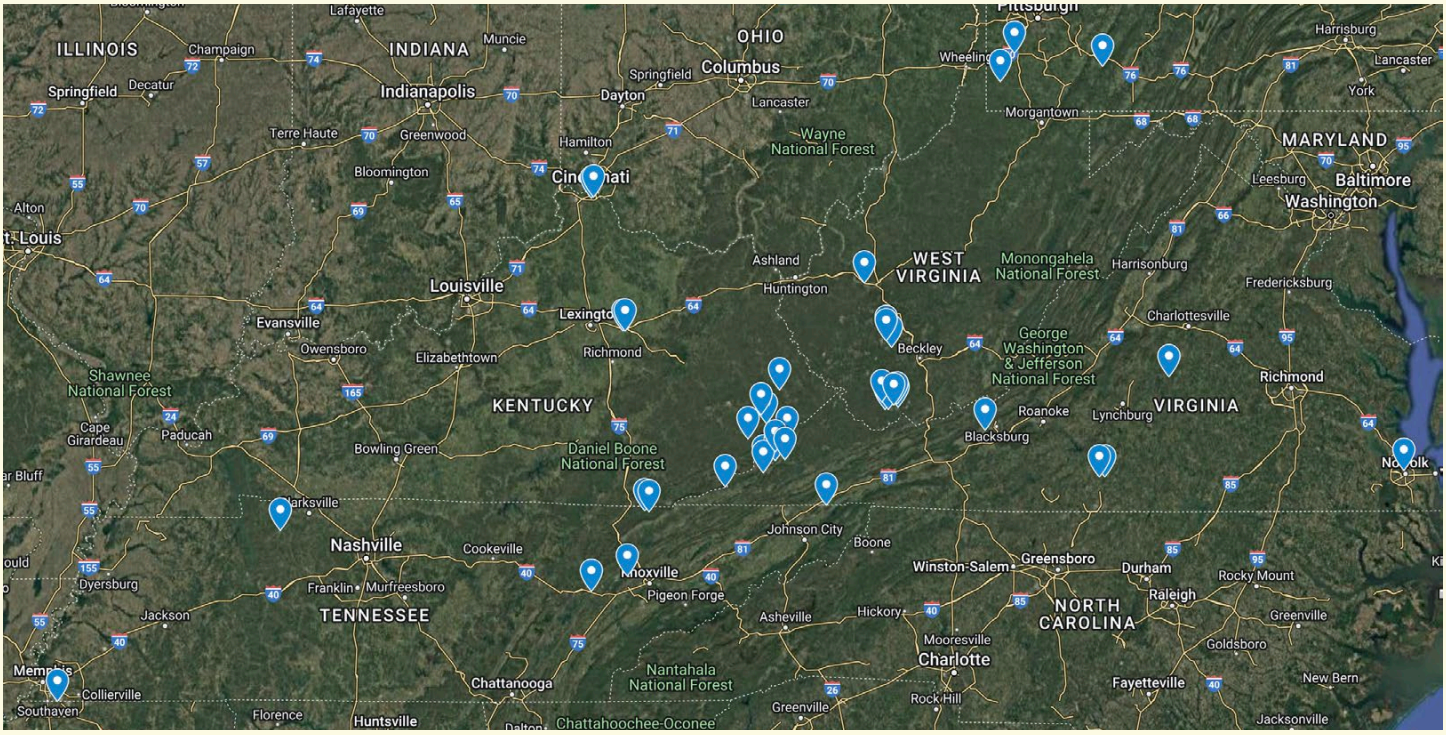
November 2024

In pursuit of a better understanding of air quality within our region, we are pleased to present the third quarterly report of the Upper South and Appalachia Citizen Air Monitoring Project (USACAMP). Funded by an Environmental Protection Agency Enhanced Air Quality Monitoring for Communities grant, USACAMP focuses on the collection and analysis of air quality data through the use of PurpleAir monitors and a few other electronic monitoring devices.

This initiative engages communities within portions of Kentucky, Pennsylvania, Tennessee, Virginia and West Virginia, deploying these devices to facilitate the collection and dissemination of air quality data (see map below). The objective is to engage community members in a dialogue around public health decision-making and policy formulation, contributing to a healthier environment across the region. All of our reports and associated data will be made available on the USACAMP webpage.

The primary focus of the project is particulate matter, a mix of solid and liquid particles suspended in the air that includes a variety of substances such as smoke, soot, dust and other pollutants. Within regulatory frameworks, particulate matter is categorized by size into two main groups: PM10 (coarse particulates) and PM2.5 (fine particulates). Exposure to these particulates is implicated in a myriad of cardiovascular and pulmonary ailments, including asthma, lung cancer and heart disease, and has the potential to worsen pre-existing health conditions. Particularly vulnerable demographics, including children,

Community Partner Locations



the elderly and individuals with chronic health conditions, are at an elevated risk. PM2.5 is considered to pose a greater health risk than PM10 due to its ability to deeply penetrate the respiratory system and pass into the bloodstream.

While selecting monitoring locations for USACAMP, we focused on vulnerable and disadvantaged communities across five states, where individuals or community organizations had expressed concern over air quality. Research indicates that communities of color and those from lower socioeconomic backgrounds are disproportionately exposed to high levels of particulate matter, making them more likely to experience the detrimental health effects associated with this exposure.

PurpleAir monitors function by drawing ambient air through laser-based sensors that detect the size of particulate matter. These particulates cause scattering of the laser light, which is measured by the sensor to estimate the air's particulate matter concentration. The devices use algorithms to adjust for environmental variables such as temperature, humidity and air pressure, which could influence measurements. These internet-connected monitors allow for the uploading of real-time data to the PurpleAir website, making this information accessible to the public.

Corrected PM2.5 = 0.38 × PA + 2.94

Where PA represents the PM2.5 measurement directly obtained from the PurpleAir® monitor.

Peer-reviewed research has shown that PurpleAir monitors may overestimate PM2.5 measurements. USACAMP has adopted a correction equation developed by Barkjohn et al for this purpose. All PM2.5 data used in this report and available on the USACAMP website has undergone this correction.

Regulatory Landscape and USACAMP Calculations for Particulate Matter

The National Ambient Air Quality Standards (NAAQS), established by the EPA under the Clean Air Act, serve as benchmarks for controlling air pollution and safeguarding public health. These standards address six air pollutants, including particulate matter. State regulators devise state implementation plans, subject to EPA approval, outlining strategies to meet and maintain air quality compliance with the NAAQS.

For particulate matter regulation, the EPA enforces three distinct standards:

1. **The 24-hour PM10 standard is set at 150 µg/m³ (micrograms per cubic meter).** This is measured by compiling daily averages over three years and incorporating a formula to account for missing data. Monitoring equipment may malfunction from time to time, causing periods of missing data. All of this data is sorted and a tally is created every time a daily average exceeds 150 µg/m³. That tally is checked quarterly and summed to an annual tally. The annual tallies are added together over a three-year period and then divided by three to check for NAAQS compliance. The NAAQS allows for a total of one exceedance per year on average over three years before an area qualifies as being non-compliant with the standard.

2. **The 24-hour PM2.5 standard imposes a 35 µg/m³ limit.** This is calculated as a three-year average of the 98th percentile of daily averages. This process sorts a year's data from lowest to highest, excluding the top 2% of values each year. If a complete annual record exists, the eighth highest value is selected. This procedure is replicated for three consecutive years, with the resulting values averaged to determine attainment or exceedence of the standard. Additional formulas address missing data scenarios.

3. **The annual PM2.5 standard has recently changed from 12 µg/m³ to a more restrictive 9 µg/m³.** Compliance with this standard is determined by calculating daily averages, using these daily figures to calculate quarterly averages, and then using these quarterly figures to calculate an annual average. This is repeated each year over a three-year period, and the resulting three-year average is considered to be the annual average for each of those three years.

Please note that on February 7, 2024, the EPA announced it would be lowering the annual average NAAQS for PM2.5 from 12 to 9 µg/m³. According to the EPA, the new standard is projected to yield substantial net public health benefits, potentially reaching $46 billion by 2032. The EPA estimates that by the year 2032, the benefits will encompass the prevention of up to 4,500 premature deaths, the avoidance of 800,000 instances of asthma symptoms, and the reduction of 290,000 lost workdays that year. The shift to a more stringent annual average standard of 9 µg/m³ aligns with evolving scientific understanding of the health impacts of PM2.5. This adjustment, based on extensive research and public health advocacy, aims to enhance protection against the myriad health risks associated with fine particulate matter exposure, from respiratory and cardiovascular diseases to broader systemic effects. The move was applauded by public health and environmental organizations, including Appalachian Voices, though experts had recommended an even stricter limit. For reference, the World Health Organization recommends an annual average limit of 5 µg/m³ for PM2.5.

The EPA began rolling out the new, stronger annual NAAQS for PM2.5 in May, but pending legal challenges and legislation may disrupt the rule's implementation. For USACAMP data, we will compare quarterly and annual average PM2.5 concentrations against the 9 µg/m³ benchmark.

The exact methodologies can be found in the Code of Federal Regulations.

Given that these standards necessitate three years of data for calculation, it is not possible to directly evaluate USACAMP data against NAAQS methodologies on a quarterly basis. However, this report provides metrics, graphs, and charts employing calculations akin to those utilized for NAAQS, enabling community partners to deduce potential chronic or acute particulate matter exposure concerns within their communities, and to gauge air quality relative to NAAQS benchmarks in the short term. One-page data summaries for each USACAMP PurpleAir monitor can be found in Appendix A to this report. These summaries include:

1. For the PM10 24-hour average, a gauge illustrating the highest daily average per quarter, a line graph illustrating daily averages over time, and a table showing the number of times the standard was exceeded in the quarter.
2. For the PM2.5 annual average, a gauge illustrating the quarterly average concentration (which serves as a preliminary step towards the annual average calculation), and a gauge illustrating the annual average to date.
3. For the PM2.5 24-hour average, a gauge reporting the quarter's second-highest daily average (mirroring the methodology for the PM2.5 24-hour standard discussed above), and a line graph illustrating daily averages over time.

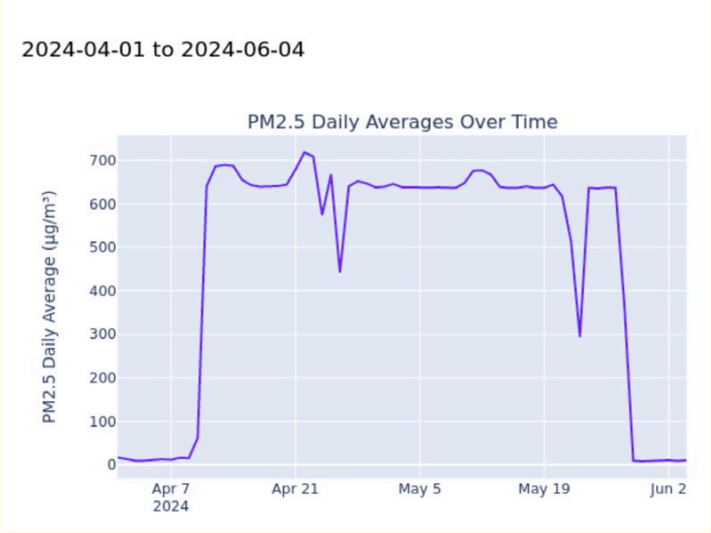
Photo: Michael Swensen for EarthJustice

Analysis of PurpleAir Monitor Performance

This quarter, two PurpleAir monitors have exhibited partial sensor failure, raising concerns about data accuracy and system reliability.

PurpleAir dust monitors use dual laser particle counters, referred to as Channel A and Channel B, to measure particulate matter (PM) concentrations. Sensor malfunctions can occur due to common issues such as debris accumulation, insect intrusion or gradual component degradation. When a sensor malfunctions, the system may automatically exclude the faulty channel's data from real-time map visualizations to maintain measurement accuracy. However, this exclusion does not extend to data downloaded via the API (Application Programming Interface). To mitigate such issues, regular maintenance—such as using compressed air to clean the sensors—is recommended.

In St. Charles, VA, one monitor exhibited abnormally high readings due to a malfunction in Channel B, while Channel A reported normal data. Despite this discrepancy, the monitor averaged the data from both channels, resulting in artificially inflated PM2.5 values. The following table and chart illustrate this issue:

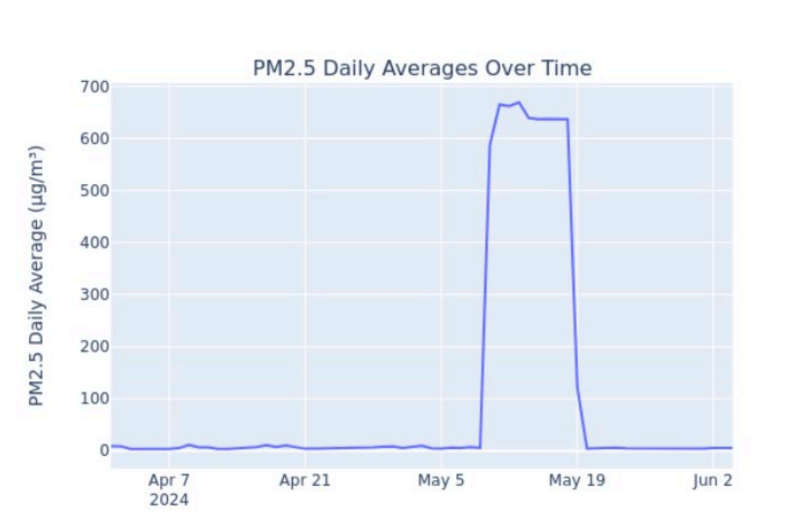


time_stamp	pm2.5_atm	pm2.5_atm_a	pm2.5_atm_b
2024-05-09T19:00:00-04:00	1669.2825	4.992	3333.573
2024-05-09T20:00:00-04:00	1669.2125	5.705	3332.72
2024-05-09T21:00:00-04:00	1669.3785	6.322	3332.435
2024-05-09T22:00:00-04:00	1669.177	6.873	3331.481
2024-05-09T23:00:00-04:00	1669.816	7.351	3332.281
2024-05-10T00:00:00-04:00	1670.944	9.497	3332.391

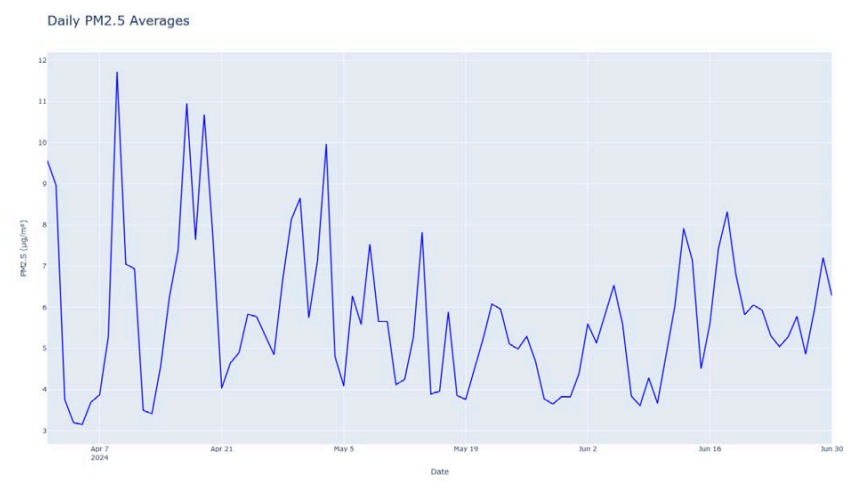
Channel B's values were disproportionately high, skewing the average PM2.5 concentration. This monitor has since been replaced by another PurpleAir device that is functioning correctly.

In Buckingham County, VA, another monitor demonstrated similar issues. Initially, Channel B reported excessively high values, followed by a complete failure where readings dropped to zero. This anomaly resulted in an overestimation, followed by an underestimation of readings.

The associated graph is below:



Below is what the same graph looks like with only the good channel of data (Channel A) being represented, providing a more accurate representation of what the data should look like.



According to our current Quality Assurance Project Plan (QAPP), any monitor with a data mismatch exceeding 10% should be replaced. However, we have requested an EPA modification to allow continued use of partially functional monitors in communities with multiple nearby devices. This approach would enable data validation through cross-referencing and reduce the frequency of sensor replacements while preserving data continuity.

Community Spotlight: HOPE for Bristol

Bristol, TN / VA

HOPE for Bristol formed in 2021 and is a small but dedicated nonprofit organization committed to addressing the environmental and health issues posed by a landfill in Bristol, Virginia. The organization emerged from the community's concerns about the adverse effects of the landfill on air quality, public health, and overall quality of life. Residents experience a range of issues, from foul odors and respiratory problems to anxiety and fear over long-term health impacts.

HOPE for Bristol engages in advocacy, education, and community organizing to combat the landfill's negative impacts. The organization works resolutely to raise awareness about the environmental hazards associated with the landfill, providing a platform for affected residents to voice their concerns and experiences.

Aligned with these efforts, USACAMP collaborates with HOPE for Bristol and other project partners to monitor additional compounds beyond particulate matter. HOPE for Bristol, through the use of devices called SENSIT RAMPs located in Bristol, Tennessee, (monitor 1144) and Bristol, Virginia, (monitor 1145), track volatile organic compounds (VOCs), carbon monoxide (CO), ammonia (NH3), sulfur dioxide (SO2), and hydrogen sulfide (H2S). They record data approximately every minute for each of these gasses through the use of electrochemical sensors, or in the case of VOCs, a photo-ionization detector. The device also measures metrics of weather, such as wind speed and direction, and temperature. This comprehensive monitoring supports ongoing efforts to understand and address the environmental challenges faced by the Bristol community.

The levels of carbon monoxide and sulfur dioxide collected by these SENSIT RAMPs are evaluated against the NAAQS to ensure compliance. Ammonia concentrations are assessed in reference to the Occupational Safety and Health Administration (OSHA) workplace exposure standards. The hydrogen sulfide measurements are analyzed against the relevant standards set by the Mine Safety and Health Administration (MSHA). A description of the measured gases and table of relevant standards is included below.

- **Volatile organic compounds (VOCs)** are a category of organic chemicals characterized by high vapor pressures at room temperature; these compounds easily transition into gaseous states under normal atmospheric conditions. Exposure to high levels of some VOCs can irritate the eyes and throat, cause nausea and trouble breathing, and is associated with damage to the central nervous system and other organs, according to the American Lung Association. Being a category of gasses, they can not be directly compared to any one standard. For the purpose of this project, the performance of the SENSIT RAMP VOC sensor is specifically compared to OSHA's exposure limits for benzene.
- **Carbon Monoxide (CO)** is a colorless, odorless gas produced by burning fossil fuels. It is harmful because it can prevent the blood from carrying oxygen to cells, tissues, and organs.
- **Ammonia (NH3)** is a colorless gas with a pungent odor, commonly used in industrial and cleaning products. It is a common toxicant that originates from wastes, fertilizers, and natural processes.
- **Sulfur Dioxide (SO2)** is a gas produced by industrial processes, especially the burning of fossil fuels containing sulfur. It can cause respiratory problems and contribute to the formation of acid rain.
- **Hydrogen Sulfide (H2S)** is a colorless gas known for its characteristic foul odor of rotten eggs. It is toxic and can cause respiratory distress and other health issues at high concentrations..

Chemical Concentration Limits

Ammonia	NH_3	OSHA sets a permissible exposure limit (PEL) of 50 parts per million (ppm) as an 8-hour time-weighted average (TWA).
Volatile organic compounds	VOCs (benzene)	OSHA sets a PEL for benzene of 1 ppm as an 8-hour time-weighted average (TWA).
Sulfur dioxide	SO_2	The EPA NAAQS for SO2 specifies that the highest observed 1-hour SO2 concentration should not exceed 75 parts per billion (ppb) more than once per year.*
Carbon monoxide	CO	The EPA NAAQS limits CO to 9 ppm over an 8-hour period and 35 ppm over a 1-hour period.
Hydrogen sulfide	H_2S	MSHA imposes a ceiling of 20 ppm to prevent chronic effects, and a short-term exposure limit (STEL) of 50 ppm for up to 10 minutes to allow for brief peak exposures without severe health risks.

VOC and Other Pollutant Data

All SENSIT RAMP data was compared against the relevant standards. No exceedances were indicated for any of the parameters measured. The table and graphs below show the highest concentrations detected by each of the SENSIT RAMP devices, utilizing calculations as described in the regulations. Sulfur dioxide is shown with the second-highest max value for the quarter, as the regulations require the highest values to be excluded from calculations.

SENSIT RAMP Data

SENSIT RAMP #1144	Value	Standard
CO highest 1-hour average concentration	2.043 ppm	35 ppm
CO highest 8-hour average concentration	0.556 ppm	9 ppm
Highest measured H2S concentration (1 minute intervals)	0.663 ppm	20 ppm ceiling and 50 ppm over 10 minutes
VOC highest 8-hour time-weighted average	0.001830 ppm	1 ppm over 8 hours, or 5 ppm over 15 minutes - (Benzene)
NH3 highest 8-hour time-weighted average	1.163 ppm	50 ppm
SO2 -highest daily average for the quarter	89.78 ppb	75 ppb, 1-hour annual

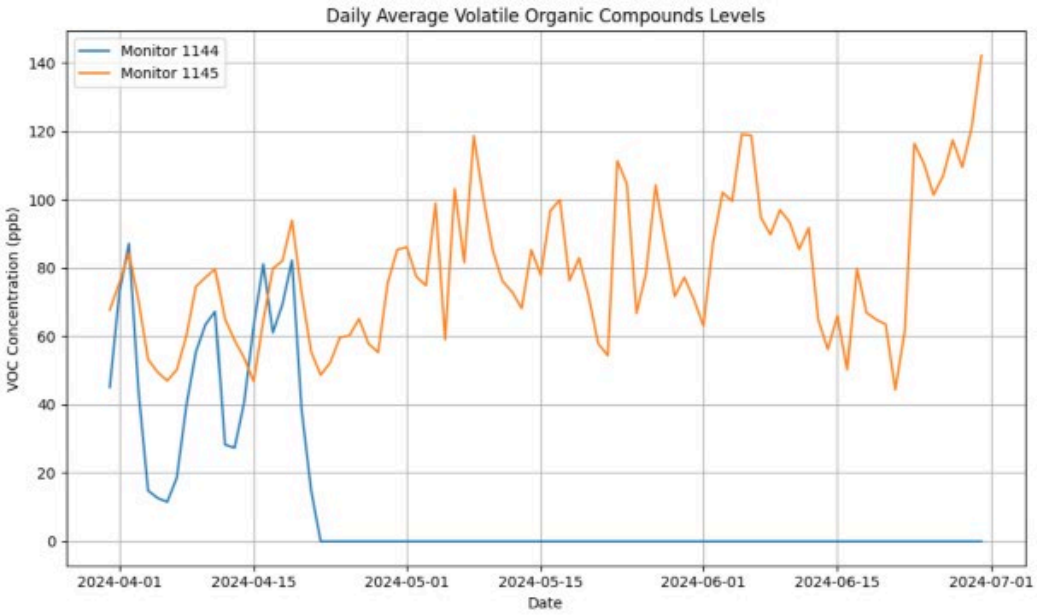
SENSIT RAMP #1145	Value	Standard
CO highest 1-hour average concentration	0.539 ppm	35 ppm
CO highest 8-hour average concentration	0.459 ppm	9 ppm
Highest measured H2S concentration, 1 minute intervals)	0.572 ppm	20 ppm ceiling and 50 ppm over 10 minutes
VOC highest 8-hour time-weighted average	0.00183 ppm	1 ppm over 8 hours, or 5 ppm over 15 minutes - (Benzene)
NH3 highest 8-hour time-weighted average	0.714 ppm	50 ppm
SO2 -highest daily average for the quarter	103.08 ppb	75 ppb, 1-hour annual*

*National primary ambient air quality standards require three years' worth of data for calculations used to determine an exceedance. That said, we do expect exceedances of SO2 will be likely, given the data we have thus far. But this data will also be averaged with data for other years, so it is possible that the average value could remain in compliance

HOPE plans to continue to monitor air quality in the neighborhoods adjacent to the Bristol landfill, and collect additional data utilizing a passive air sampling method called sorbent tube testing. Data from that testing will also be made available on our website as it is gathered.

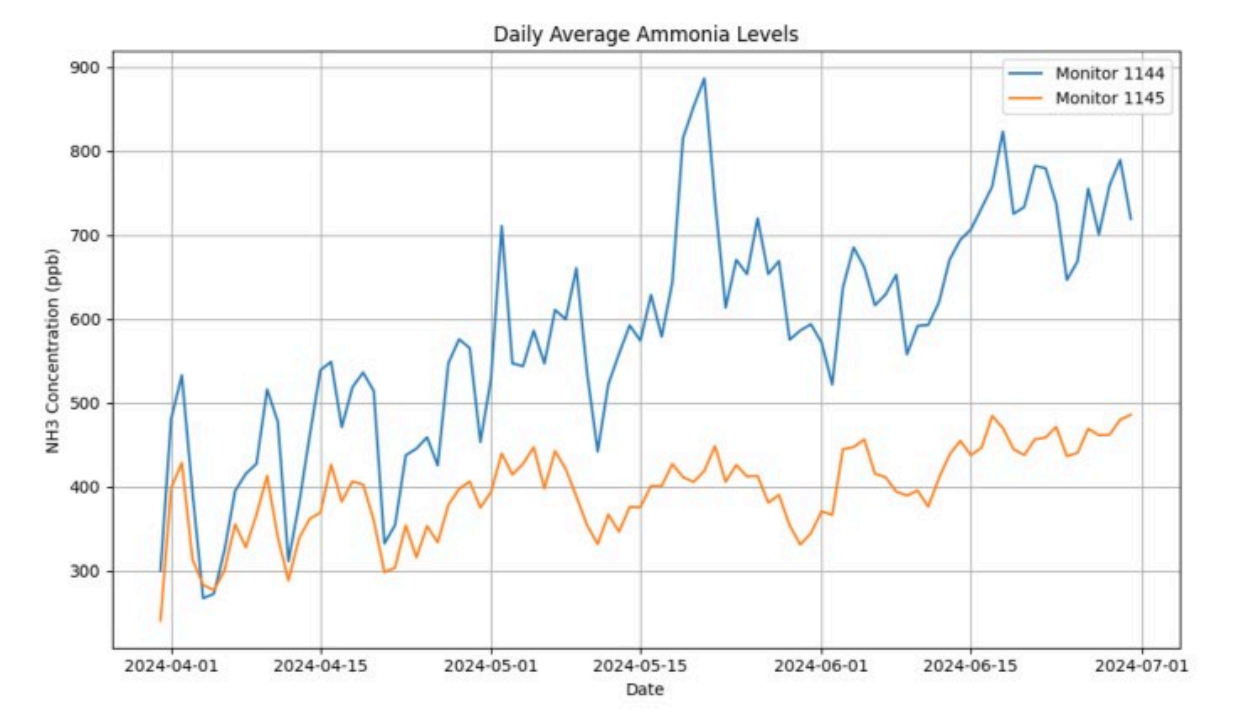
Graphs of data from the SENSIT RAMPs are shown below:

Volatile Organic Compounds: Bristol, Virginia and Tennessee

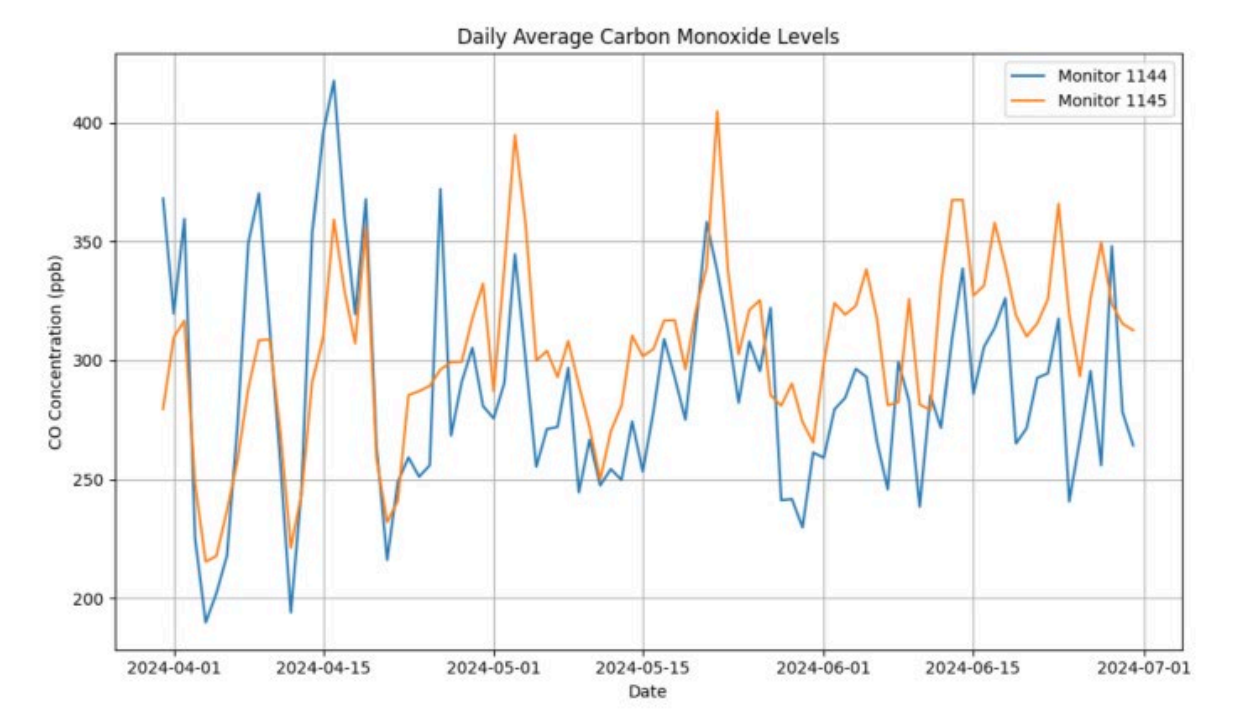


SENSIT RAMP monitors.

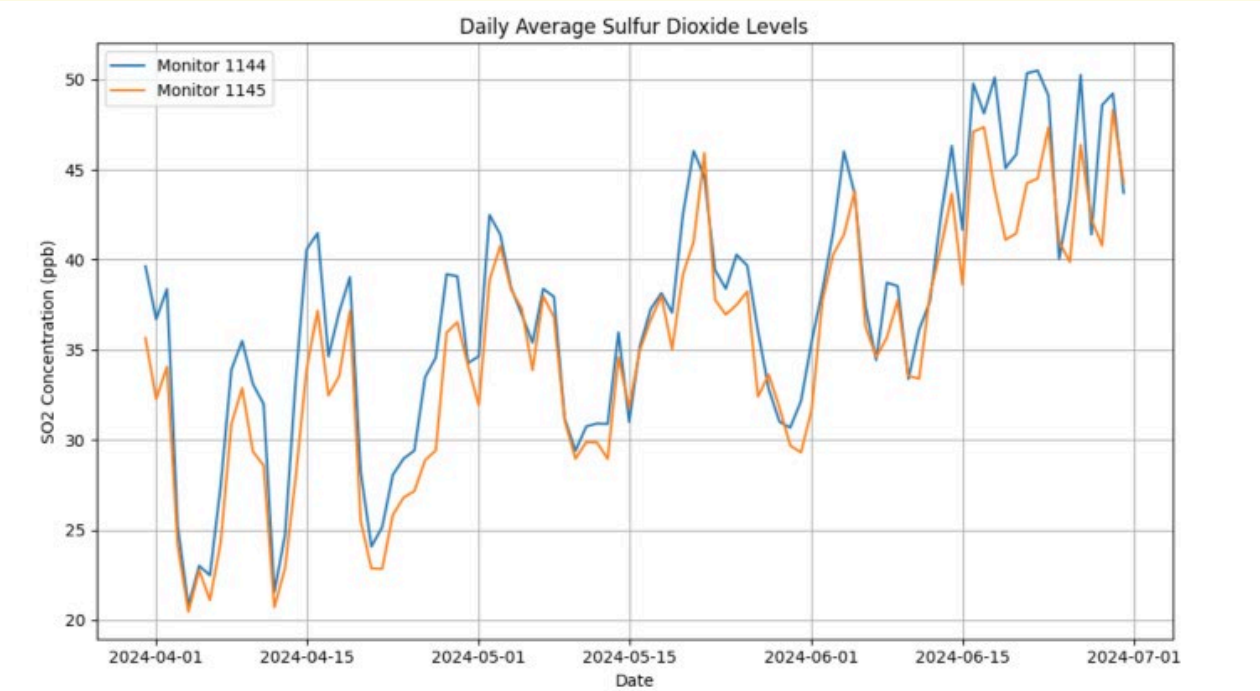
Ammonia: Bristol, Virginia and Tennessee



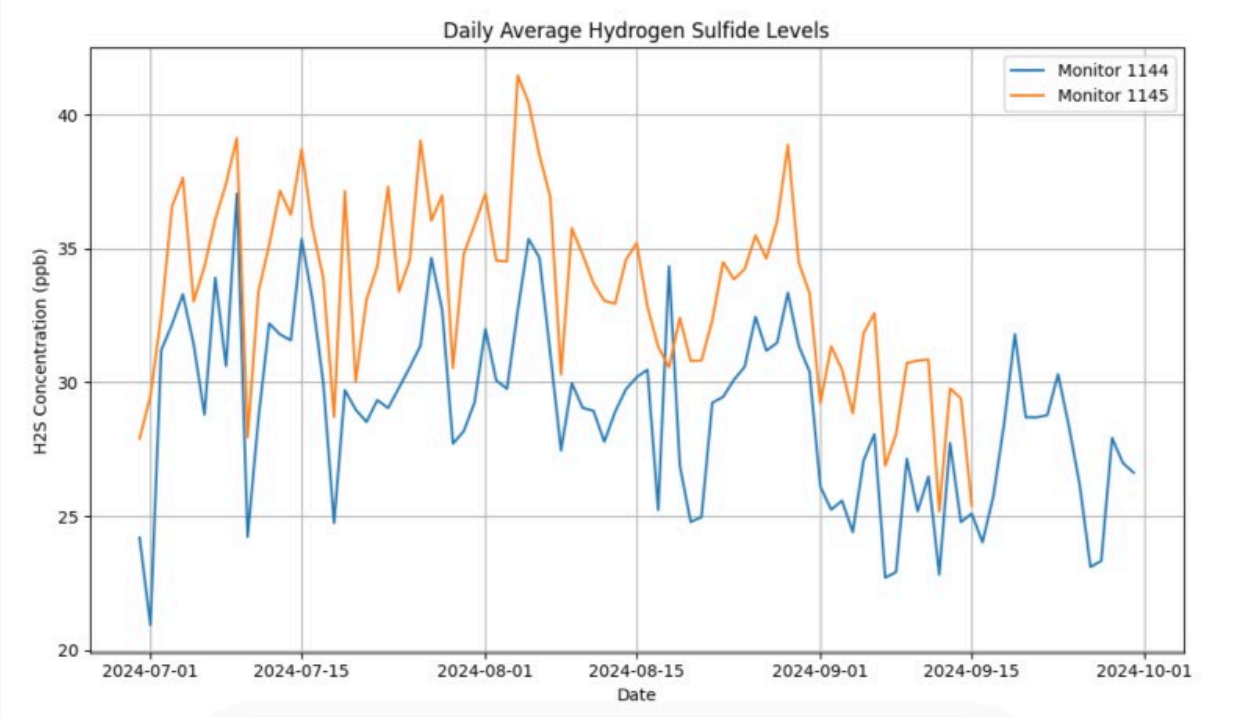
Carbon Monoxide: Bristol, Virginia and Tennessee



Sulfur Dioxide: Bristol, Virginia and Tennessee



Hydrogen Sulfide: Bristol, Virginia and Tennessee



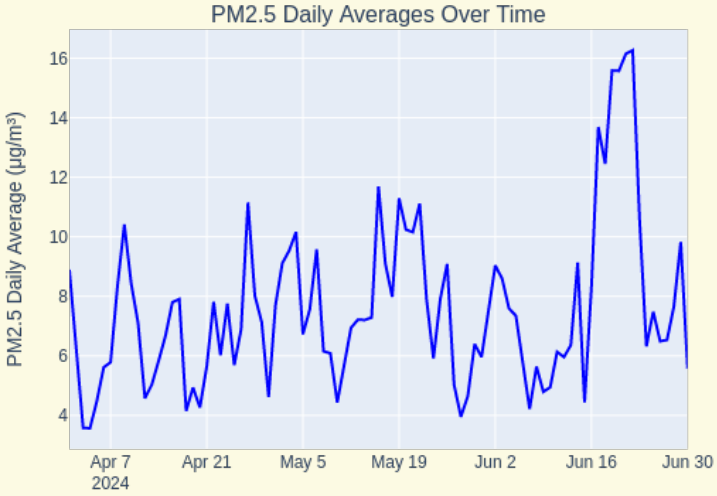
Future Outlook and Next Steps

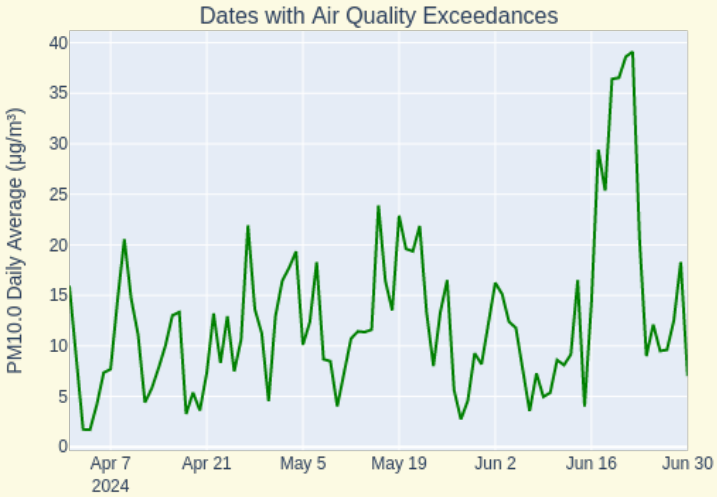
USACAMP plans to continue its investigations into all of the communities where we have monitors placed and share any significant findings in future reports and during annual webinars. Next quarter, we hope to incorporate data from another SENSIT device being deployed near Blacksburg, Virginia, and direct measurements from our sorbent tube testing in Bristol, as well as share new PurpleAir monitor data with the public. We expect to have all the project monitors deployed by the next report.

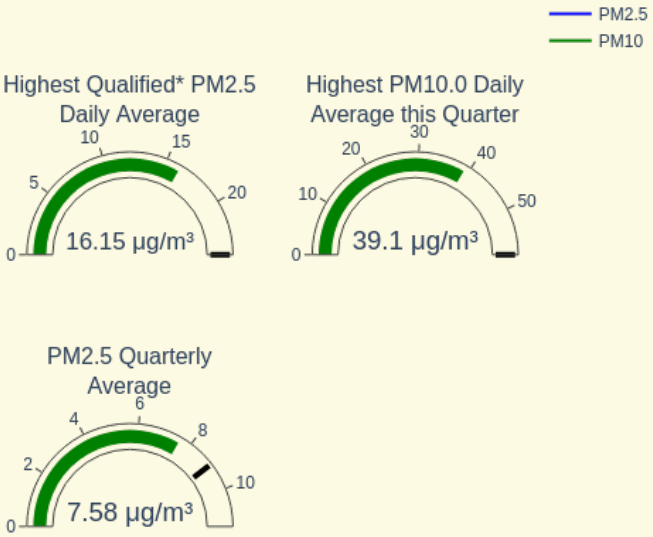
The primary objective of this project is to encourage meaningful discussions about air quality within and among communities. If you have any questions regarding this report, please feel free to contact Willie Dodson at willie@appvoices.org or Matt Hepler at matt.hepler@appvoices.org.

Appendix

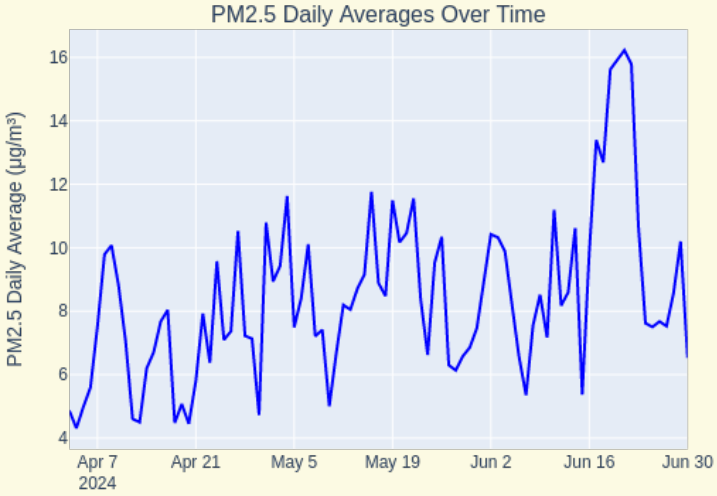
2024-04-01 to 2024-06-30 Report for Sensor 183777: AV-13-7D:E7, Kenton_County, KY

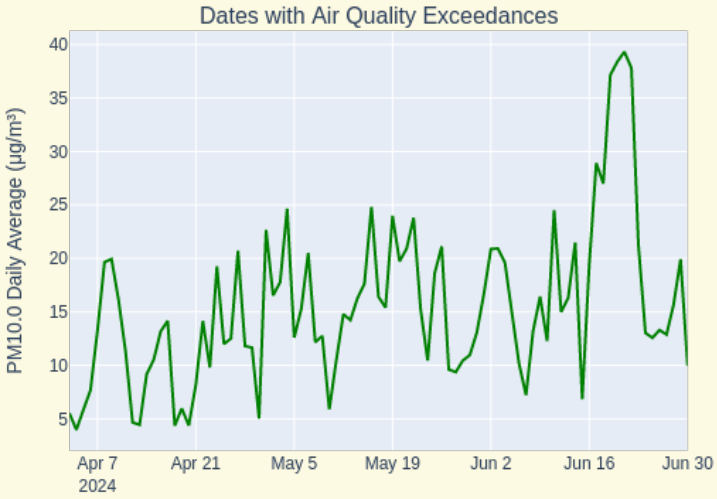


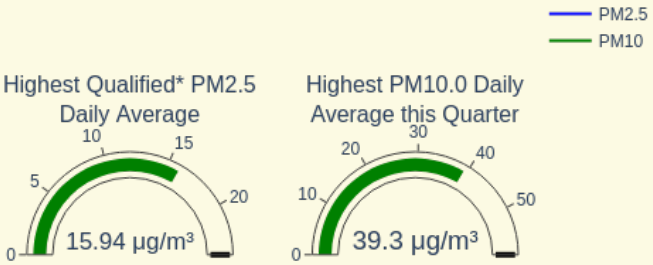


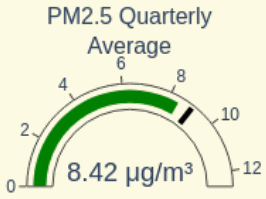


2024-04-03 to 2024-06-30 Report for Sensor 183773: AV-14-987, Kenton_County, KY



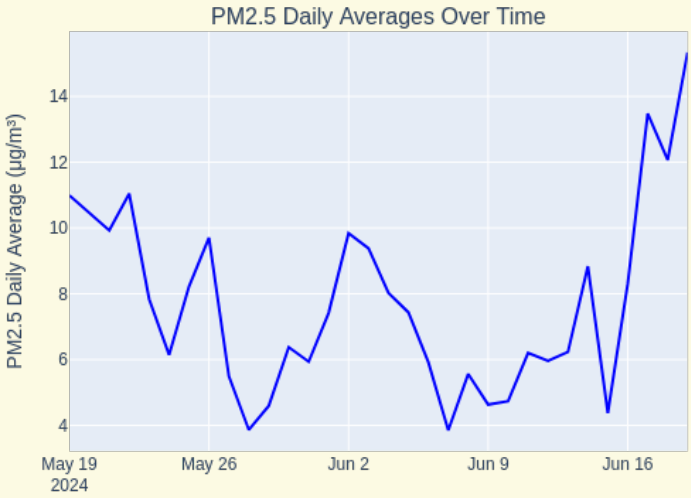


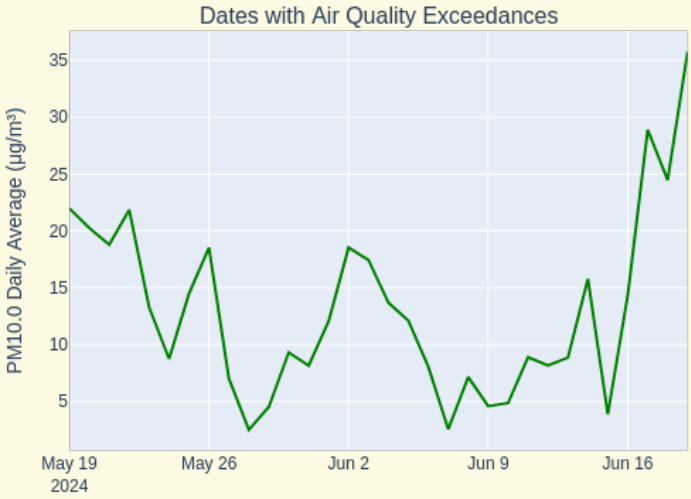


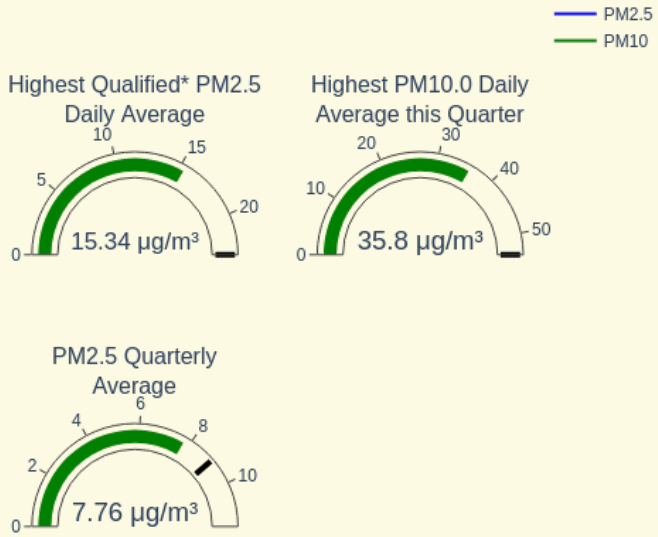


2024-05-19 to 2024-06-19 Report for Sensor 183761: AV-15-558F, Kenton_County, KY

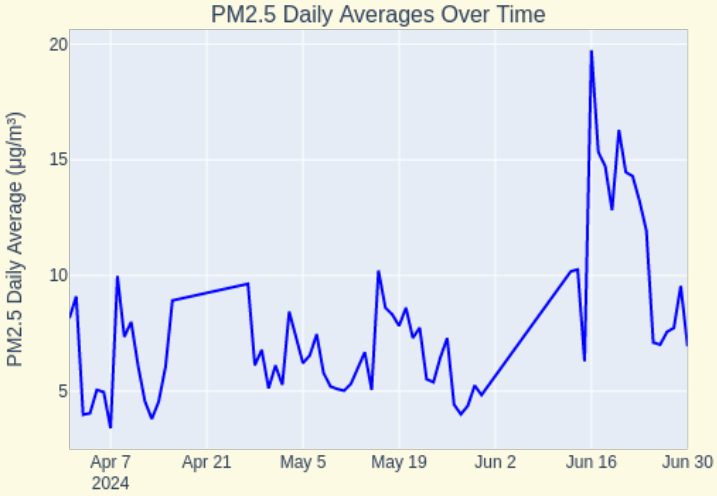
Note: This report has been flagged as possibly returning insufficient data.

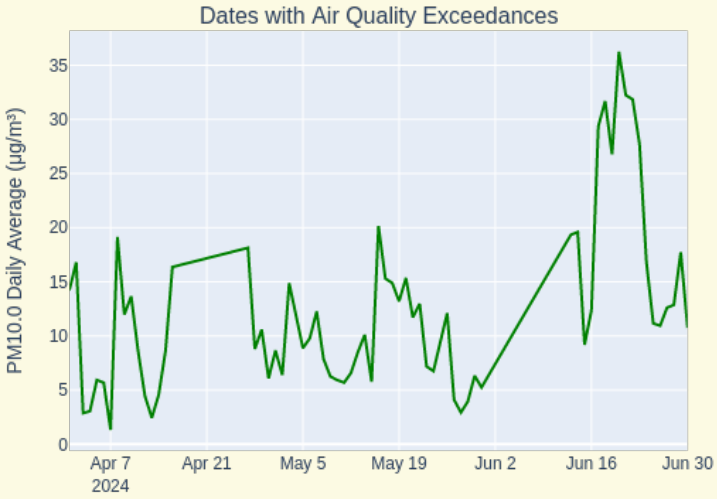


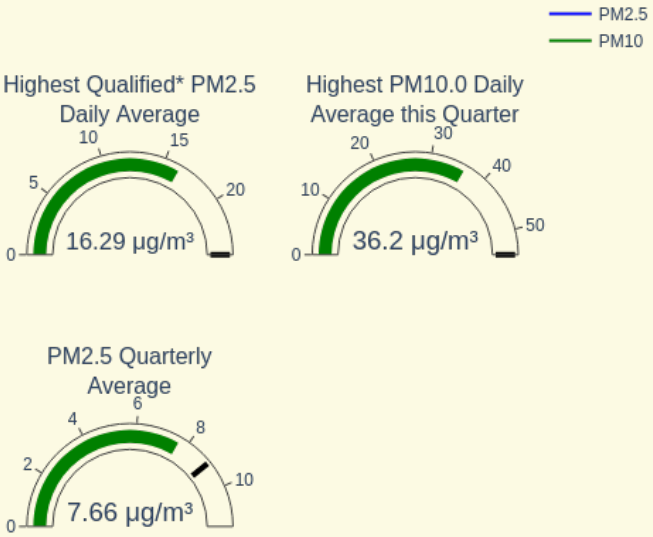




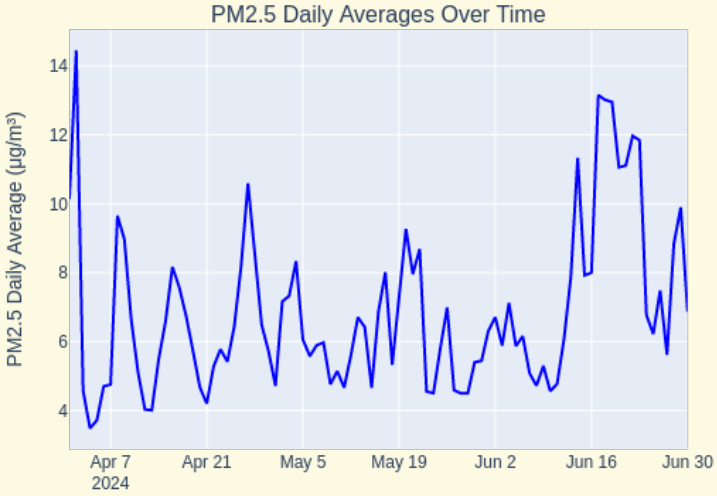
2024-04-01 to 2024-06-30 Report for Sensor 184511: AV-22-4C62, Clark_County, KY

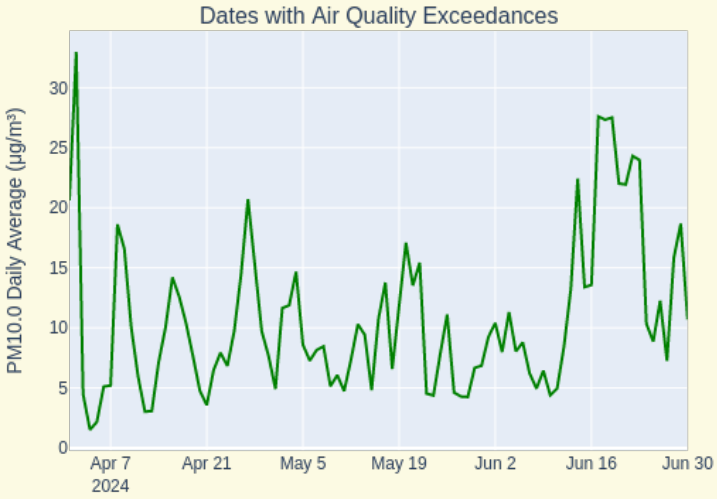


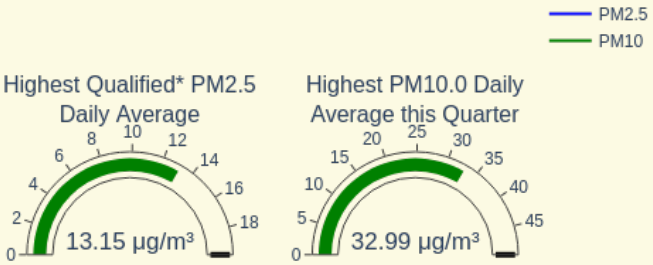


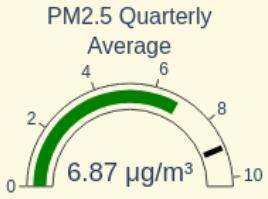


2024-04-01 to 2024-06-30 Report for Sensor 184563: AV-26-38:7, Floyd_County, KY

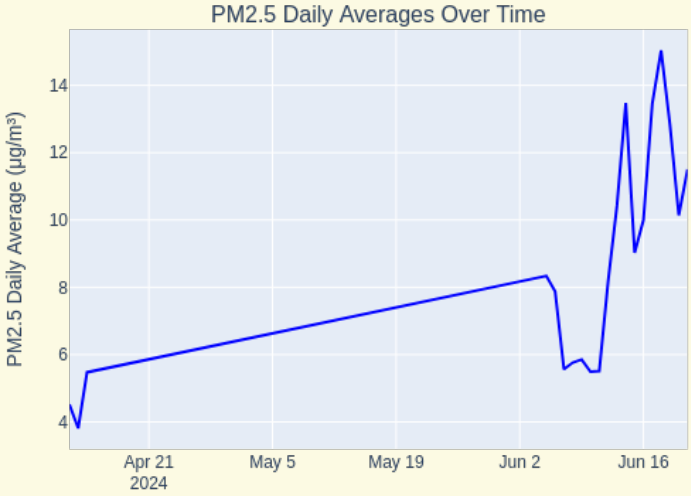


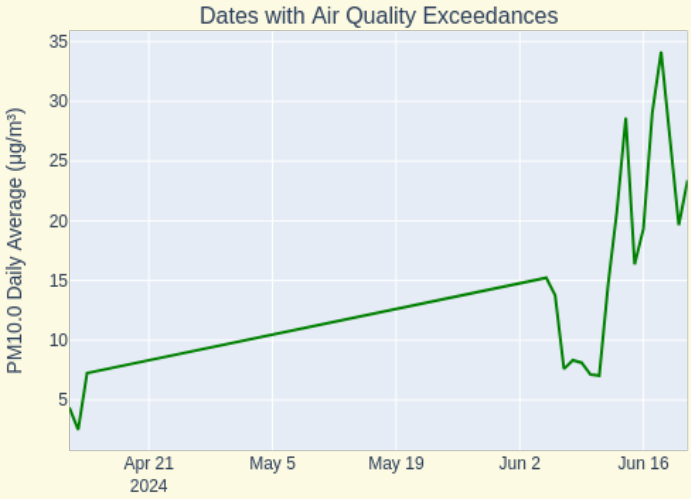


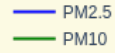


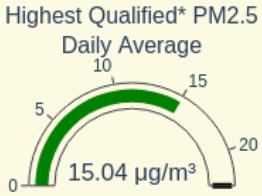


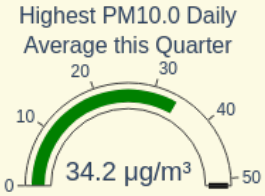
2024-04-12 to 2024-06-21 Report for Sensor 184537: AV-27-F7:83, Letcher_County, KY

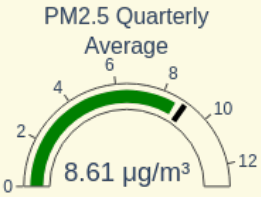




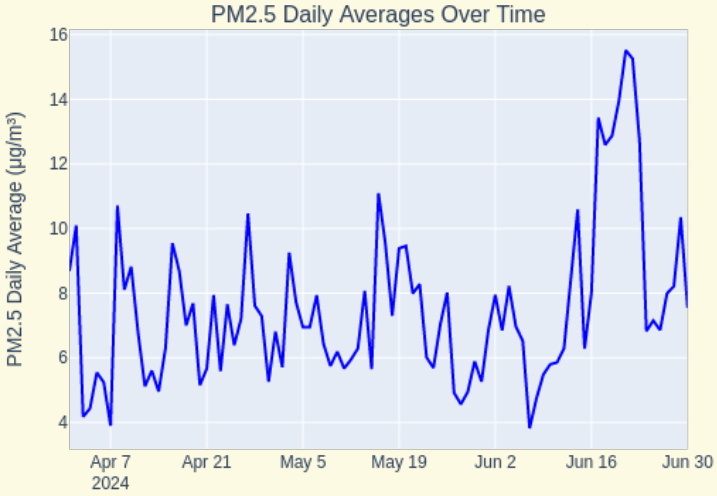


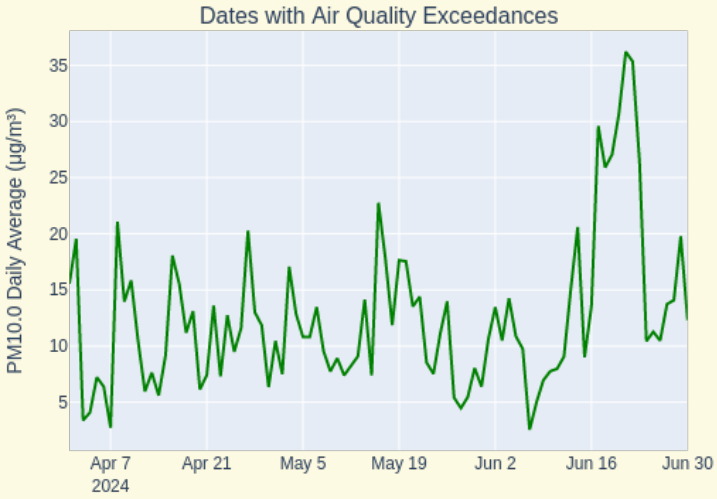


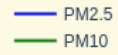


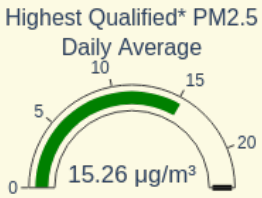


2024-04-01 to 2024-06-30 Report for Sensor 184505: AV-40-F7:3B, Clark_County, KY

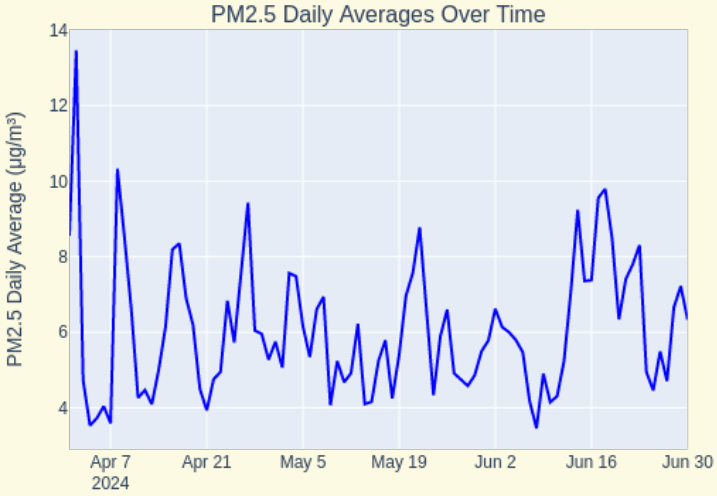


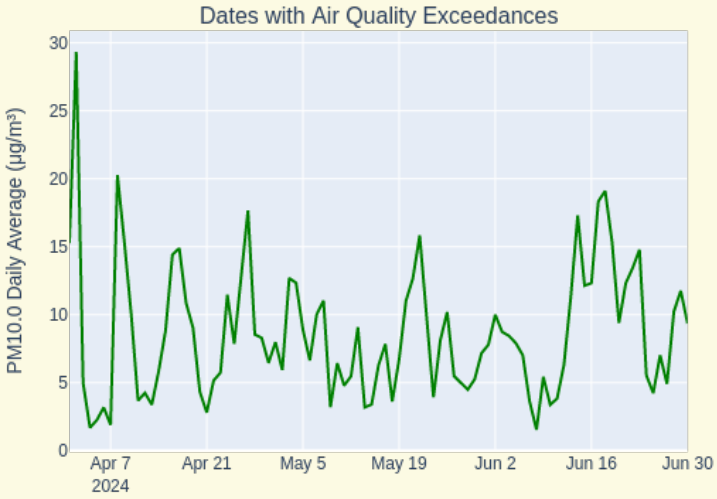


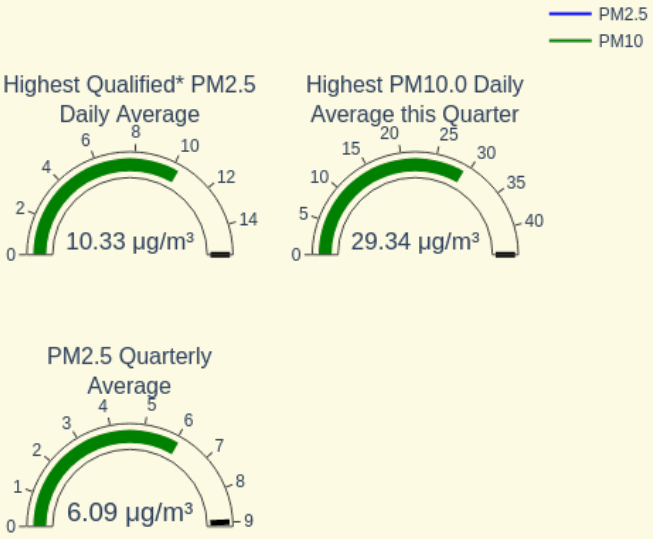




2024-04-01 to 2024-06-30 Report for Sensor 198479: AV-51-4E:63, Harlan_County, KY

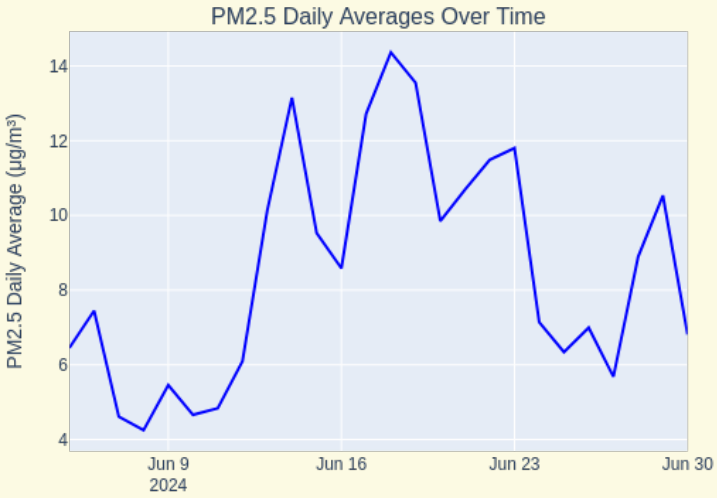


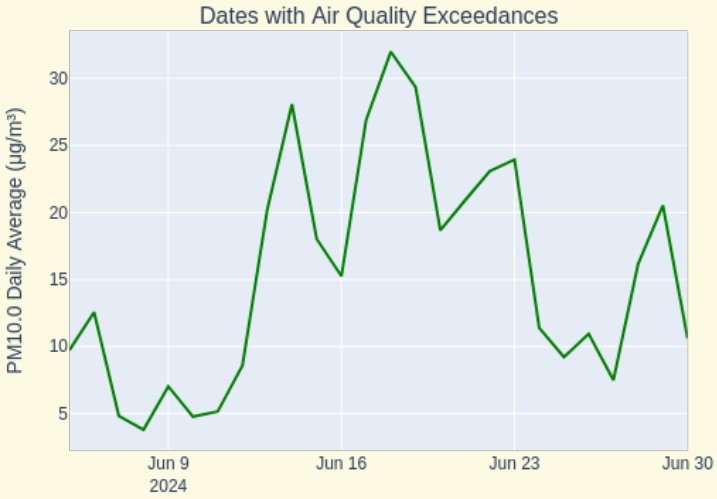


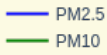


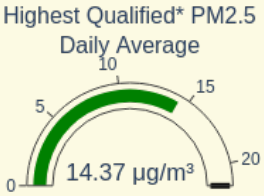
2024-06-05 to 2024-06-30 Report for Sensor 211965: AV70-B1:18, Knott_County, KY

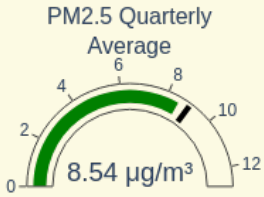
Note: This report has been flagged as possibly returning insufficient data.



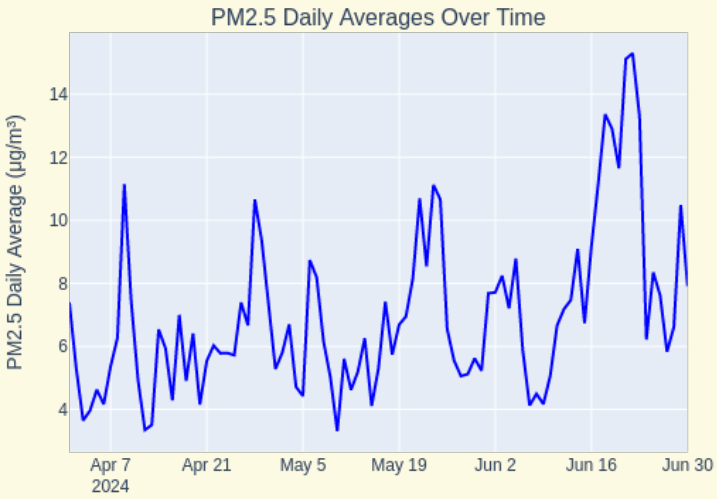


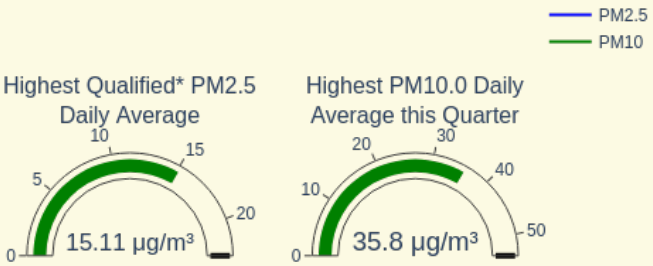


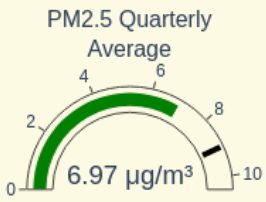


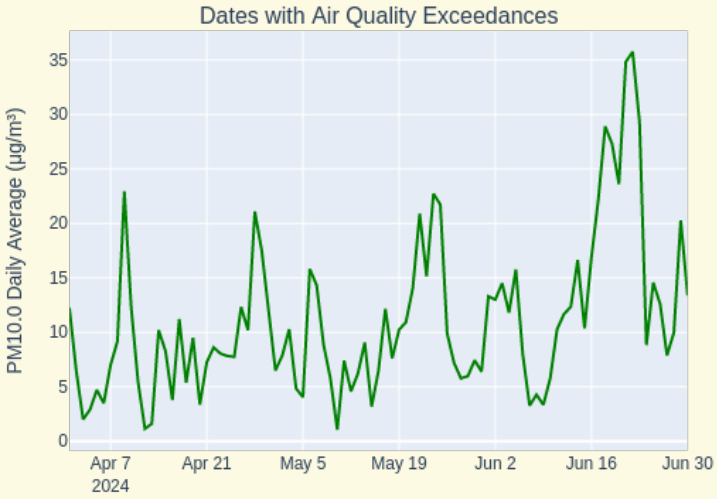


2024-04-01 to 2024-06-30 Report for Sensor 183811: Av-10-51:DF, Westmoreland_County, PA



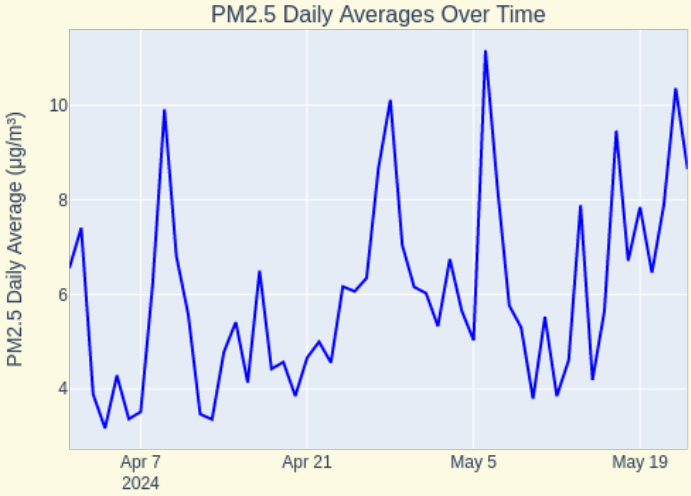


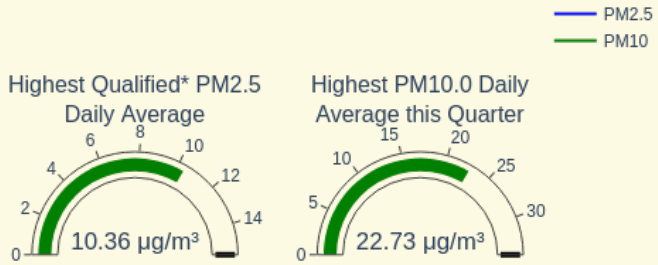


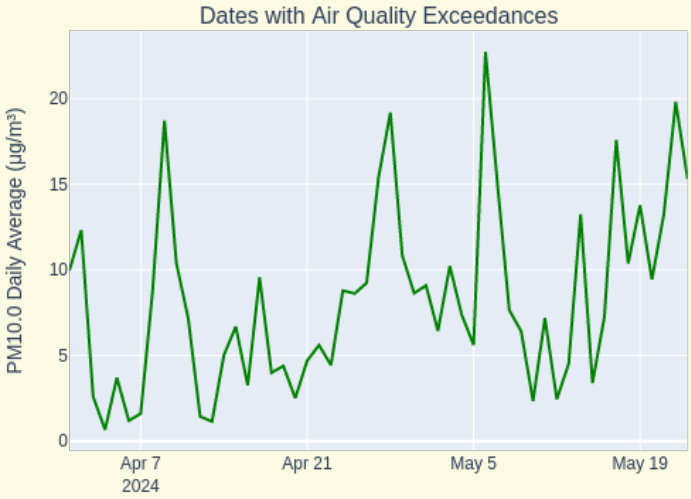


2024-04-01 to 2024-05-23 Report for Sensor 183751: AV-12-9EAC, Greene_County, PA

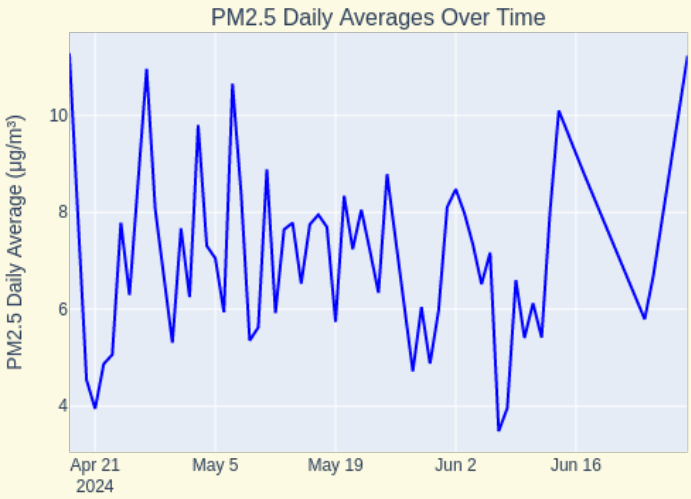
Note: This report has been flagged as possibly returning insufficient data.

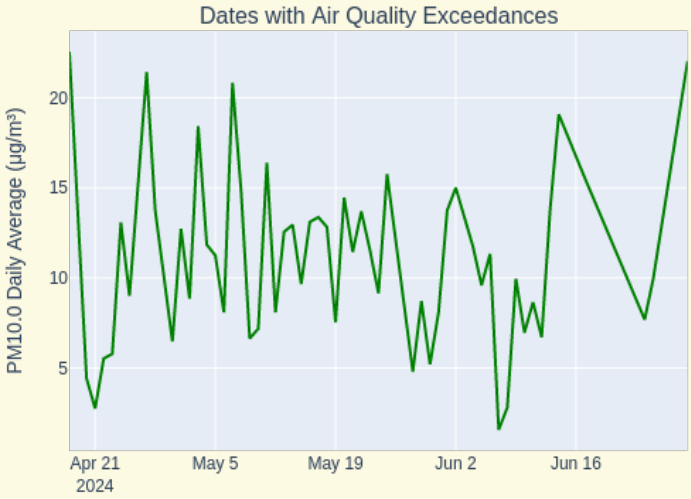


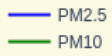




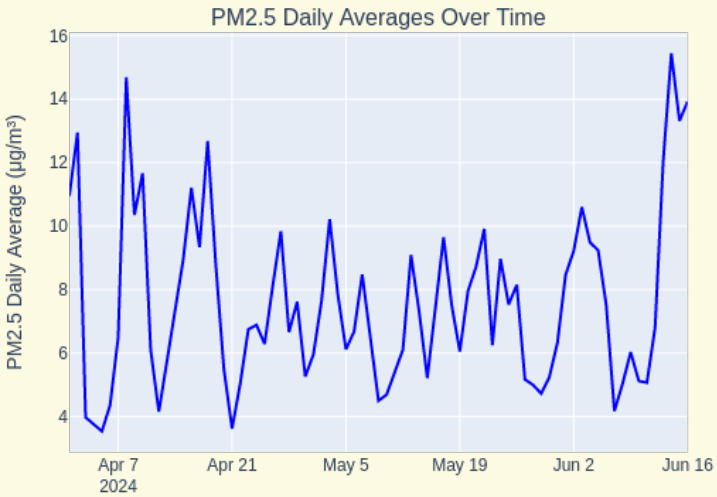
2024-04-18 to 2024-06-29 Report for Sensor 184531: AV-29-F9ED, Montgomery_County, TN

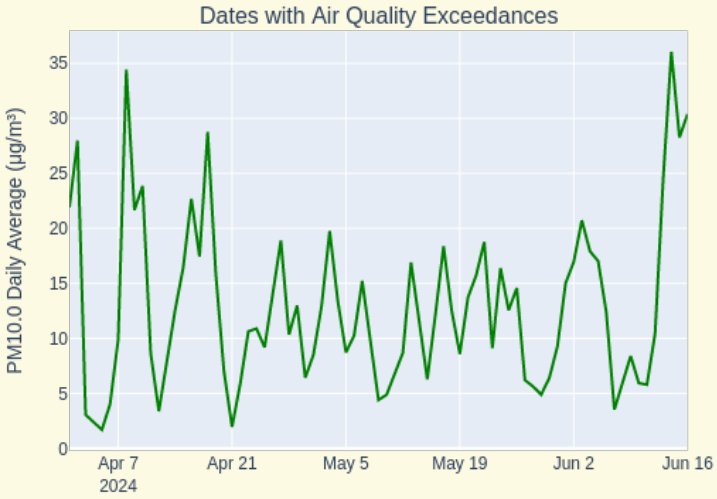


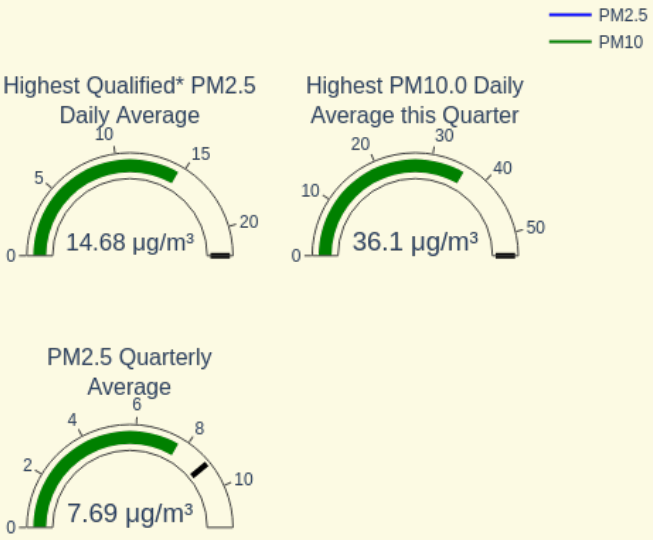




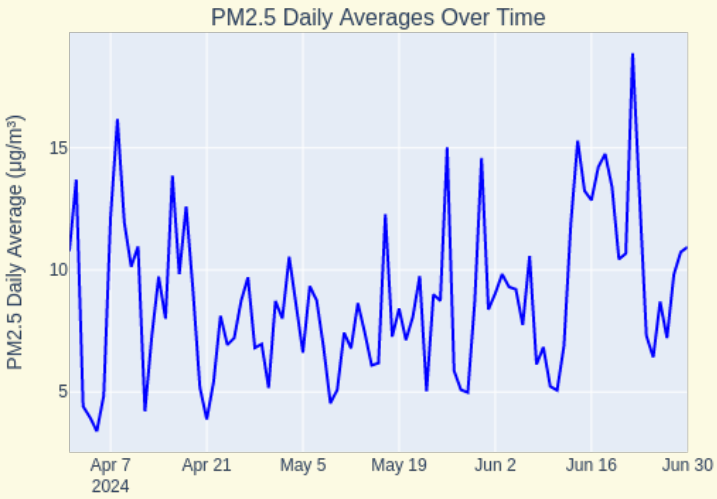
2024-04-01 to 2024-06-16 Report for Sensor 184349: AV-30-A:DB, Roane_County, TN

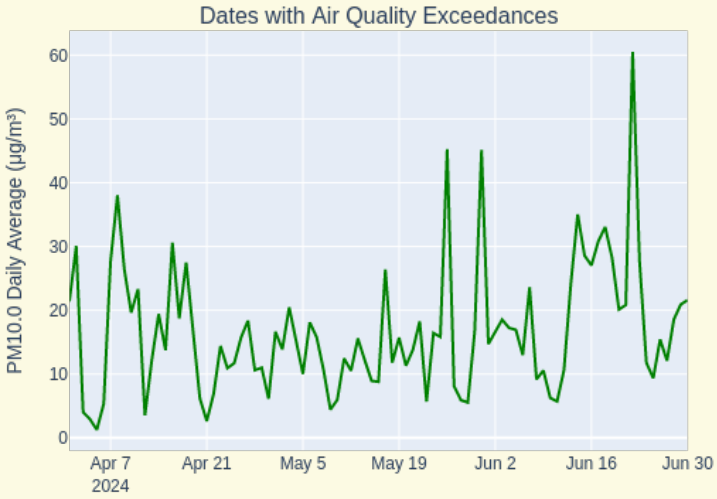


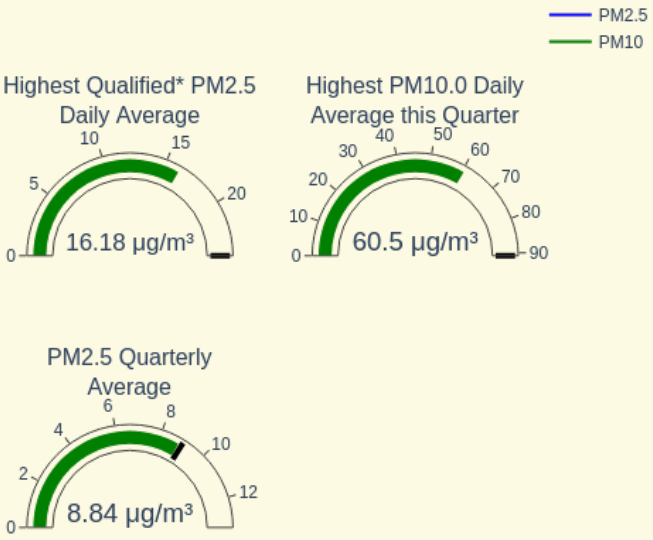




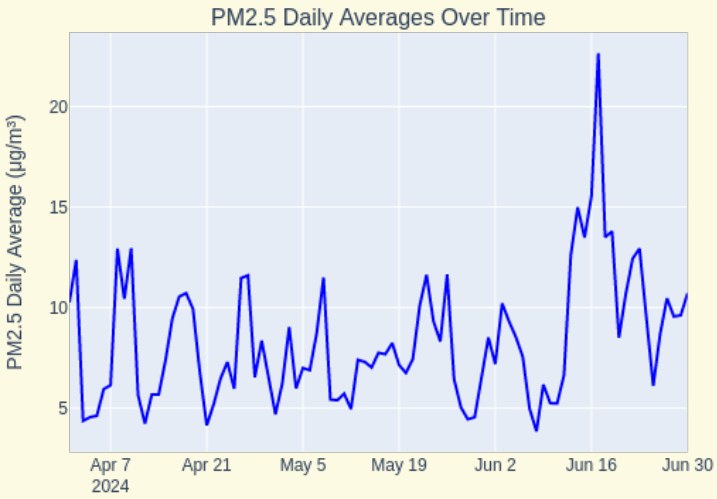
2024-04-01 to 2024-06-30 Report for Sensor 196109: AV-49-50:4F, Anderson_County, TN

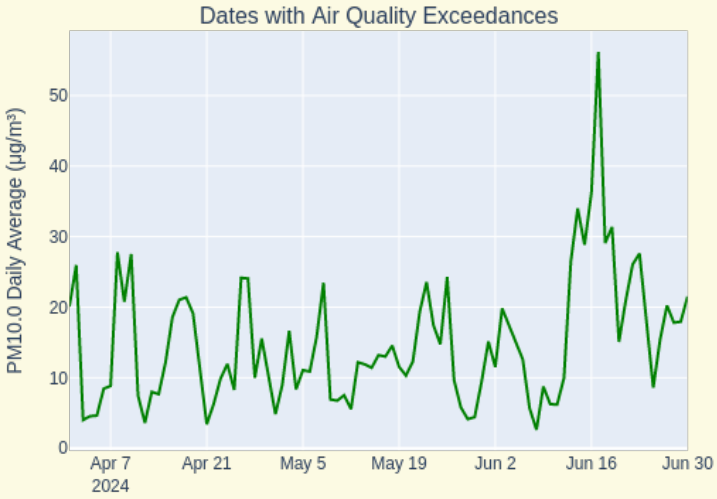


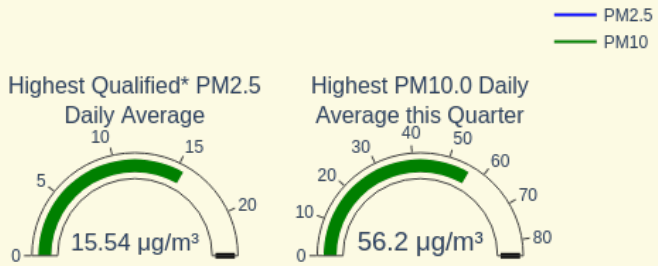


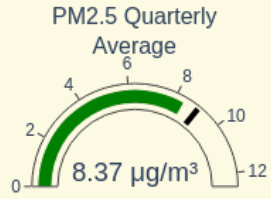


2024-04-01 to 2024-06-30 Report for Sensor 196153: AV-50-1D7F, Grundy_County, TN

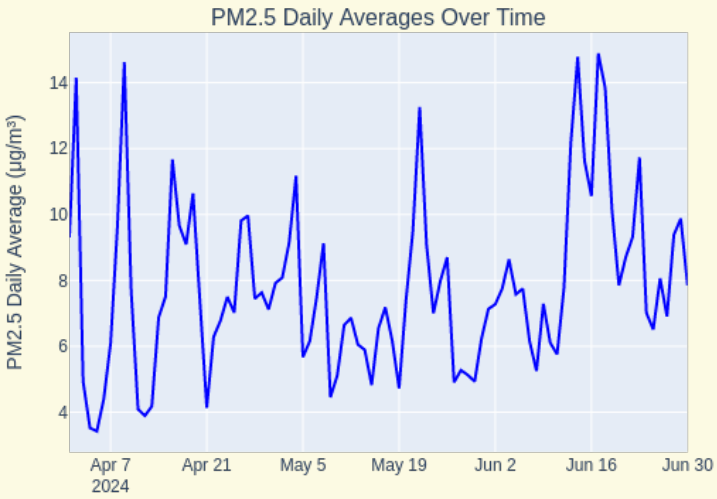


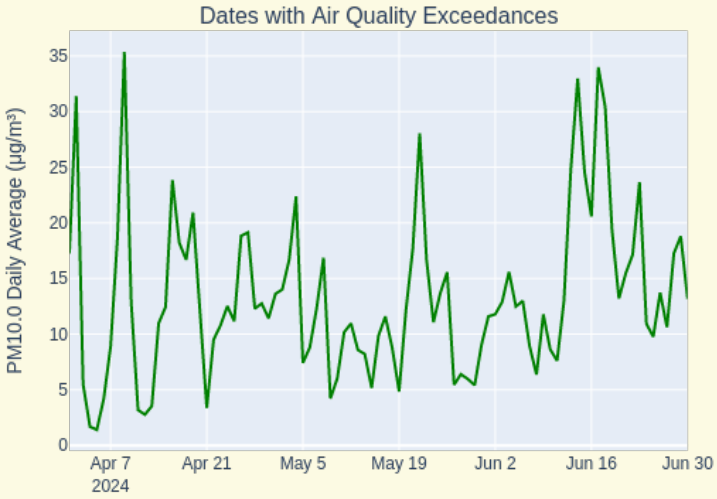


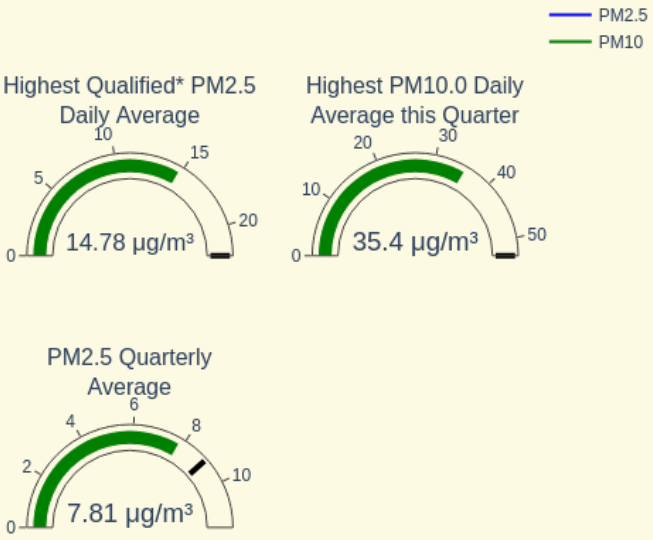




2024-04-01 to 2024-06-30 Report for Sensor 198979: AV59-85-6B, Sullivan_County, TN

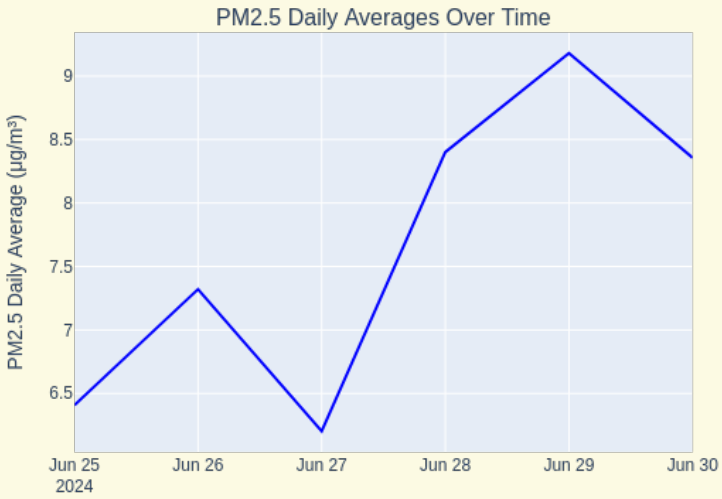


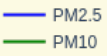


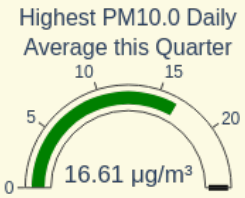


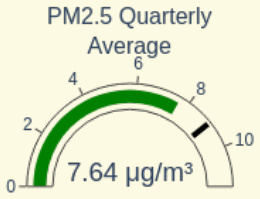
2024-06-25 to 2024-06-30 Report for Sensor 212029: AV60-4E20, Sullivan_County, TN

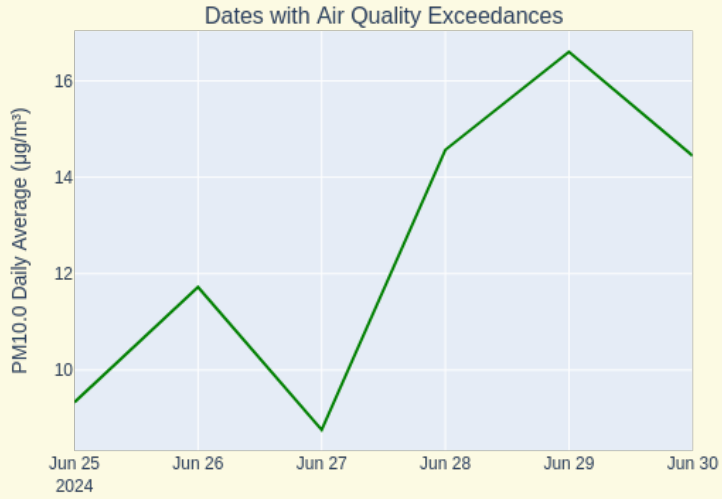
Note: This report has been flagged as possibly returning insufficient data.





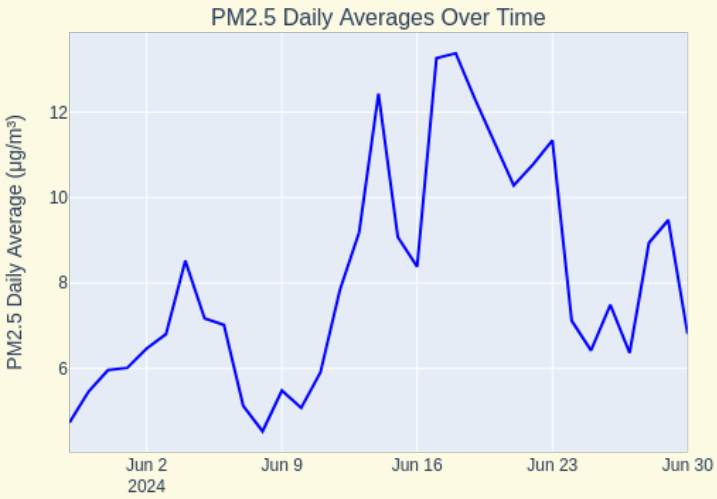


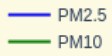


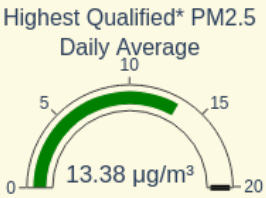


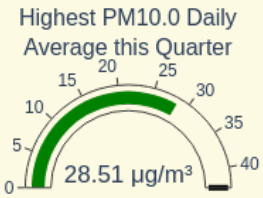
2024-05-29 to 2024-06-30 Report for Sensor 211973: AV63-51:94, Shelby_County, TN

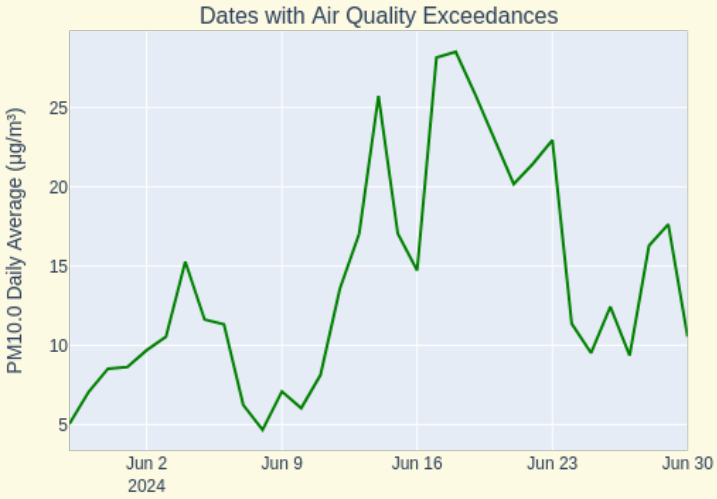
Note: This report has been flagged as possibly returning insufficient data.



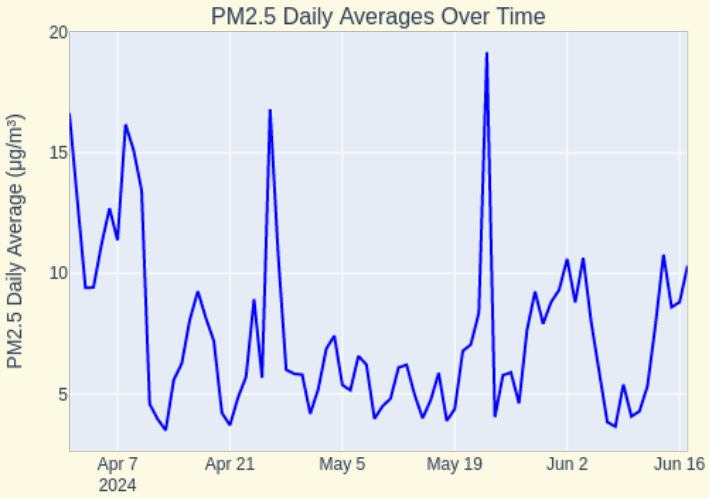


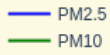


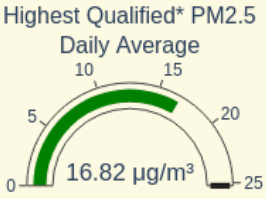


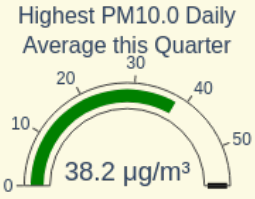


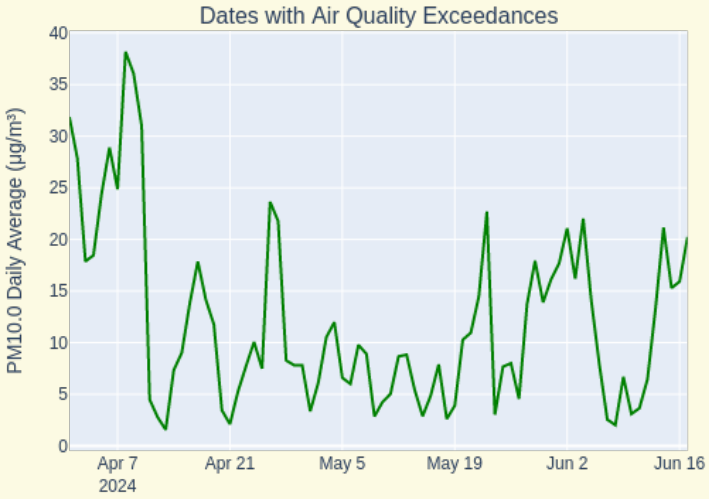
2024-04-01 to 2024-06-17 Report for Sensor 183791: AV-2-53:E1, Lee_County, VA



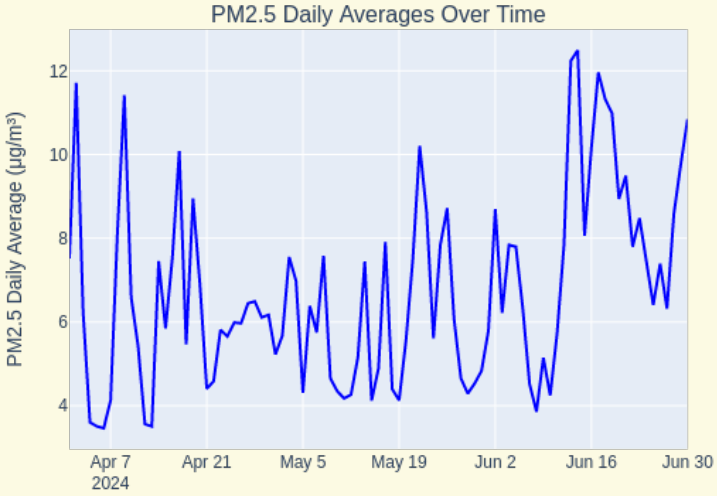


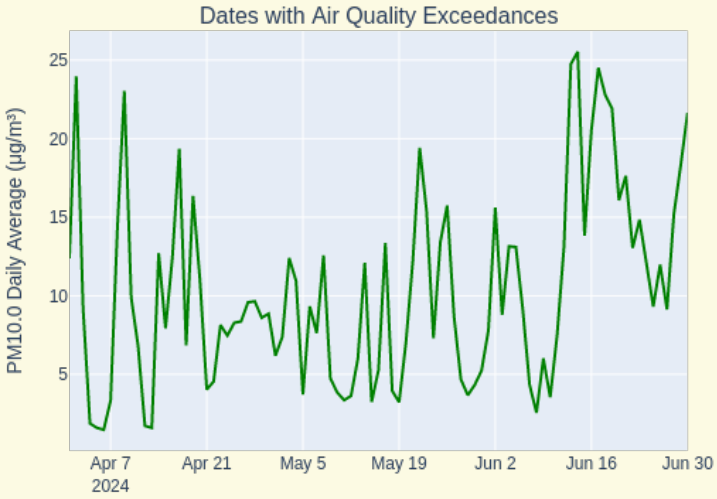


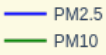


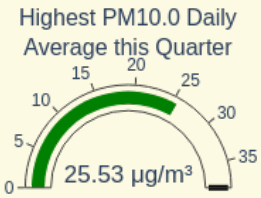


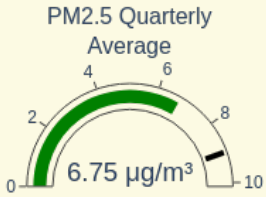
2024-04-01 to 2024-06-30 Report for Sensor 183743: AV-4-51:2E, Montgomery_County, VA





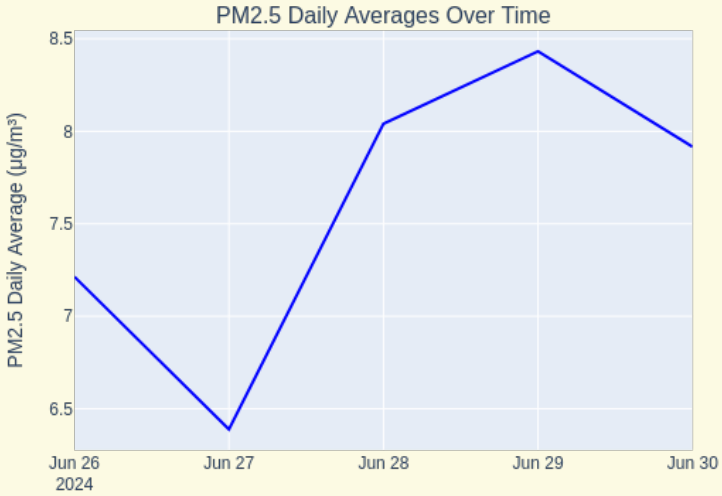


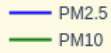


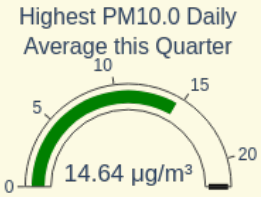


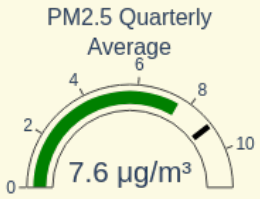
2024-06-26 to 2024-06-30 Report for Sensor 183813: AV-5-AF43, Montgomery_County, VA

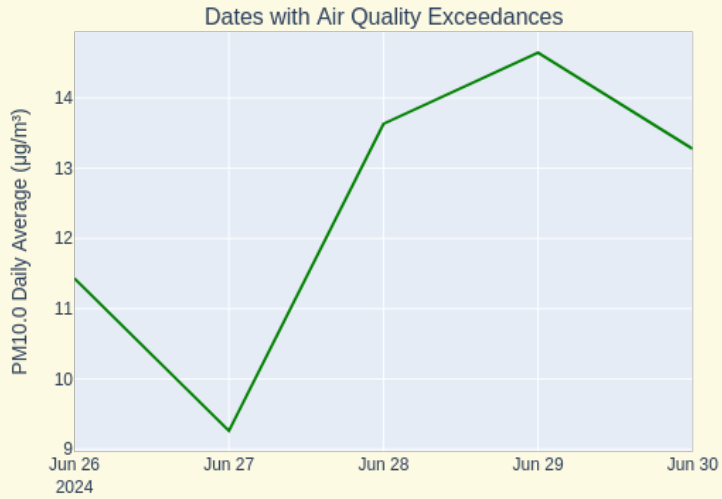
Note: This report has been flagged as possibly returning insufficient data.



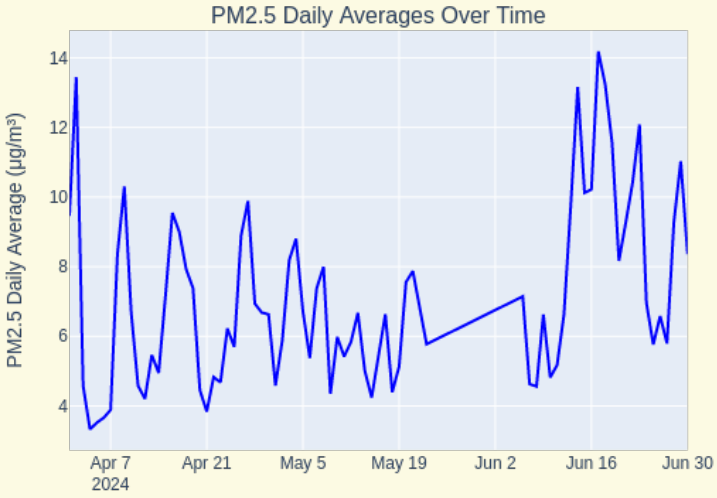


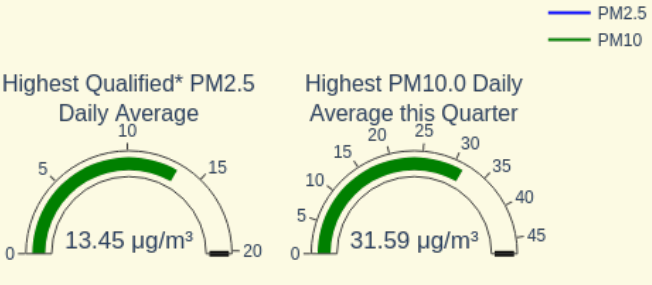


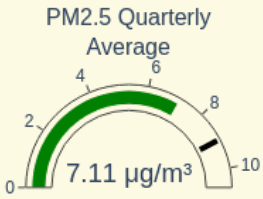


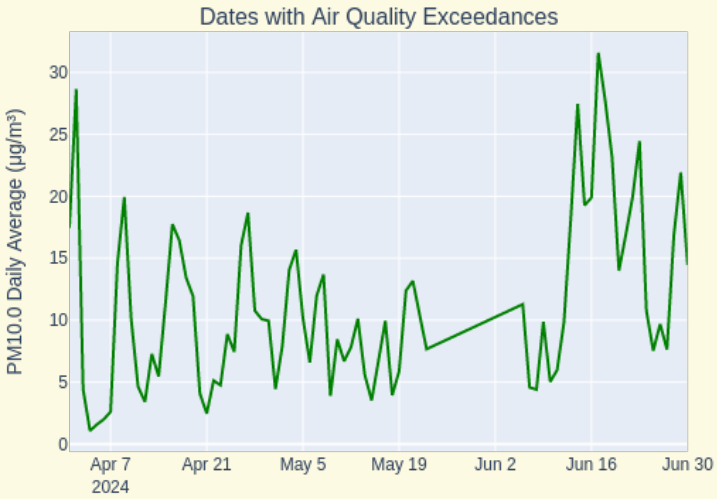


2024-04-01 to 2024-06-30 Report for Sensor 183749: AV-16-9999, Wise_County, VA



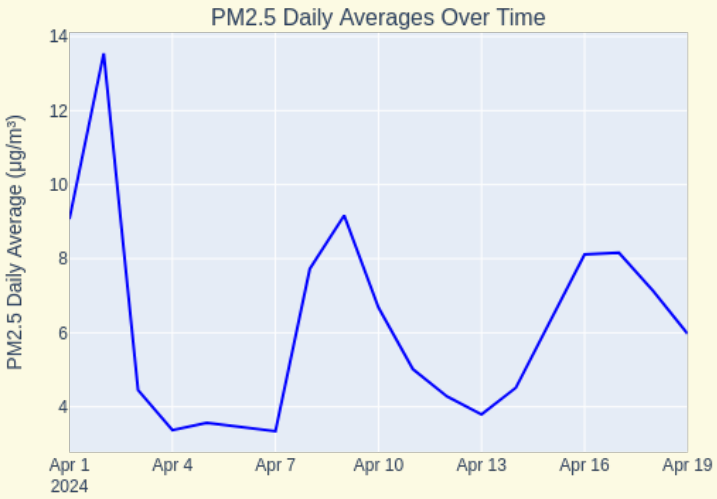


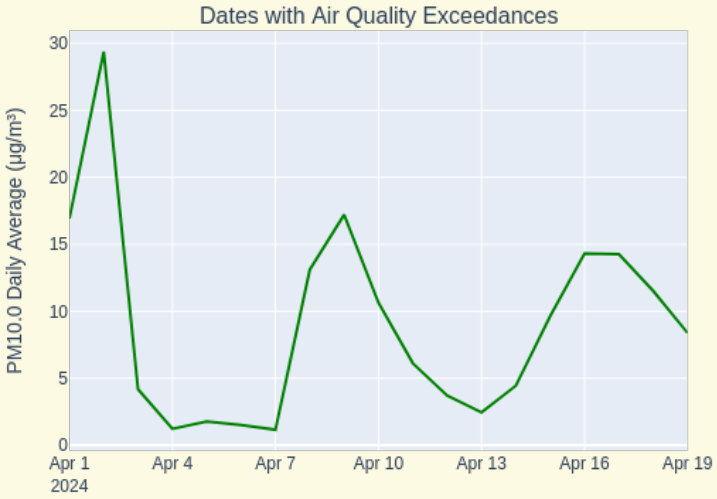


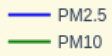


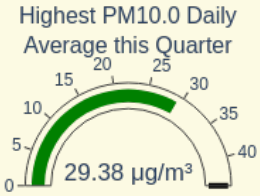
2024-04-01 to 2024-04-19 Report for Sensor 183799: AV-17-51:E7, Wise_County, VA

Note: This report has been flagged as possibly returning insufficient data.

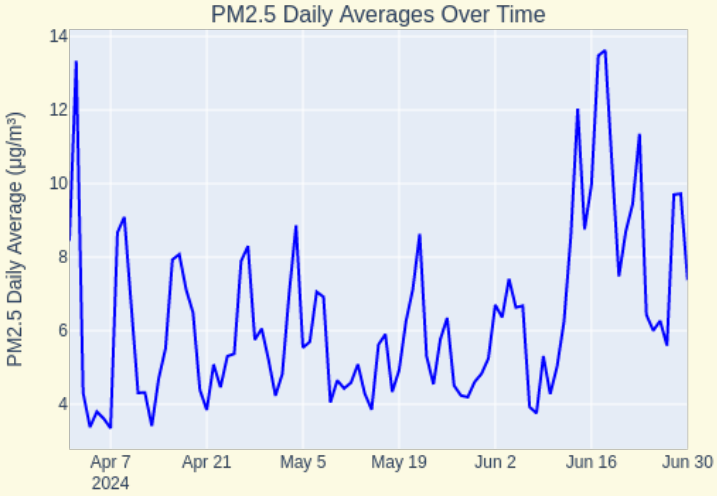


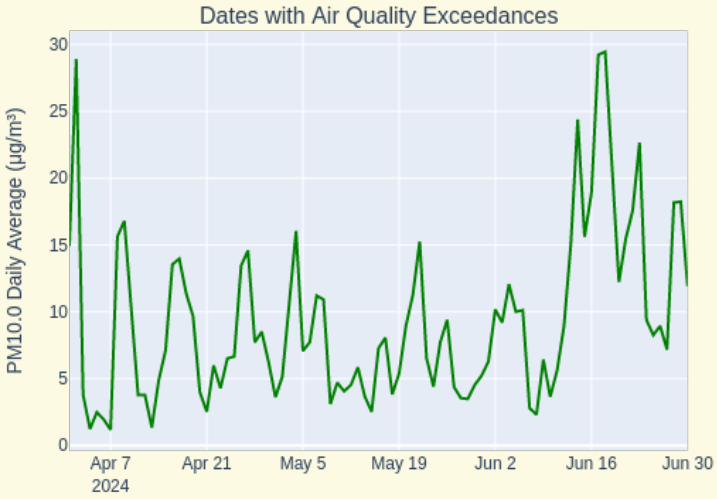


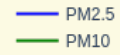


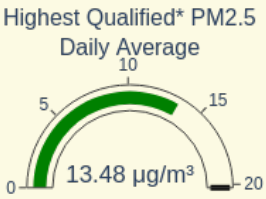


2024-04-01 to 2024-06-30 Report for Sensor 184351: AV-19-4A9, Wise_County, VA



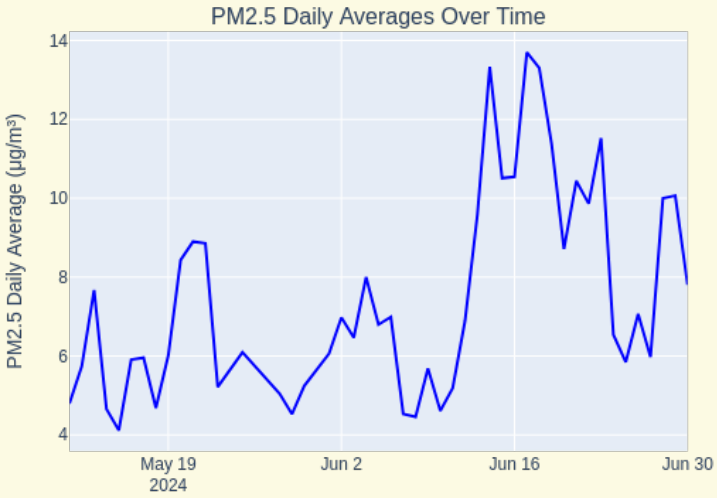


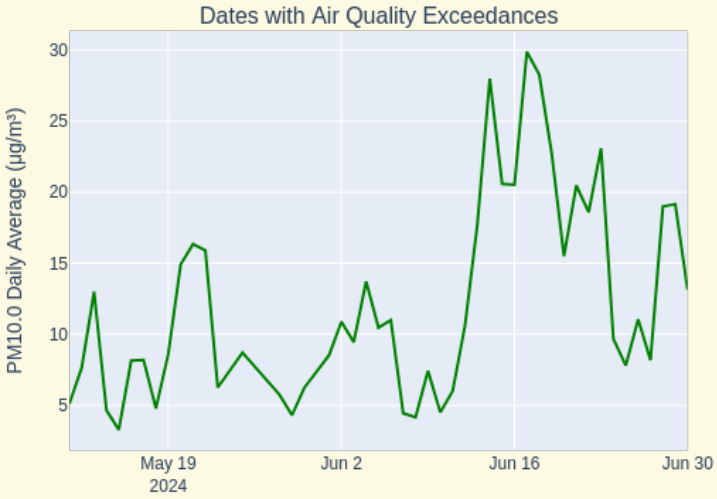


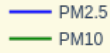


2024-05-11 to 2024-06-30 Report for Sensor 184559: AV-25-f85c, Wise_County, VA

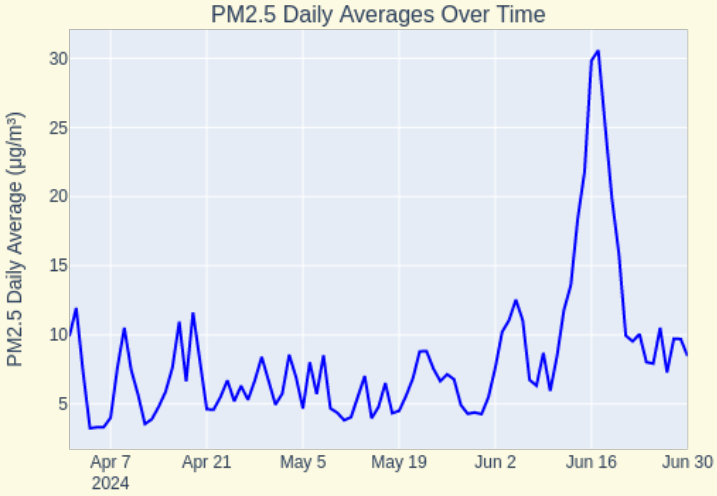
Note: This report has been flagged as possibly returning insufficient data.

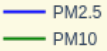


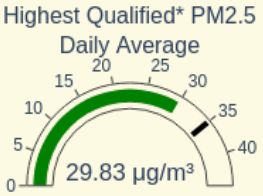


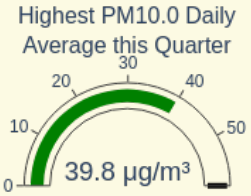


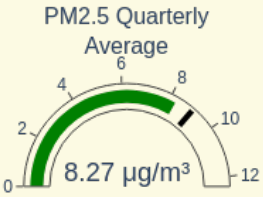
2024-04-01 to 2024-06-30 Report for Sensor 184567: AV-31-86:35, Pittsylvania_County, VA

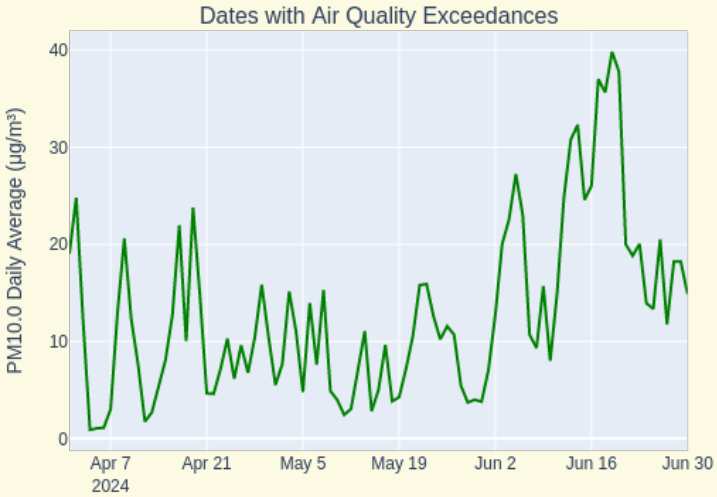






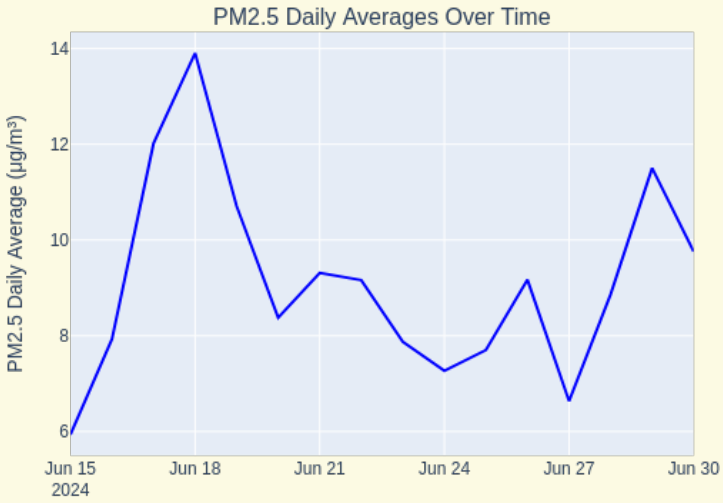


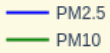


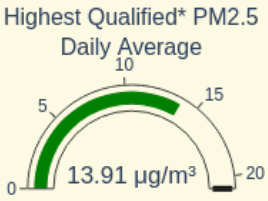


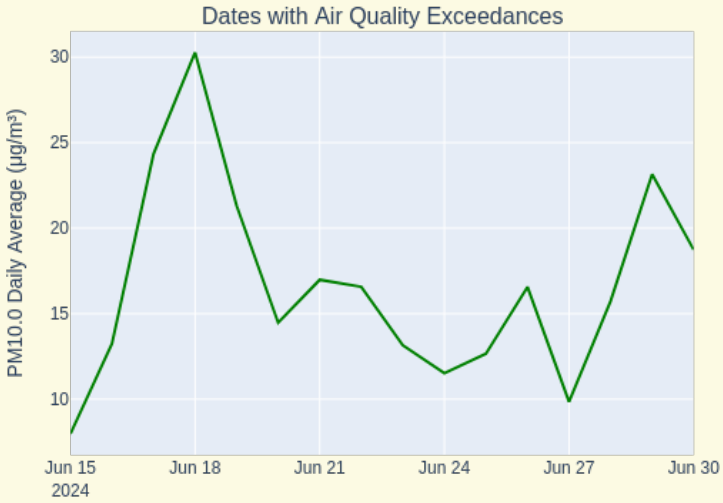
2024-06-15 to 2024-06-30 Report for Sensor 183737: AV-34-F645, Buckingham_County, VA

Note: This report has been flagged as possibly returning insufficient data.



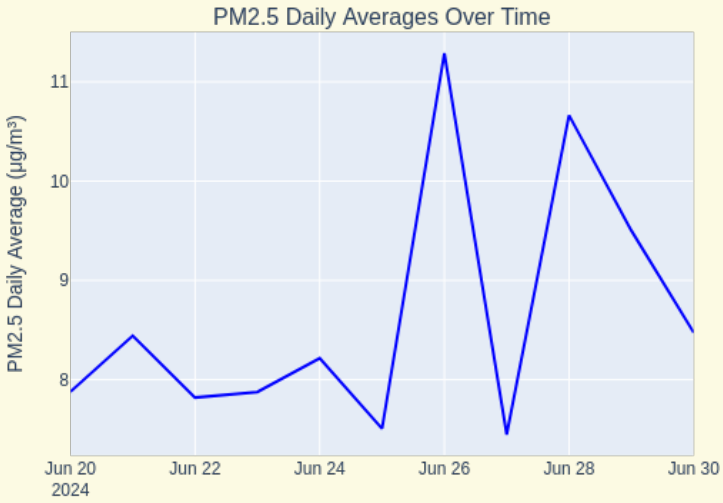


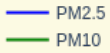


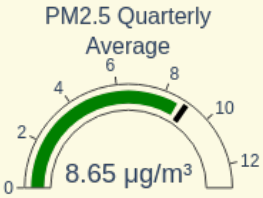


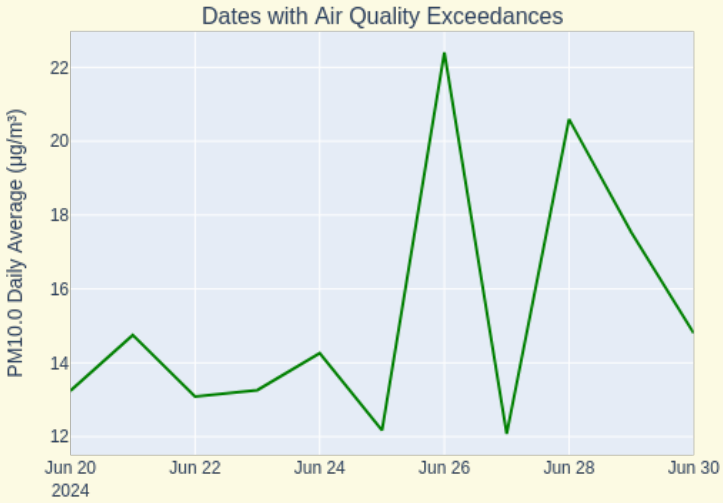
2024-06-20 to 2024-06-30 Report for Sensor 184519: AV-35-CE54, Pittsylvania_County, VA

Note: This report has been flagged as possibly returning insufficient data.

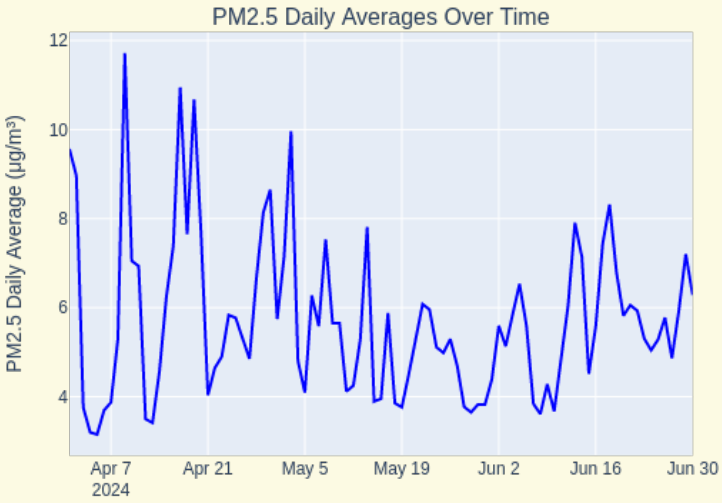


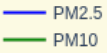


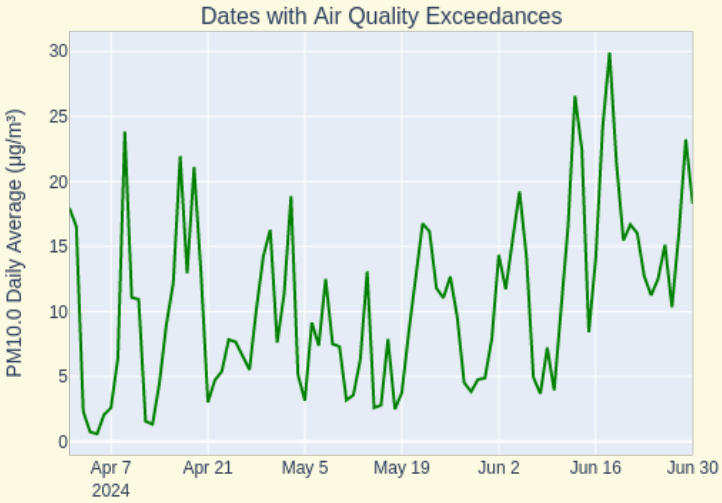




2024-04-01 to 2024-06-30 Report for Sensor 184523: AV-39-F7:FE, Buckingham_County, VA

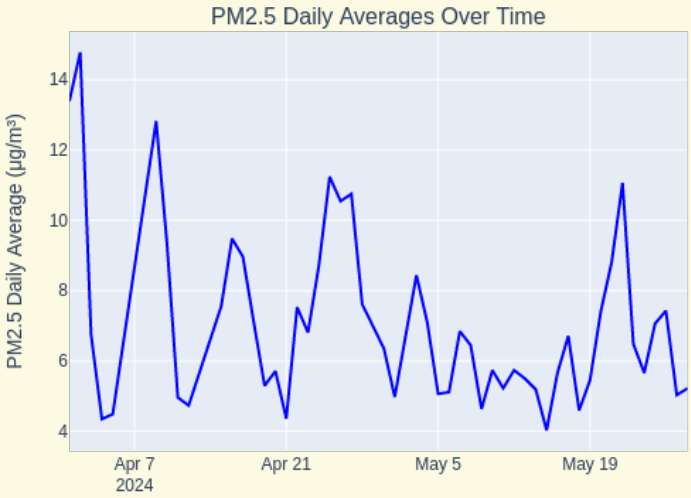


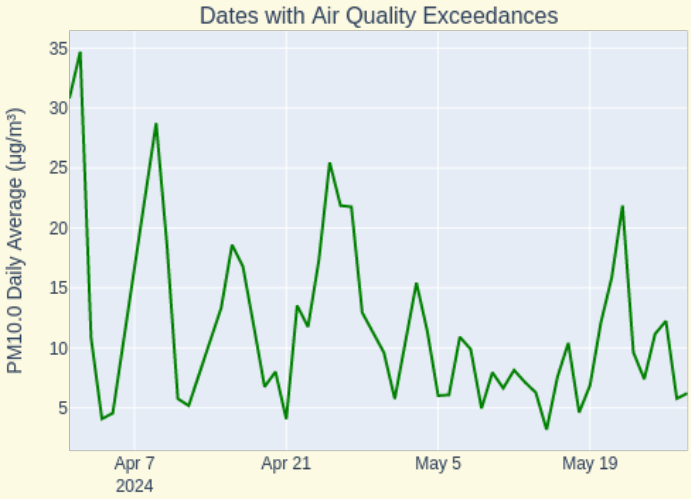


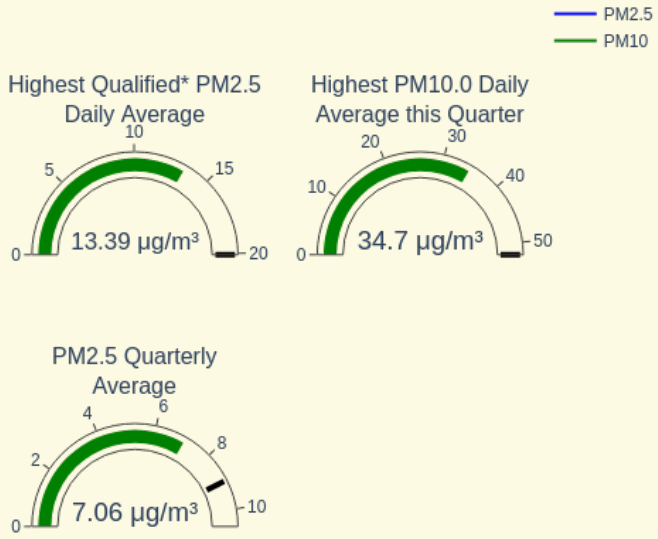


2024-04-01 to 2024-05-28 Report for Sensor 199033: AV-55-1C:E7, Buchanan_County, VA

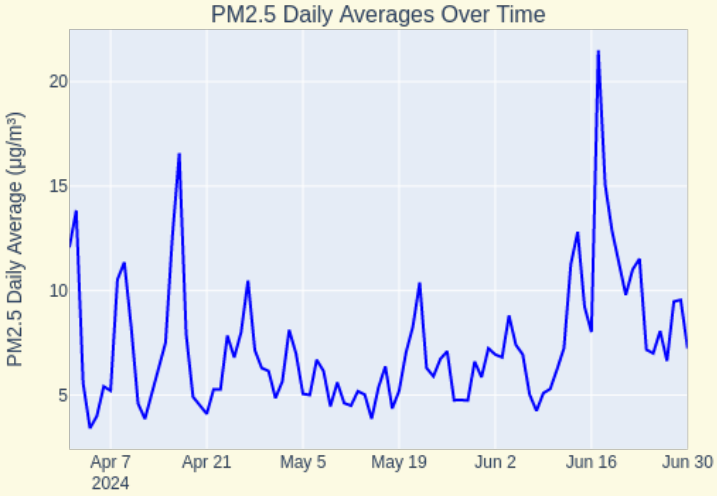
Note: This report has been flagged as possibly returning insufficient data.

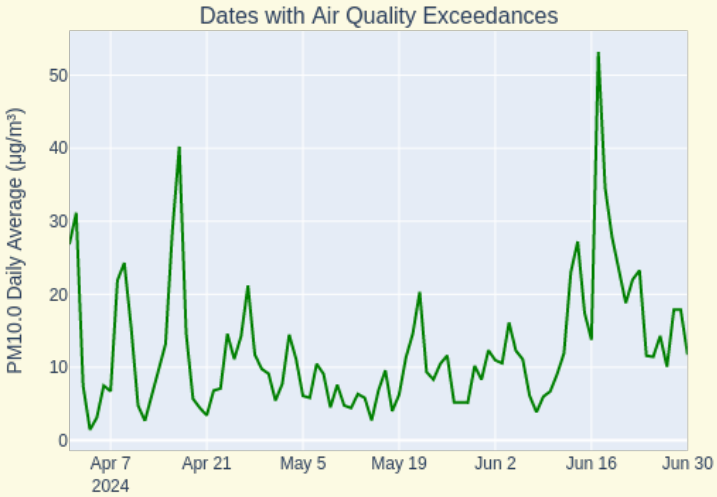


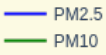


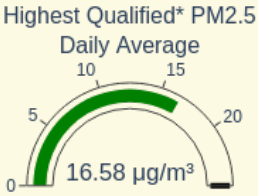


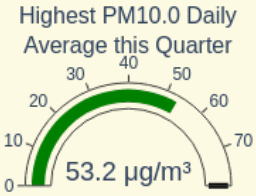
2024-04-01 to 2024-06-30 Report for Sensor 198281: AV56-4E:2D, Buchanan_County, VA





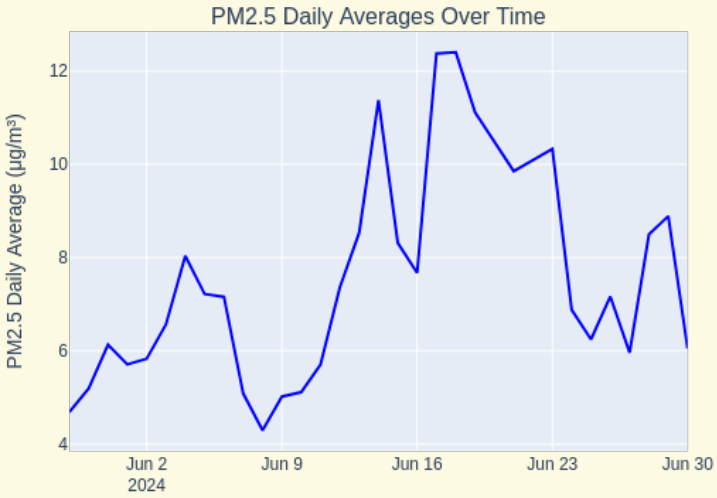


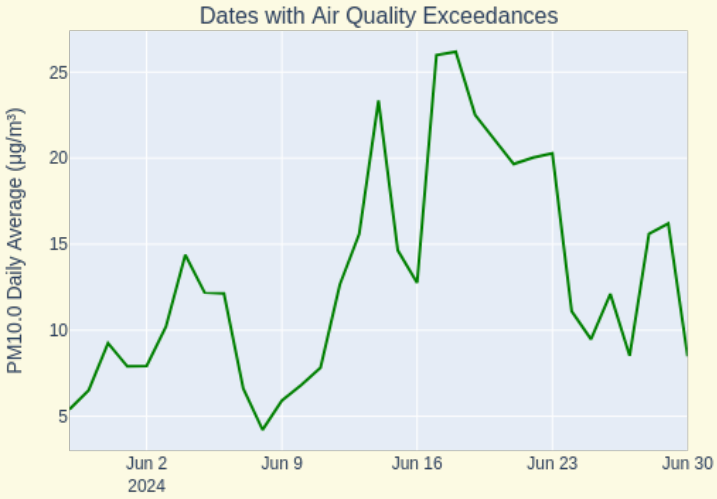


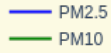


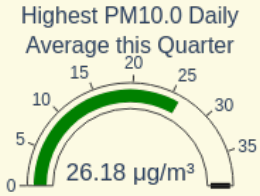
2024-05-29 to 2024-06-30 Report for Sensor 211937: AV 64-37:BE, Buchanan_County, VA

Note: This report has been flagged as possibly returning insufficient data.

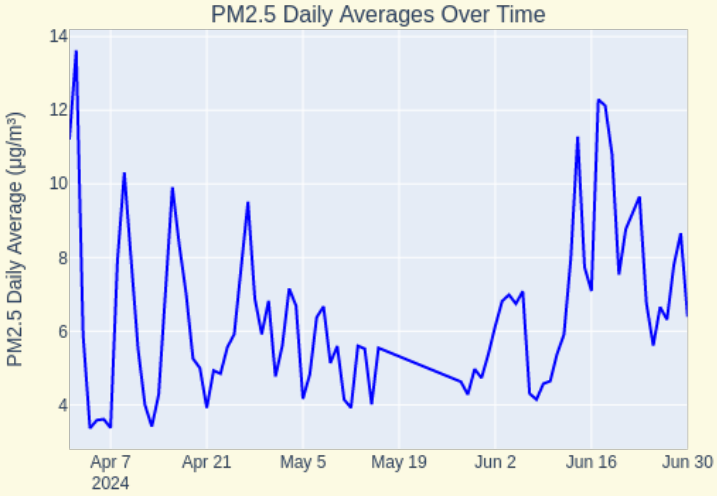


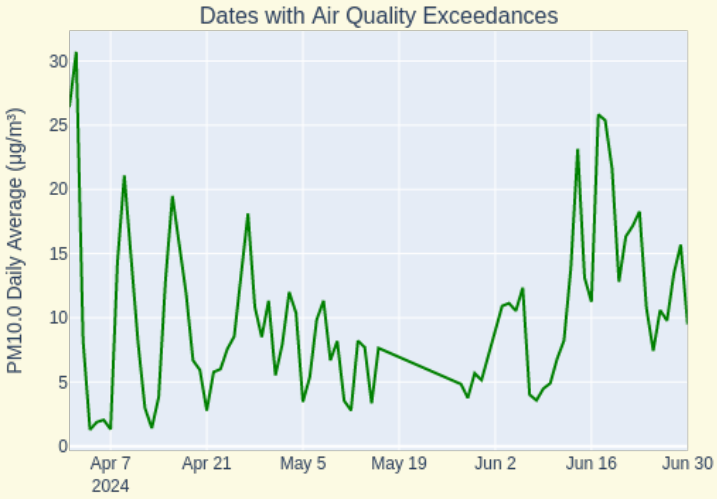


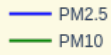


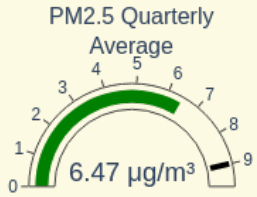


2024-04-01 to 2024-06-30 Report for Sensor 198969: AV65-77:96, Buchanan_County, VA



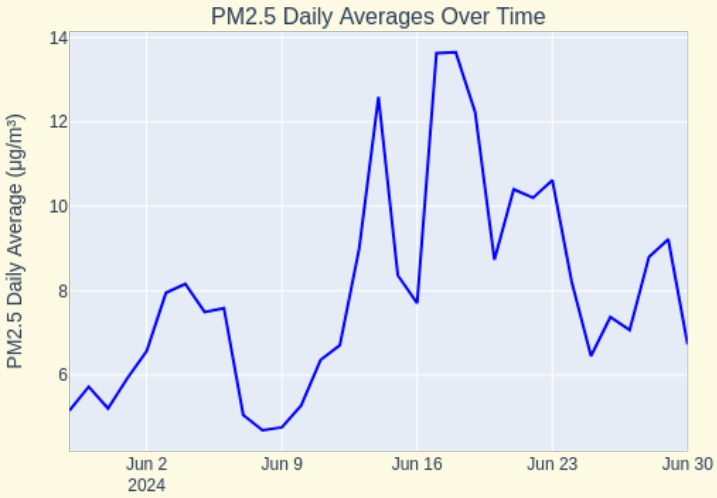


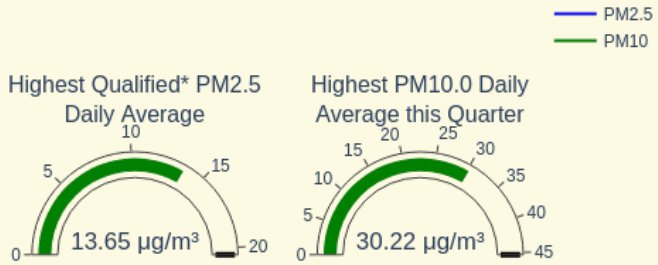


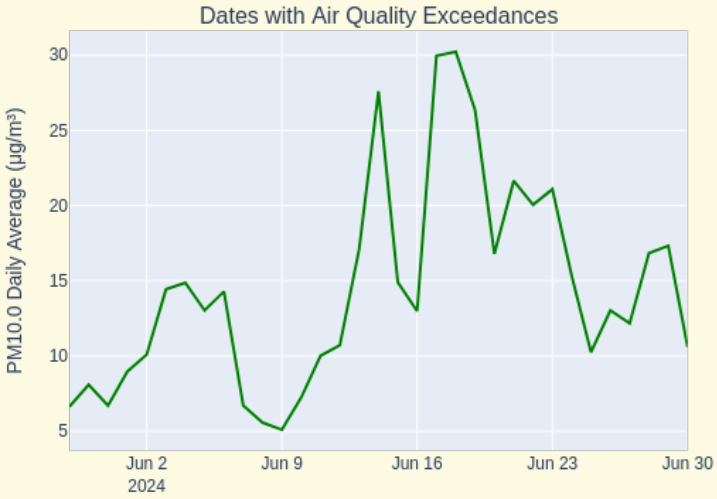


2024-05-29 to 2024-06-30 Report for Sensor 211961: AV 66-35:25, Buchanan_County, VA

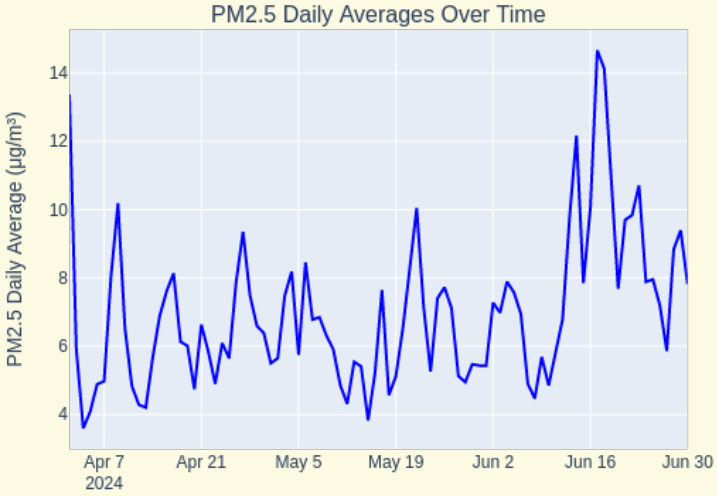
Note: This report has been flagged as possibly returning insufficient data.

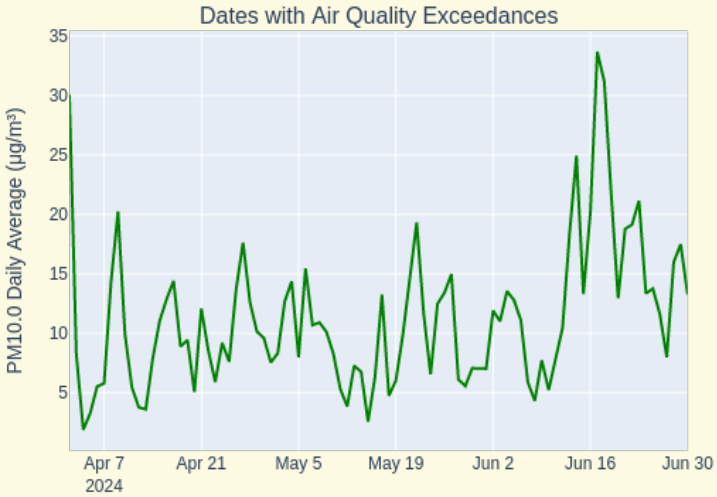


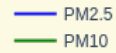


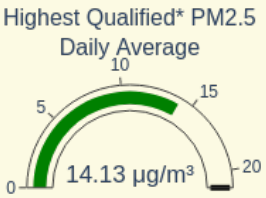


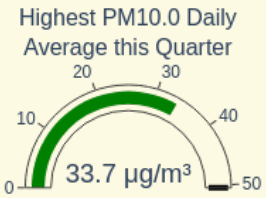
2024-04-02 to 2024-06-30 Report for Sensor 183807: AV-3-7:D5, McDowell_County, WV

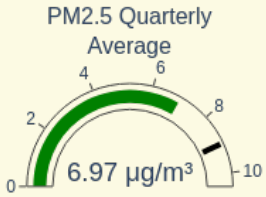






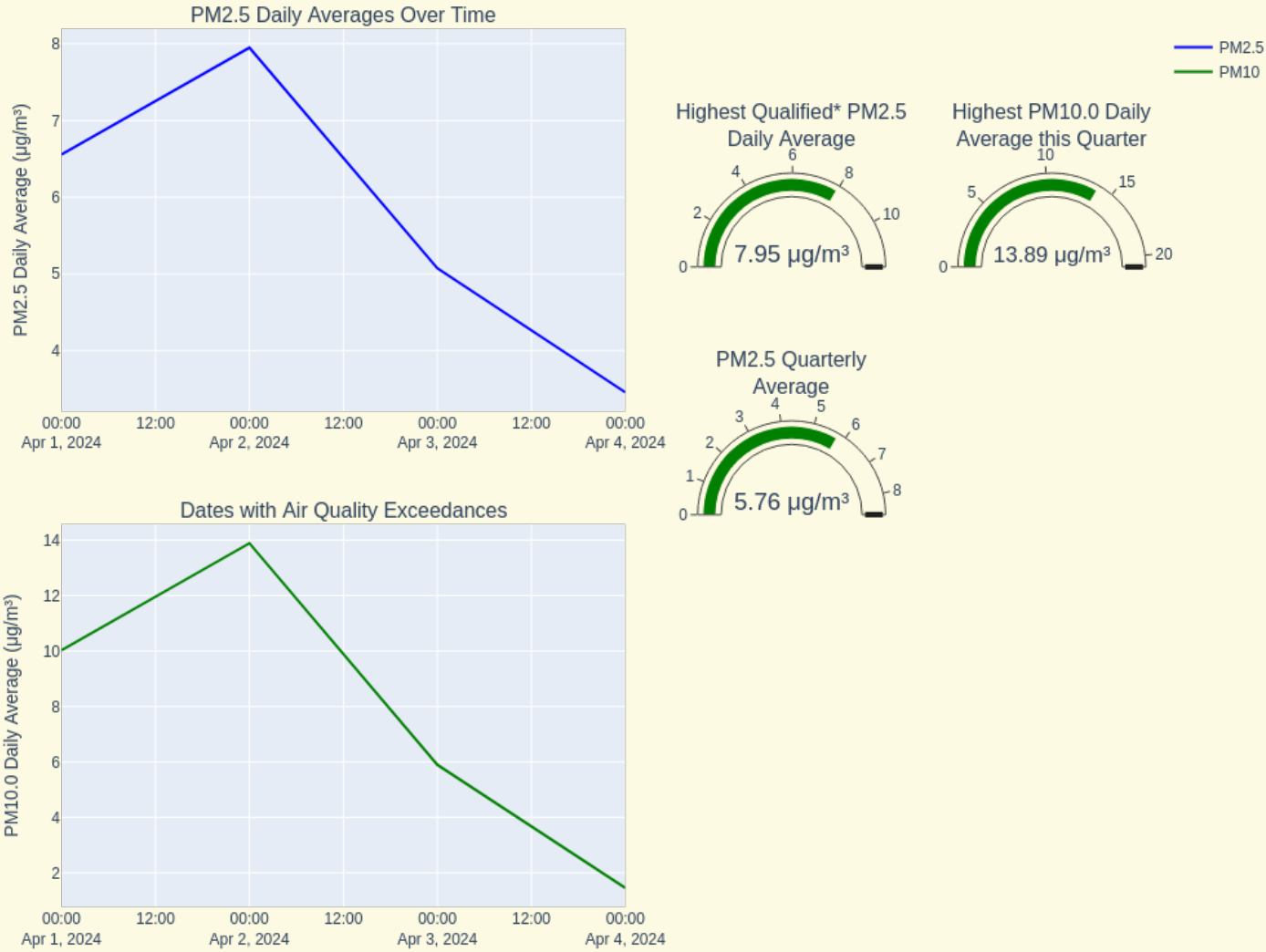






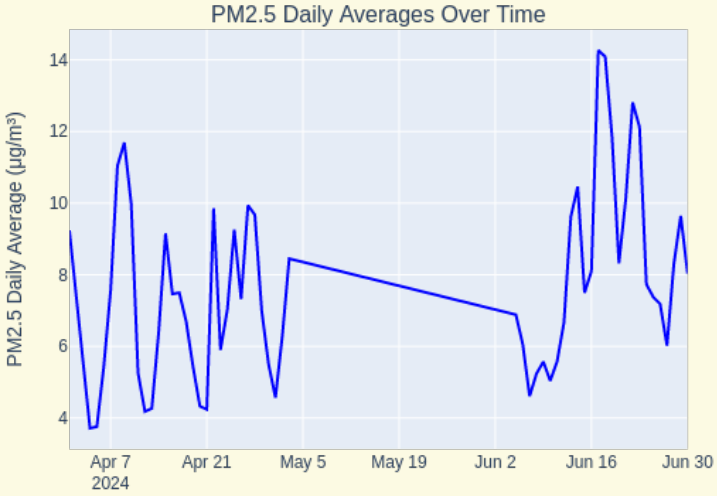
2024-04-01 to 2024-04-04 Report for Sensor 183739: Av-6-78AF, Raleigh_County, WV

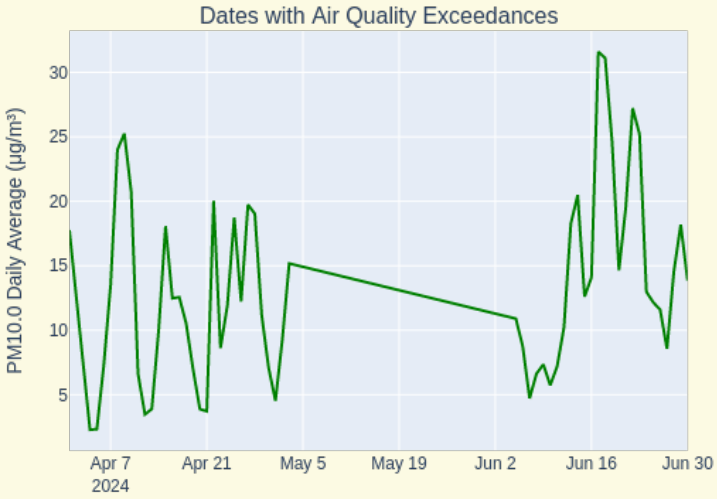
Note: This report has been flagged as possibly returning insufficient data.

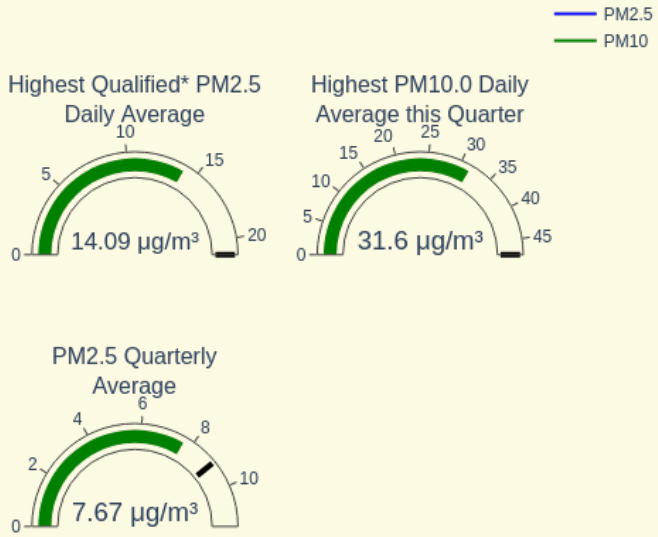


2024-04-01 to 2024-06-30 Report for Sensor 183769: AV-8-E6:40, Raleigh_County, WV

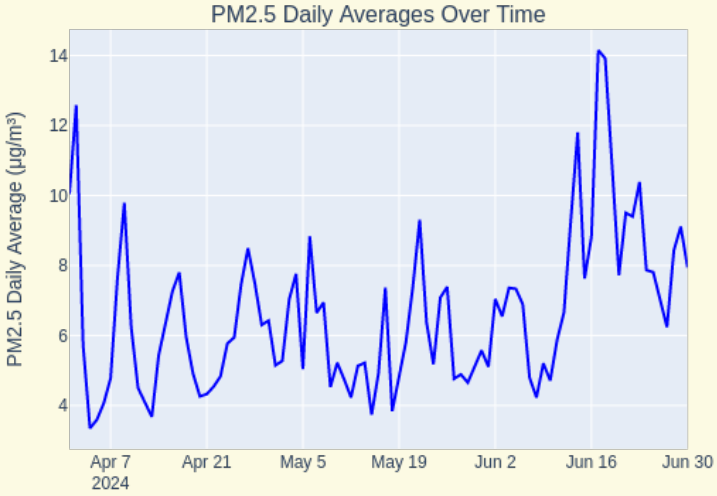
Note: This report has been flagged as possibly returning insufficient data.

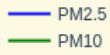


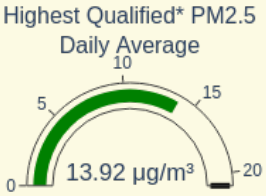


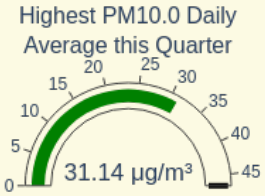


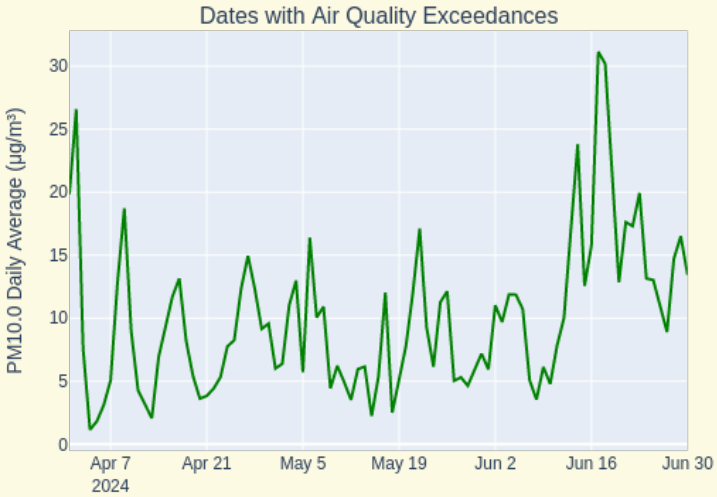
2024-04-01 to 2024-06-30 Report for Sensor 183741: AV-20-1C53, McDowell_County, WV



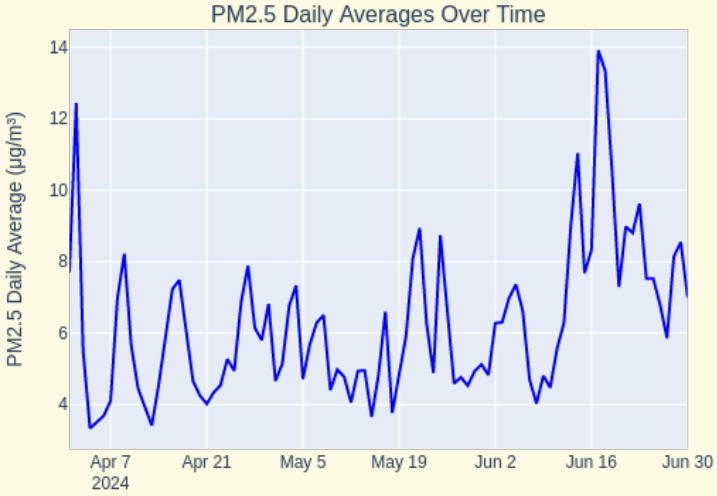


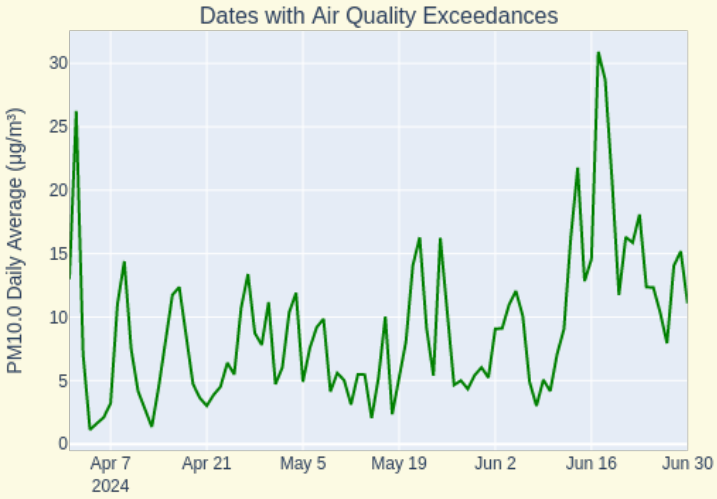


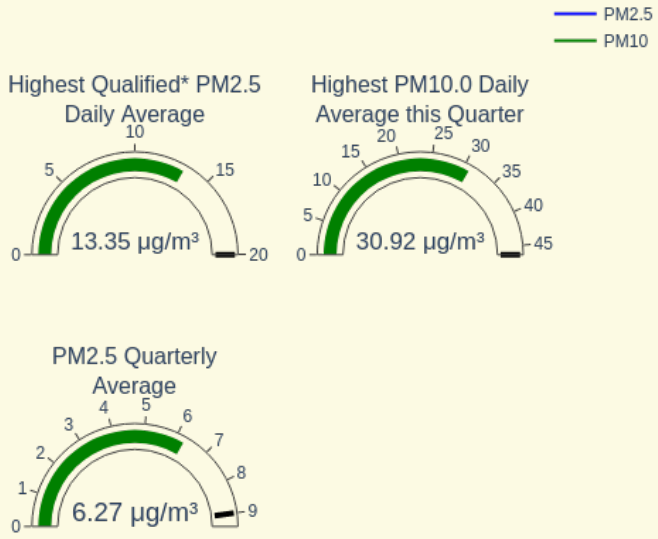




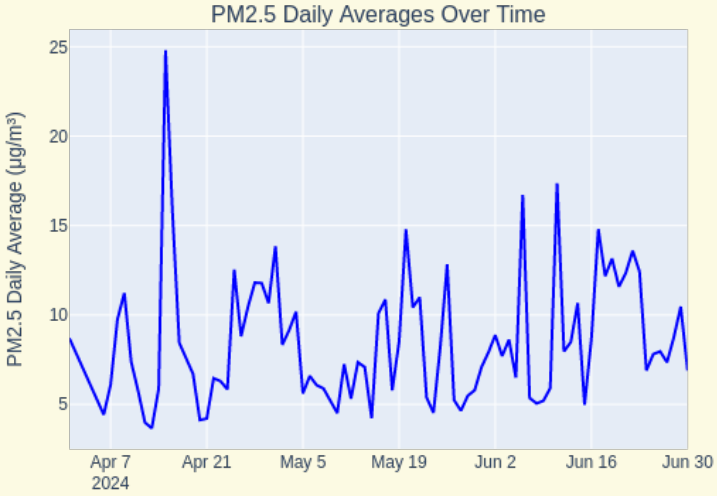
2024-04-01 to 2024-06-30 Report for Sensor 183779: AV-21-79E1, McDowell_County, WV

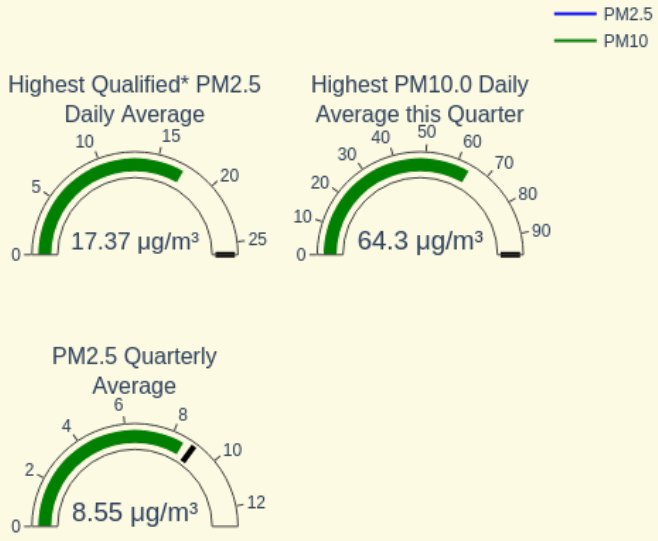


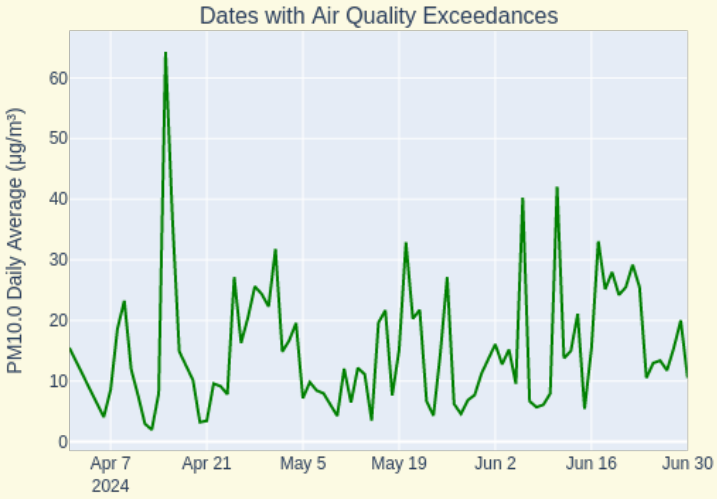




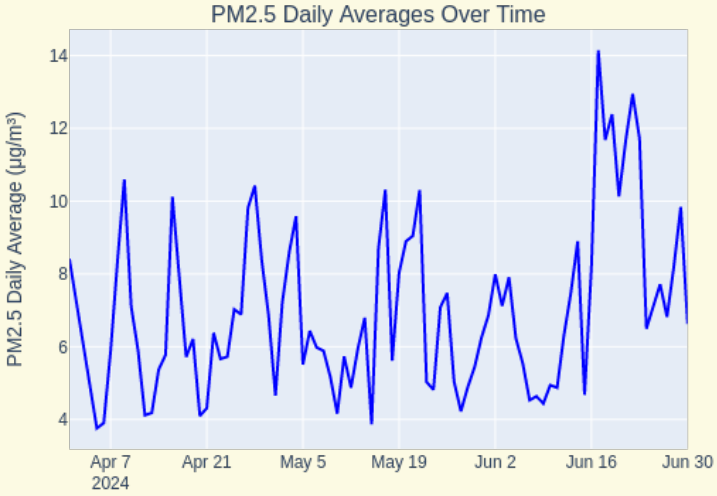
2024-04-01 to 2024-06-30 Report for Sensor 184513: AV-24-F6:AB, Kanawha_County, WV

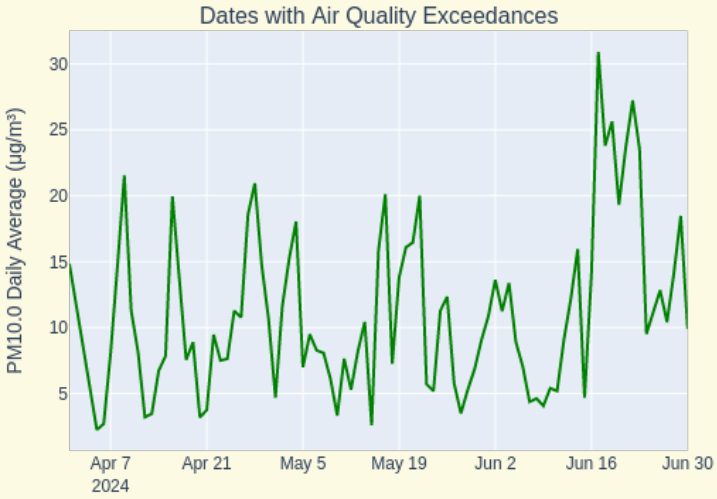


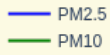


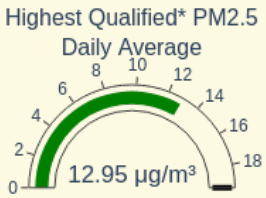


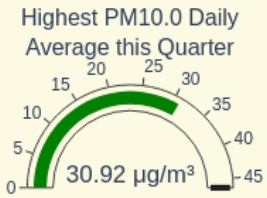
2024-04-01 to 2024-06-30 Report for Sensor 184561: AV-32-F8:44, Kanawha_County, WV



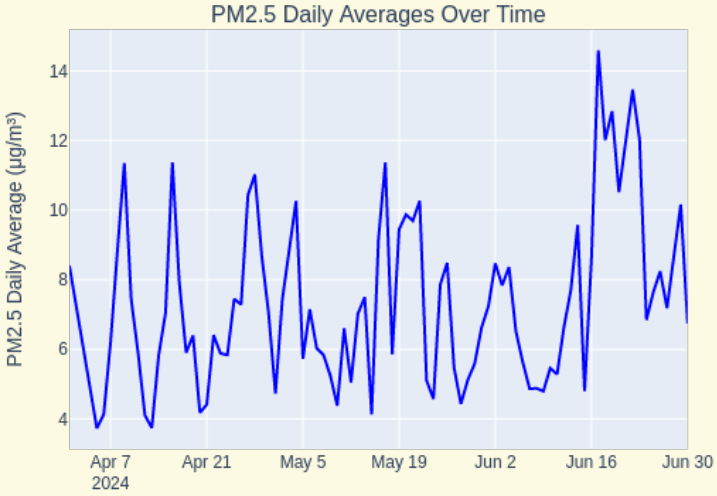


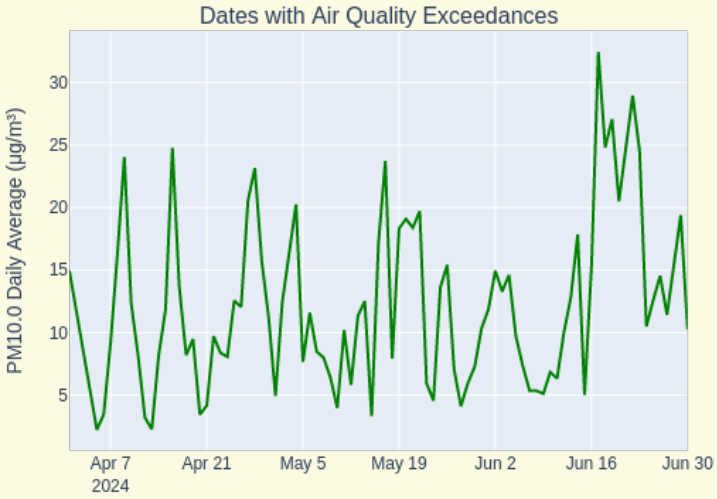


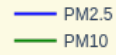


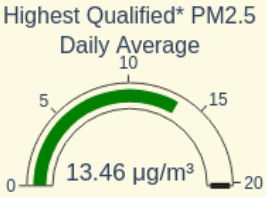


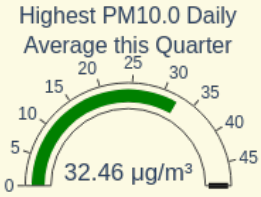
2024-04-01 to 2024-06-30 Report for Sensor 184515: AV-36-B7:A7, Kanawha_County, WV

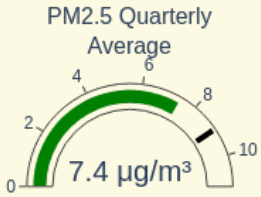






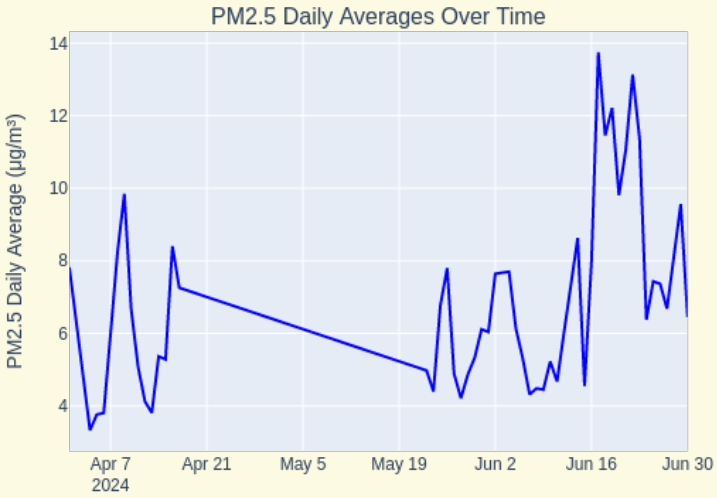


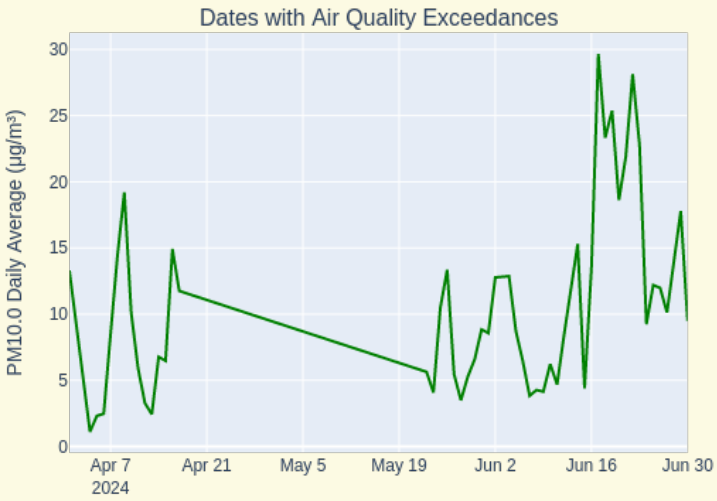


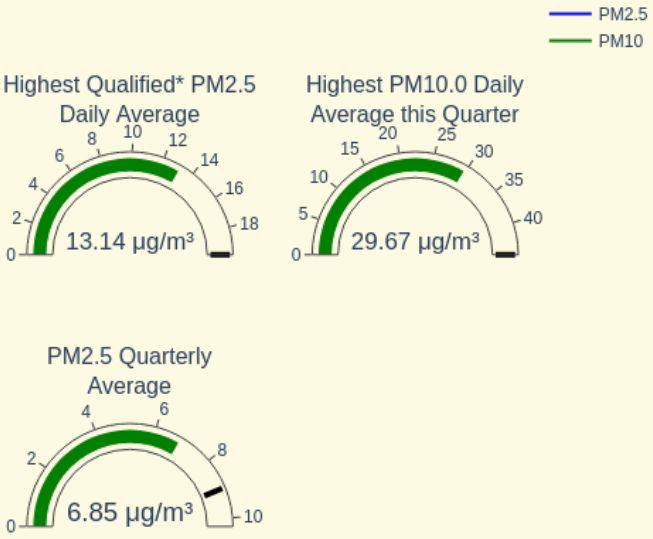


2024-04-01 to 2024-06-30 Report for Sensor 183793: AV-38-76:1D, Kanawha_County, WV

Note: This report has been flagged as possibly returning insufficient data.

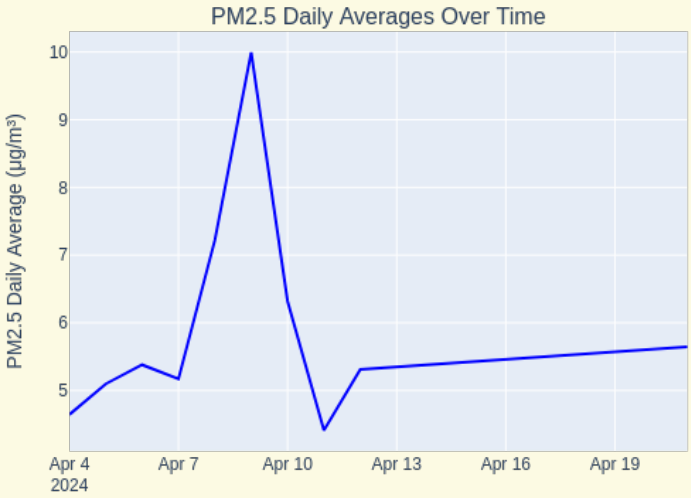


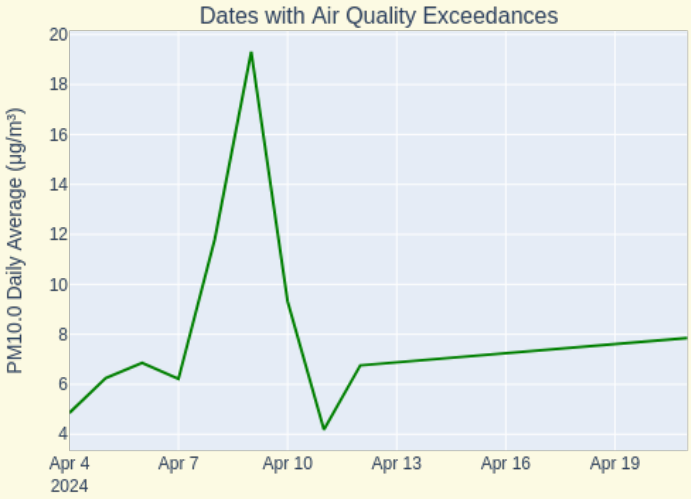


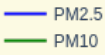


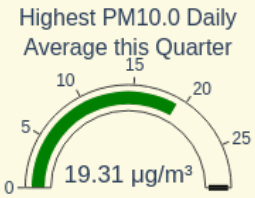
2024-04-04 to 2024-04-21 Report for Sensor 198821: AV-41-4e:8a, McDowell_County, WV

Note: This report has been flagged as possibly returning insufficient data.

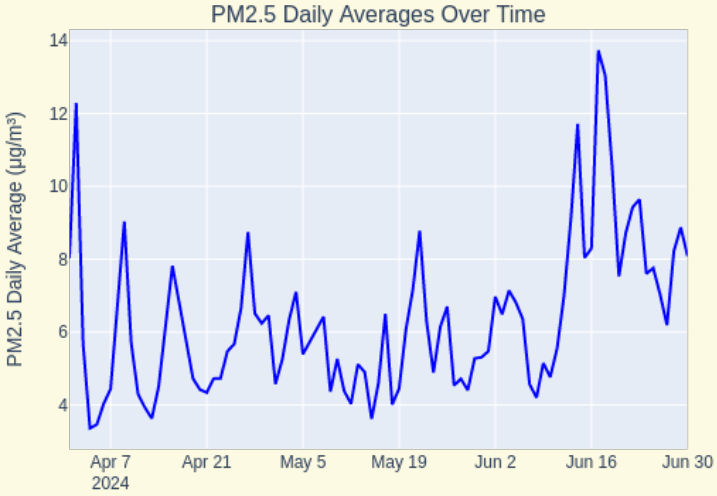


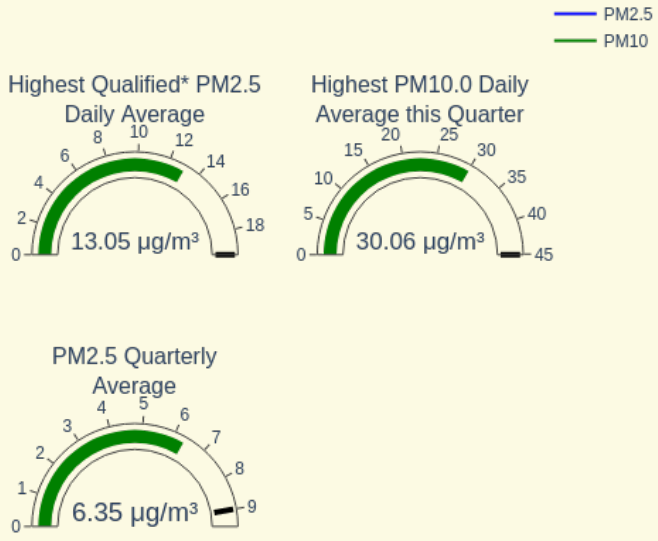


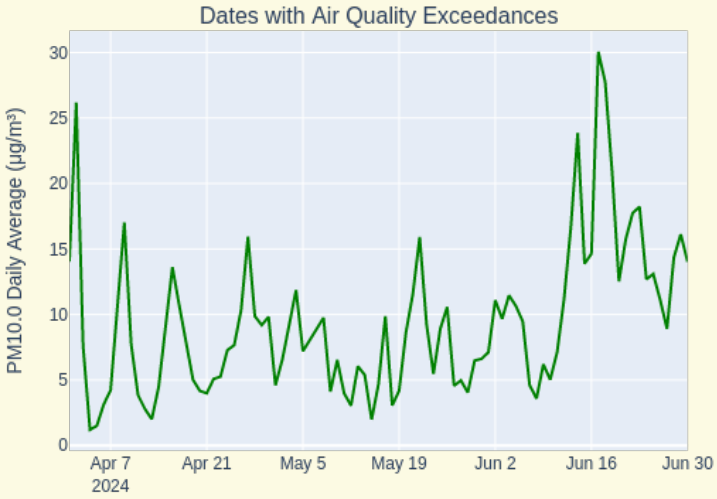




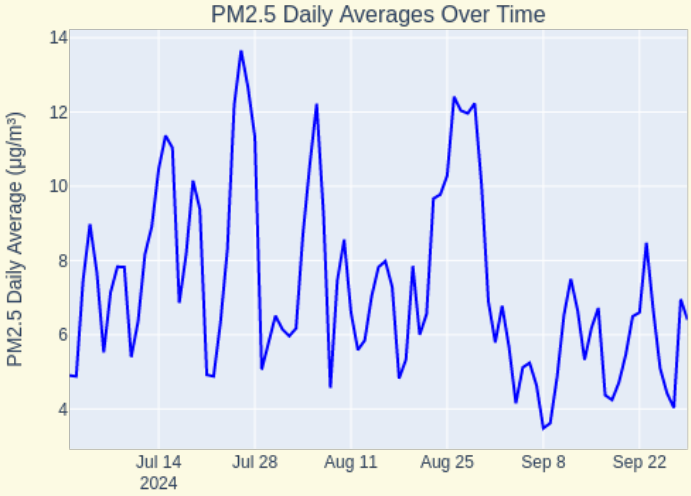
2024-04-01 to 2024-06-30 Report for Sensor 198997: AV-42-b0:7b, McDowell_County, WV

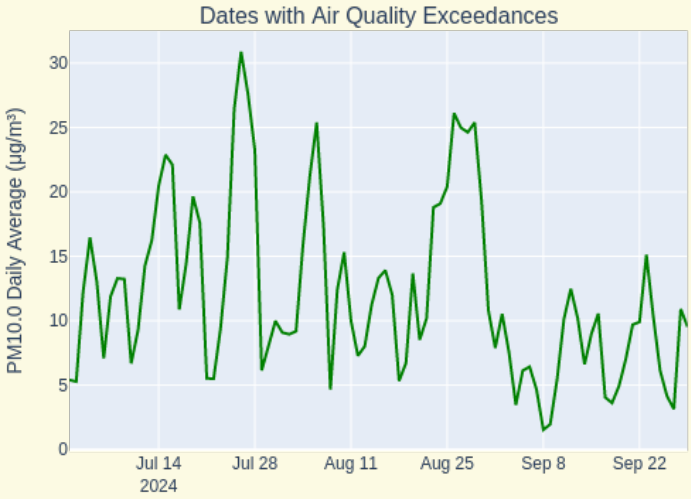


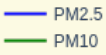


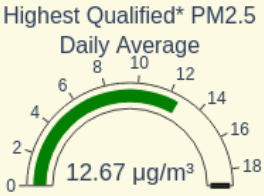


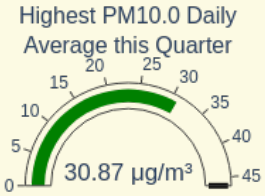
2024-07-01 to 2024-09-29 Report for Sensor 199027: AV44-50:9B, McDowell_County, WV





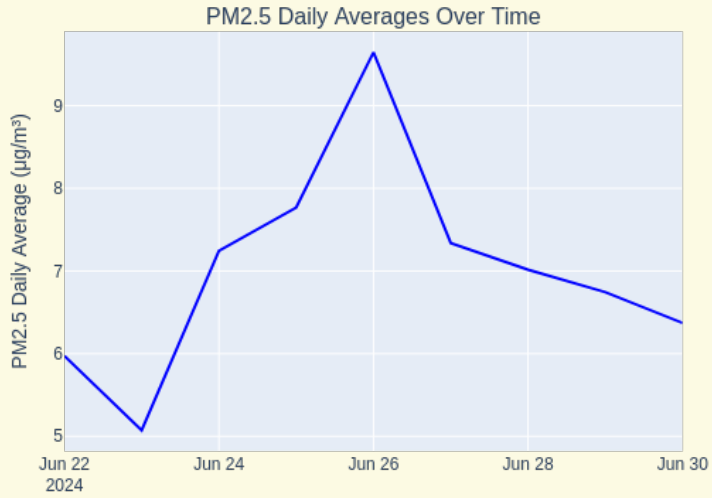


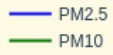


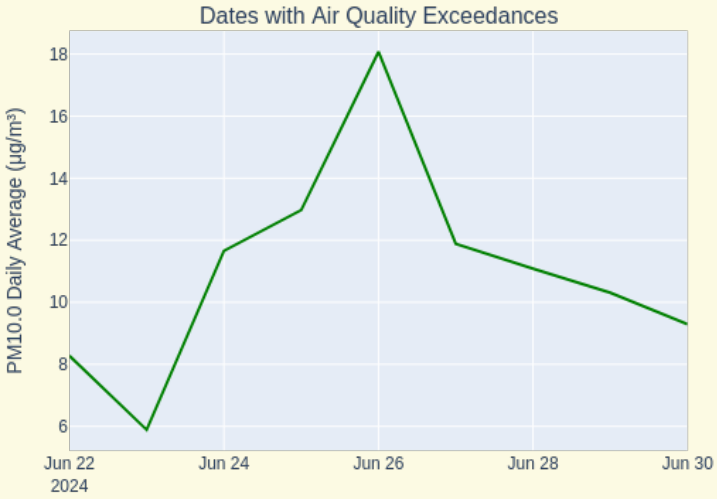


2024-06-22 to 2024-06-30 Report for Sensor 196167: AV47-22:BB, Norfolk, VA

Note: This report has been flagged as possibly returning insufficient data.

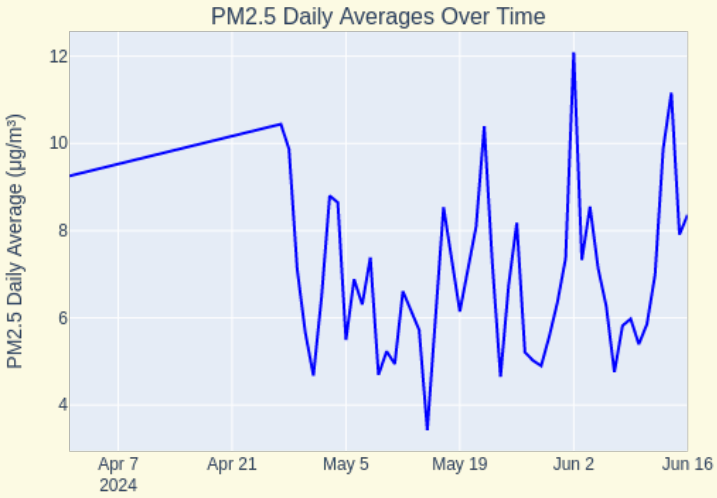


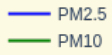


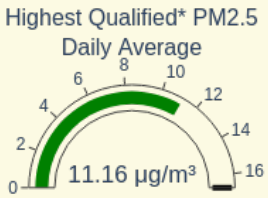


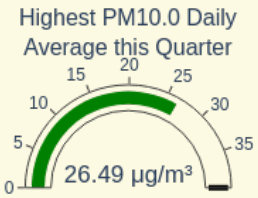
2024-04-01 to 2024-06-16 Report for Sensor 199037: AV53-4FC2, Wise_County, VA

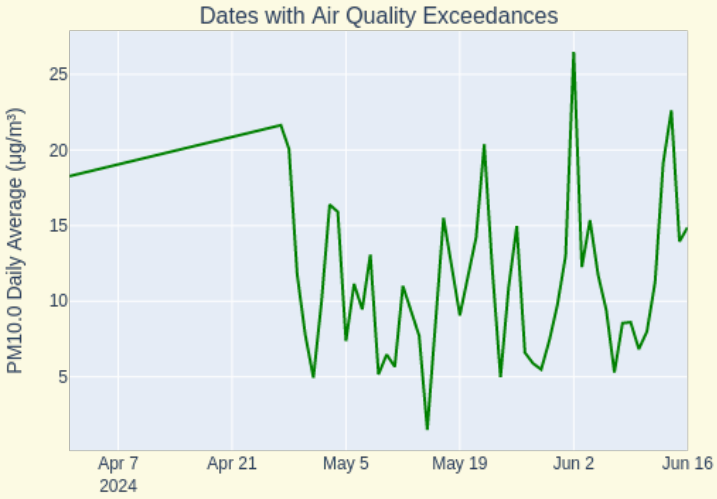
Note: This report has been flagged as possibly returning insufficient data.





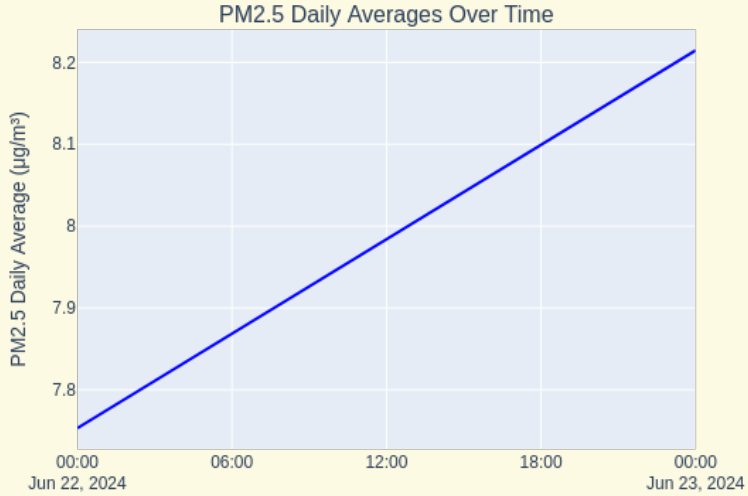


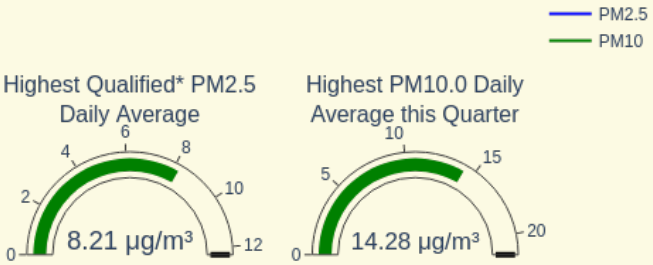


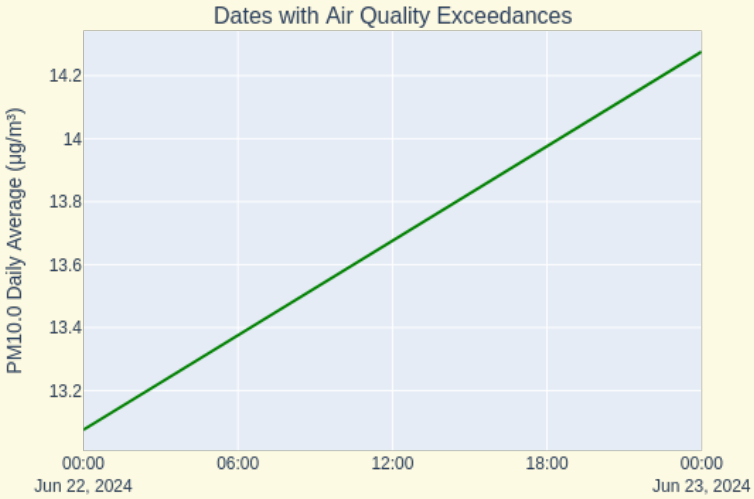


2024-06-22 to 2024-06-23 Report for Sensor 211949: AV-61-48:A, Raleigh_County, WV

Note: This report has been flagged as possibly returning insufficient data.







The following monitors are either offline or received insufficient data to include in this quarter's report:

AV-1, sensor 183803 — Test monitor. No longer receiving data.

AV-9, sensor 183735 — No data.

AV-7, sensor 183755, Naoma, Raleigh County, WV — No data. Removed.

AV-11, sensor 183781, Lackwana, PA — Persistent data issue. Working on adjustment.

AV-18, sensor 183753, UVA Wise, Wise County VA — Replaced.

AV-23, sensor 184345, White Oak, Campbell County, TN — No data.

AV-33, sensor 184553, Eagan, Claiborne County, TN — No data. Removed.

Av-43, sensor 198477- Eunice, Raleigh County, WV — No data. Removed.