2023 Joint Chairman's Report: Ambient Air Monitoring

Maryland Department of the Environment

Submitted December 31, 2023

Maryland General Assembly




Table of Contents:

I. Executive Summary

The 2023 Joint Chairman's Report (JCR) requires the Maryland Department of the Environment (MDE or the Department) to complete a report on ambient air monitoring. Specifically, the committees are interested in what is needed to deploy an ambient air monitoring network across the State and how this would improve public health. Per the JCR request, MDE has provided information on the ambient air monitoring network that is already deployed statewide; how that network is used to mitigate exposure to pollutants, inform regulatory decision-making processes, and how that network can be used to help reduce the cumulative impact of certain air pollutants.

Maryland currently operates 24 air monitoring sites around the state that measure ground-level concentrations of criteria pollutants, air toxics, meteorological parameters, and research-oriented parameters. In addition to collecting the ambient air quality data, the Air and Radiation Administration at MDE performs all quality assurance, quality control and analysis procedures of the pollutant concentrations measured. Near real-time hourly air quality data is posted on our webpage for several criteria pollutants, including Ozone and Fine Particulate Matter or PM2.5. In addition, hourly data is shared on many platforms and with many other partners, including the U.S. Environmental Protection Agency's AirNow and the National Weather Service.

The State has made tremendous progress on clean air in the past twenty years. Air quality that historically exceeded federal standards over large areas is now a rarity. Now instead of large areas of the state experiencing frequent days with high levels of air pollution for various criteria pollutants, smaller areas of the State experience infrequent levels of air pollution slightly above the ozone air quality standard.

While the trends have generally been very good, wildfire smoke affected the whole state this summer. Dry conditions and warmer than normal temperatures contributed to many wildfires in the US and Canada in 2023. The wildfire smoke impacted parts of the United States and led to record setting PM2.5 events across all of Maryland in June. These concentrations were the worst PM2.5 levels ever recorded in Maryland. MDE utilized the existing network to get data on what was happening around the state and shared that data with the public via alerts on Facebook, X, and the MDE website. MDE meteorologists also worked closely with the National Weather Service to provide the updated information on air quality that was sent out via alerts to smart phones.

In addition to the robust air monitoring network described above, MDE engages in various research projects with universities and federal partners. MDE has also partnered on three current local air sensor networks in the overburdened communities of Cheverly and Curtis Bay, Maryland. Along with these two communities, the community of Turner Station and the University of Maryland, MDE was awarded a grant from EPA to fund continued air monitoring in overburdened communities. The objective of the project is to identify and characterize cumulative air pollution levels in these communities and make recommendations on ways to mitigate exposure.

MDE, through a partnership with the Keith Campbell Foundation for the Environment, the Delmarva Chicken Association and the University of Maryland Eastern Shore, an ambient air monitoring study is underway to measure ambient ammonia and fine particle pollution in the vicinity of poultry houses on the Lower Eastern Shore of Maryland.

Finally, the report provides observations based on the Department's low-cost sensor work over the past few years and suggestions for what it would take to expand local low-cost sensor monitoring moving forward. As noted in the Report, MDE has been partnering with various universities and communities who are deploying hyperlocal air monitoring networks. However, MDE does not have the staffing resources or funding to conduct this work at a statewide level. MDE's suggestion for expanding local low-cost sensor monitoring moving forward is to provide more funding and staffing resources to the Department, so we can effectively engage with more communities and partners who are pursuing local air monitoring. In addition, creating more opportunities for counties and universities to take the lead on local monitoring efforts, with assistance from MDE in various capacities, would also alleviate some of the funding/staffing resource issues for MDE and possibly allow for further local network expansion.

II. 2023 JCR Request

The 2023 Joint Chairman's Report (JCR) requires the Maryland Department of the Environment (MDE or the Department) to complete a report on ambient air monitoring. Specifically, the committees are interested in what is needed to deploy an ambient air monitoring network across the State and how this would improve public health. Therefore, the committees request that MDE submit a report on what is needed to deploy an ambient air monitoring network across the State. In addition, the report is requested to include information on how the data collected from a network would mitigate exposure to toxic pollutants, inform permit decision-making processes, and help reduce the cumulative impacts of pollutants such as particulate matter and fine particulate matter. The report is requested to be submitted to the committees by December 31, 2023.

III. Introduction

In recent years, Maryland, and other states around the country, have seen an increase in various entities conducting local air monitoring using low-cost sensors. In addition to these efforts going on through various partnerships across Maryland, the Maryland General Assembly has introduced a few bills over the years, such as HB 473 from 2023, that would require MDE to deploy ambient air monitors or sensors at various locations around the State. Per the JCR request above, MDE is hereby providing information on the following issues: the ambient air monitoring network that is already deployed statewide; how that network is used to mitigate exposure to

pollutants and inform regulatory decision-making processes; and how that network can be used to help reduce the cumulative impact of certain air pollutants. In addition to the network that is already in place, MDE has provided information on several research initiatives and several local low-cost sensor networks that the Department is partnering on with universities and local communities. Finally, the report provides observations based on the Department's low-cost sensor work over the past few years and suggestions for what it would take to expand local low-cost sensor monitoring moving forward.

IV. Ambient Air Quality Monitoring – Regulatory Based

a. Clean Air Act of 1970 -

In 1970, Congress passed the Clean Air Act (CAA) that authorized the Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) for pollutants shown to threaten human health and welfare. Primary standards were set according to criteria designed to protect public health, including an adequate margin of safety to protect sensitive populations such as children and asthmatics. Secondary standards were set according to criteria designed to protect public welfare (decreased visibility, damage to crops, vegetation, buildings, etc.). As part of the CAA, both local and state air quality agencies are required to maintain and operate ambient air quality monitoring networks.

The six pollutants that currently have a NAAQS established are: ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter ($PM_{2.5}$ and PM_{10}), and lead (Pb). They are commonly called the "criteria" pollutants. When air quality does not meet the NAAQS for one of the criteria pollutants, the area is said to be in "non-attainment" with the NAAQS for that pollutant.

The data MDE collects are used to determine the 3-year average values called Design Values (DV). These DVs are then compared against the NAAQS to determine attainment. Currently Maryland is in attainment for all criteria pollutants except ozone. For the past few years, Maryland has measured, using this regulatory network, ozone levels statewide that are either below or meeting the current ozone NAAQS. Maryland is currently working with EPA and other states in the Mid-Atlantic to implement various actions that will determine the official future "attainment" status for Ozone. The current NAAQS are below:

Pollutant	Primary/Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)	primary	8 hours	9 ppm	Not to be exceeded more than once per year
		1 hour	35 ppm	
Lead (Pb)	primary and secondary	Rolling 3 month average	0.15 µg/m³	Not to be exceeded
Nitrogen Dioxide (NO_2)	primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	primary and secondary	1 year	53 ppb	Annual Mean
Ozone (O_3)	primary and secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution ($PM_{2.5}$)	primary	1 year	12.0 µg/m³	annual mean, averaged over 3 years
	secondary	1 year	15.0 µg/m³	annual mean, averaged over 3 years
	primary and secondary	24 hours	35 µg/m³	98th percentile, averaged over 3 years
Particle Pollution (PM_{10})	primary and secondary	24 hours	150 µg/m³	Not to be exceeded more than once per year, on average over 3 years
Sulfur Dioxide (SO_2)	primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

b. Maryland's Ambient Air Monitoring Network

MDE's air quality surveillance system consists of a network of State and Local Air Monitoring Stations (SLAMS) that includes Federal Reference Method (FRM), Federal Equivalent Method (FEM), and Automated Reference Method (ARM) monitors, all of which meet rigorous equipment specifications mandated by the EPA. These network monitors cost tens of thousands of dollars and must be housed in climate-controlled shelters. Meteorological equipment is often attached to the shelters. The combined cost of the equipment across MDE's network is approximately $6 million. Several stations fulfill other network requirements, such as National Core (NCore), Chemical Speciation Network (CSN), and the photochemical assessment monitoring stations (PAMS) networks. The primary objective of SLAMS is comparison to the NAAQS, but they may serve other purposes such as providing air pollution data to the general public in a timely manner, supporting compliance with air quality standards and emissions strategy development, and supporting air pollution research studies. The SLAMS network does not include Special Purpose Monitors (SPM) and other monitors used for non-regulatory or local monitoring projects. For example, the Lower Eastern Shore Ammonia Monitoring Project monitors (included on the below network map) are not part of our regulatory network.

Maryland currently operates 24 air monitoring sites around the state that measure ground-level concentrations of criteria pollutants, air toxics, meteorological parameters, and research-oriented parameters. This total includes two 'Haze Cams', cameras exclusively used to monitor visibility, and one IMPROVE network monitor. The IMPROVE (Interagency Monitoring of Protected Visual Environments) network monitor is operated near the Piney Run monitoring station. The IMPROVE network monitors measure $PM_{2.5}$, PM_{10}, $PM_{10\text{-}2.5}$, and speciated $PM_{2.5}$. The number of stations that monitor for each pollutant include:

- 18 Ozone (O3) (20 including the 2 CASTNET stations operated by EPA with audit support provided by MDE)

- 4 Carbon Monoxide (CO)
- 4 Sulfur Dioxide (SO_2)
- 5 Nitrogen Dioxide (True NO_2)
- 3 Nitrogen Oxides (NOx/NOy)
- 12 Fine Particulate Matter ($PM_{2.5}$ - including both filter and continuous methods)
- 2 Chemical Speciation ($PM_{2.5}$)
- 3 Particulate Matter (PM_{10})
- 4 Air toxics
- 2 Photochemical air monitoring sites (PAMS)
- 17 Meteorology
- 0 Pb (Maryland stopped monitoring for Pb in 2019, after receiving a waiver from EPA due to very low concentrations)

This equipment is operated and maintained by a staff of six technicians within MDE, in addition to meteorologists, statisticians, quality assurance personnel and lab scientists to analyze and interpret collected data. Below is a table detailing MDE's current ambient air monitoring sites and pollutants being measured:

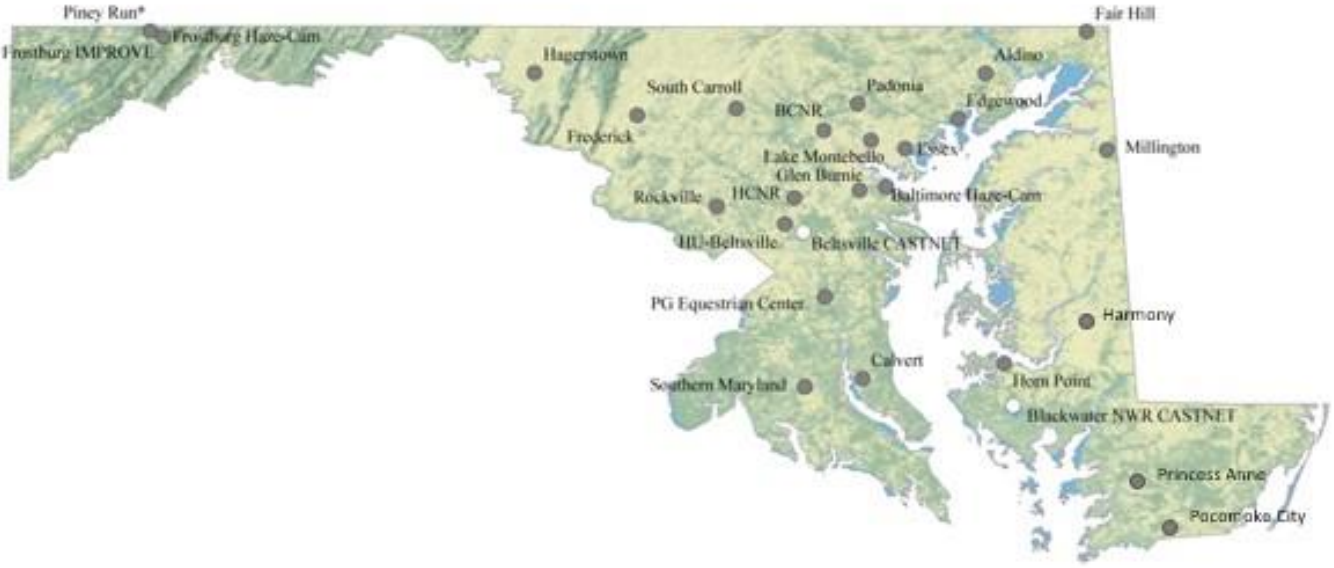
Site Name & AQS ID	Parameter	Start Date	Method Code	Monitor Objective	Monitor Network/Type	Schedule
Aldino, 240259001	Ozone (O_3)	04/20/1990	047	Highest Concentration	SLAMS	H, S
Baltimore County Near Road 240050009	Direct NO_2 (CAPS)	01/01/2019	212	Source Oriented/Highest Conc	SLAMS	H
Baltimore Haze Cam Brandon Shores	Visibility	04/01/2007	NA	Public Notification	NA	NA
Beltsville CASTNET, 240339991	Ozone (O_3)	04/01/2011	047	Regional Transport	CASTNET	H
Blackwater NWR CASTNET, 240199991	Ozone (O_3)	01/01/2011	047	Regional Transport	CASTNET	H
Calvert, 240090011	Ozone (O_3)	04/01/2005	087	Population Exposure	SLAMS	H, S
Edgewood, 240251001	Ozone (O_3)	03/10/1980	047	Highest Concentration	SLAMS	H, S
	$PM_{2.5}$ - Hourly	09/01/2011	170	Population Exposure	SLAMS	H

Site Name & AQS ID	Parameter	Start Date	Method Code	Monitor Objective	Monitor Network/Type	Schedule
Essex, 240053001	Air Toxics	01/01/1990	150	Population Exposure	Other	6
	Carbon Monoxide (CO)	02/15/2006	593	Highest Concentration	SLAMS	H
	Direct NO_2 (CAPS)	08/10/2017	212	Population Exposure	SLAMS	H
	Nitric Oxide (NO)	11/16/2017	699	Maximum Precursor	PAMS	H
	Reactive Oxides of Nitrogen (NO_Y)	11/16/2017	699	Maximum Precursor	PAMS	H
	NO_Y - NO	11/16/2017	699	Maximum Precursor	PAMS	H
	Ozone (O_3)	01/01/1972	087	Highest Conc, Pop. Expos	SLAMS	H
	$PM_{2.5}$ - Local Conditions	01/01/1999	145	Population Exposure	SLAMS	6
	$PM_{2.5}$ - Speciation	07/08/2004	812	Population Exposure	Trends Speciation	3
	Sulfur Dioxide (SO_2)	07/01/2003	600	Highest Concentration	SLAMS	R
	PAMS VOCS	01/01/1992	126, 142, 102*	Max Precursor, Highest Conc	PAMS / SLAMS	6; S:H, 3
Fair Hill, 240150003	Ozone (O_3)	01/01/1992	087	Regional Transport	SLAMS	H, S
	$PM_{2.5}$ - Hourly	07/01/2010	170	Population Exposure	SLAMS	H
Frederick Airport, 240210037	Ozone (O_3)	07/09/1998	087	Population Exposure	SLAMS	H, S
Frostburg IMPROVE, 240239000	IMPROVE Parameters	03/01/2004	NA	Public Notification	NA	3
Frostburg Haze Cam	Visibility	10/01/2005	NA	Public Notification	NA	NA
Glen Burnie, 240031003	Ozone (O_3)	04/01/2016	087	Population Exposure	SLAMS	H, S
	PM_{10} - STP	08/22/2008	127	Population Exposure	SLAMS	6
	PM_{10} - STP	08/22/2008	127	Population Exposure	QA-Collocated	6
Hagerstown, 240430009	Ozone (O_3)	04/01/1999	087	Highest Conc/ Population Exposure	SLAMS	H, S
	$PM_{2.5}$ - Hourly	07/01/2010	170	Highest Conc	SLAMS	H
Horn Point, 240190004	Ozone (O_3)	04/01/2012	087	General/Background	SLAMS	H
	$PM_{2.5}$ - Hourly	04/01/2012	170	General/Background	SLAMS	H
	Sulfur Dioxide (SO_2)	04/01/2012	600	General/ Background	SLAMS	R

Site Name & AQS ID	Parameter	Start Date	Method Code	Monitor Objective	Monitor Network/Type	Schedule
Howard County Near Road, 240270006	Air Toxics	04/01/2014	150	Source Oriented/Highest Conc	SLAMS	6
	Black Carbon	08/01/2015	894	Source Oriented/Highest Conc	SPM	H
	Ultrafine Particle Counter	01/01/2017	173	Source Oriented/Highest Conc	SPM	H
	Carbon Monoxide (CO)	04/01/2014	593	Source Oriented/Highest Conc	SLAMS	H
	Nitric Oxide (NO)	04/01/2014	599	Source Oriented/Highest Conc	SLAMS	H
	Nitrogen Dioxide (NO_2)	04/01/2014	599	Source Oriented/Highest Conc	SLAMS	H
	Oxides of Nitrogen (NO_X)	04/01/2014	599	Source Oriented/Highest Conc	SLAMS	H
	$PM_{2.5}$ - Hourly	04/01/2014	170	Source Oriented/Highest Conc	SLAMS	H
HU-Beltsville, 240330030	Carbon Monoxide (CO)	01/01/2007	593	General/Background	SLAMS/NCore	H
	Air Toxics	05/05/2005	150	Population Exposure	Other	6
	Direct NO_2 (CAPS)	11/1/2019	212	General/Background	SLAMS/NCore	H
	Ozone (O_3)	05/01/2005	087	Highest Conc./ Population Exposure	SLAMS/NCore	H
	$PM_{2.5}$ Speciation	12/05/2004	812	Population Exposure General/Background	SLAMS/NCore	3
	PM_{10} – STP	07/25/2010	127	Population Exposure	SLAMS/NCore	3
	$PM_{10-2.5}$ - Local Conditions	07/25/2010	176	Population Exposure	SLAMS/NCore	3
	$PM_{2.5}$ - Local Conditions	07/10/2004	145	Population Exposure	SLAMS/NCore	3
	$PM_{2.5}$ - Local Conditions	07/31/2010	145	Population Exposure	QA-Collocated	12
	$PM_{2.5}$ – Hourly	07/01/2010	170	Population Exposure	SLAMS/NCore	H
	Black Carbon	12/01/2007	894	NA	SPM	H
	Sulfur Dioxide (SO_2)	09/29/2006	560	General/Background	SLAMS/NCore	R
	VOCS	05/05/2005	126	Upwind/Background	Old PAMS/EMP	6; S: 3
Lake Montebello,	Ozone (O_3)	1/20/2022	087	Population Exposure	SLAMS	H, S
	Air Toxics	1/20/2022	150	Population Exposure	Other	6

Site Name & AQS ID	Parameter	Start Date	Method Code	Monitor Objective	Monitor Network/Type	Schedule
245105253	Nitric Oxide (NO)	1/20/2022	599	Highest Concentration	SLAMS	H
	Nitrogen Dioxide (NO_2)	1/20/2022	599	Highest Concentration	SLAMS	H
	Oxides of Nitrogen (NO_X)	1/20/2022	599	Highest Concentration	SLAMS	H
	PM_{10} – STP	1/20/2022	127	Population Exposure	SLAMS	6
	$PM_{2.5}$ - Local Conditions	1/20/2022	145	Highest Concentration	SLAMS	3
	$PM_{2.5}$ - Hourly	1/20/2022	170	Highest Concentration	SLAMS	H
Millington, 240290002	Ozone (O_3)	06/19/1989	087	Population Exposure	SLAMS	H, S
	$PM_{2.5}$ - Hourly	07/01/2010	170	Population Exposure	SLAMS	H
Padonia, 240051007	Ozone (O_3)	01/01/1979	087	Population Exposure	SLAMS	H, S
	$PM_{2.5}$ - Hourly	01/01/2016	170	Population Exposure	SLAMS	H
	$PM_{2.5}$ - Local Conditions	01/01/1999	145	Population Exposure	SLAMS	12
PG Equestrian Center, 240338003	Ozone (O_3)	04/01/2002	087	Population Exposure	SLAMS	H, S
Piney Run, 240230002	Carbon Monoxide (CO)	09/01/2007	593	Regional Transport	SLAMS/NCore	H
	Direct NO_2 (CAPS)	07/12/2019	212	Regional Transport	SLAMS/NCore	H
	Nitric Oxide (NO)	05/01/2004	699	Regional Transport	SLAMS/NCore	H
	NO_Y – NO	05/01/2004	699	Regional Transport	SLAMS/NCore	H
	Reactive Oxides of Nitrogen (NO_Y)	05/01/2004	699	Regional Transport	SLAMS/NCore	H
	Ozone (O_3)	04/01/2004	087	Regional Transport	SLAMS/NCore	H
	$PM_{2.5}$ – Hourly	07/01/2010	170	Regional Transport	SLAMS/NCore	H
	Sulfur Dioxide (SO_2)	04/01/2004	600	Population Exposure	SLAMS/NCore	R
Riviera Beach, 240032002	Sulfur Dioxide (SO_2)	1/12/2018	060	Highest Concentration	SLAMS	R
Rockville, 240313001	Ozone (O_3)	01/01/1980	087	Population Exposure	SLAMS	H, S
	$PM_{2.5}$ - Hourly	07/01/2010	170	Population Exposure	SLAMS	H
South Carroll, 240130001	Ozone (O_3)	07/14/1983	087	Population Exposure	SLAMS	H, S
Southern Maryland, 240170010	Ozone (O_3)	10/02/1984	087	General Background	SLAMS	H, S

Below is MDE's 2023 Ambient Air Monitoring Network Map:



Although monitoring takes place statewide, most of the stations are concentrated in the urban/industrial areas that have the highest population and number of pollutant sources. To support the multiple objectives, monitoring networks are designed with a variety of monitoring sites that are used to determine the highest concentrations expected to occur in the area covered by the network; typical concentrations in areas of high population density; the impact on ambient pollution levels of significant sources or source categories; the general background concentration levels; the extent of regional pollutant transport among populated areas and in support of secondary standards; and air pollution impacts on visibility, vegetation damage, or other welfare-based impacts. The monitoring aspects of the SLAMS programs are found in the Code of Federal Regulations, Title 40, Parts 50, 53, and 58.

In addition to the ambient air monitoring stations operated and quality assured by MDE, two Clean Air Status and Trends Network (CASTNET) sites are located in Maryland, one at the Blackwater National Wildlife Refuge in Dorchester County and the other in Beltsville in Prince Georges County. CASTNET is a long-term environmental monitoring network with 90 sites located throughout the US and Canada. The sites are managed and operated by EPA's Clean Air Markets Division (CAMD) in cooperation with the National Parks Service (NPS) and other federal, state, and local partners. CASTNET was established under the 1991 Clean Air Act Amendments (CAAA) to assess trends in acidic deposition due to emission reduction programs, such as the Acid Rain Program, NO_x Budget Trading Program, and the Clean Air Interstate Rule

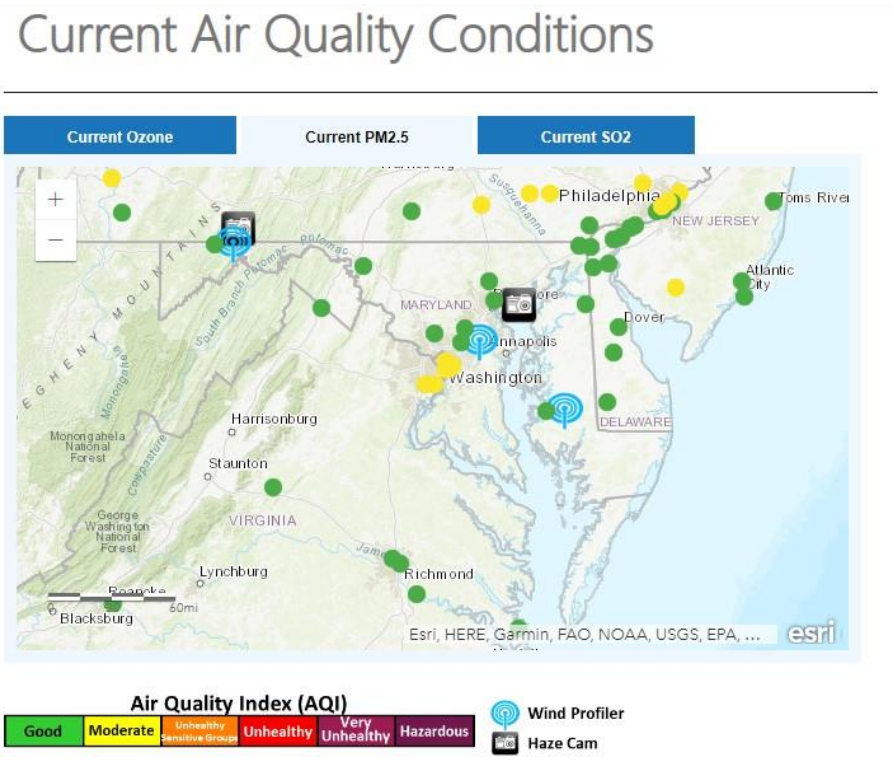
(CAIR). CASTNET measures ambient concentrations of sulfur and nitrogen species as well as rural ozone concentrations. Results from CASTNET are used to report on geographic patterns and temporal trends in acidic pollutants, deposition, and regional ozone concentrations. For these two CASTNET sites, MDE provides auditing support, performing annual ozone analyzer audits.

In addition to collecting the ambient air quality data, the Program performs all quality assurance, quality control and analysis procedures of the pollutant concentrations measured. Quality Assurance Project Plans (QAPPS) and standard operating procedures (SOPs) are developed and routinely updated for each pollutant measured. These documents are reviewed yearly and are required to be fully updated and EPA approved every five years. A full review and evaluation of all operations, quality assurance and quality control documents, data management practices on submitted data and electronic files is performed by EPA Region III during periodic Technical System Audits (TSA's).

Every year, the Air Monitoring Program prepares an Annual Network Plan (ANP) detailing the entire monitoring network, pollutants being measured, monitoring locations as well as any network changes being requested over that period. Each draft plan is posted for public comment for 30 days prior to being submitted to EPA for review and approval.

c. Data sharing

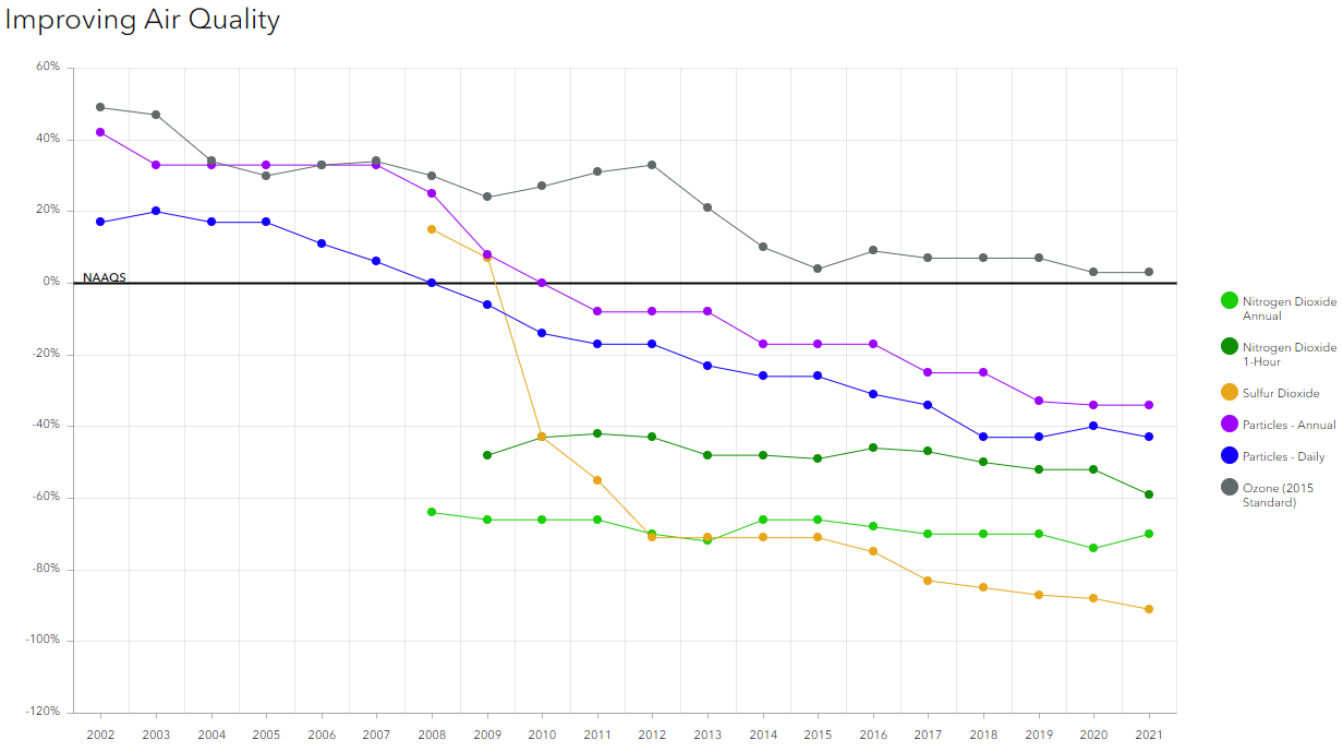
Near real time hourly data is posted on our webpage for several criteria pollutants, including Ozone and Fine Particulate Matter or PM2.5. See the Current Conditions map below. This map allows the public to not only see the actual pollutant concentrations, but also it is color coded so that concentrations align with their respective Air Quality Index (AQI) value. By clicking on individual sites, one can review the previous 12 hours of pollutant data, depending on which tab is active. Below are examples of current conditions maps for PM2.5 across the network.



In addition, hourly data is shared on many platforms including AirNow, Clean Air Partners, Airnowtech (for EPA air quality maps and Air Quality Index forecasting purposes) and the National Weather Service.

d. Air Quality Progress

While Maryland's air quality is often strongly influenced by transported pollution from neighboring states, progress has been made in reducing both transported pollution and pollution from local sources. Reducing pollution emissions is key to achieving cleaner air. Emissions from the major source categories have steadily decreased over the last 30 years in Maryland and nationwide. Regulations that have been initiated through the federal and state levels have helped lessen harmful pollutants from entering the atmosphere. The state has witnessed positive trends in criteria and toxic air pollutants entering our atmosphere from mobile, stationary, and area sources. Those trends are shown below, comparing several criteria pollutants to their respective NAAQS over the last twenty years.

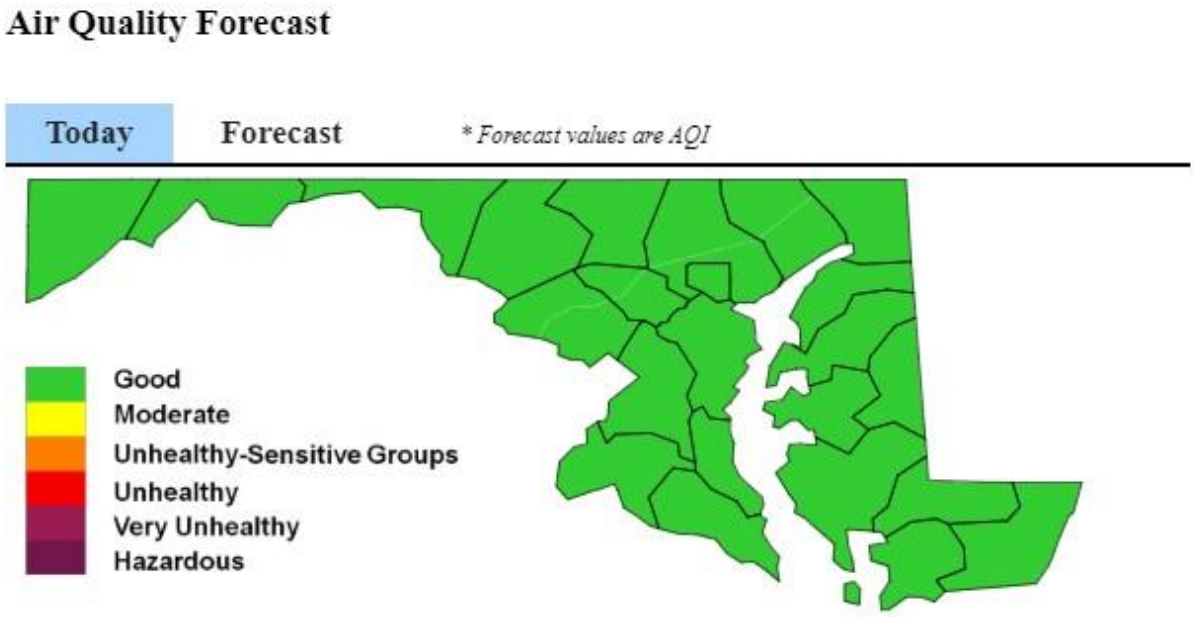


2022 Maryland Clean Air Progress Report

V. Air Quality Forecasting, Alerts to the Public and Emergency Preparedness

a. AQ Forecasting and Updated Statewide Forecast Regions

MDE has air quality forecasters (meteorologists) that provide daily forecasts (and up to 3 days in advance) year-round for fine particulate matter (PM2.5) pollution and ground level ozone (O3) pollution. These air quality forecasts and discussions are prepared by the MDE meteorologists in partnership with Metropolitan Washington Council of Governments (MWCOG), DC Department of Energy and Environment (DOEE), and Virginia Department of Environmental Quality (VADEQ). Air quality forecasts provided by the MDE (example shown below) are available through a variety of online sources such as MDE's Air Quality Forecast Page, AirNow, Clean Air Partners, National Weather Service, as well as on MDE's website. Air quality notifications can also be sent to your inbox by signing up for AirNow's EnviroFlash. The Clean Air Partners and AirNow apps also deliver real-time air quality conditions and forecasts to your smartphone.

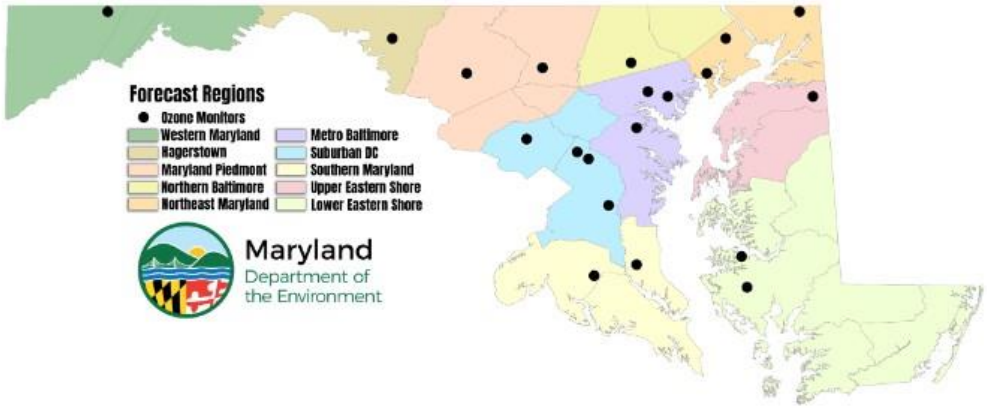


In 2022, MDE greatly expanded its forecasting procedure, breaking the forecasting area into ten regions across the State instead of just four. This change was brought on by several factors. First, the geographic scope and amount of air quality exceedance days in Maryland has drastically decreased in the past two decades. Air quality that historically exceeded federal standards over large areas is now a rarity. The State has made significant progress on clean air. Now instead of large areas of the state experiencing frequent days with high levels of air pollution for various criteria pollutants, smaller areas of the State experience infrequent levels of air pollution slightly above the ozone air quality standard.

Secondly, Maryland's investments in scientific research that precipitated this cleaner air now afford the ability to forecast localized areas of air quality that may be slightly above the standards. An air quality forecast methodology that reflects the contemporary environment also better informs Maryland public health decisions. Technology has also advanced over the last two decades. Information technology and communication have undergone significant transformations. Affordable small sensors and new satellites can identify localized air quality hot spots. Changes to the MDE forecast protocol will allow MDE to embrace and take advantage of these developments.

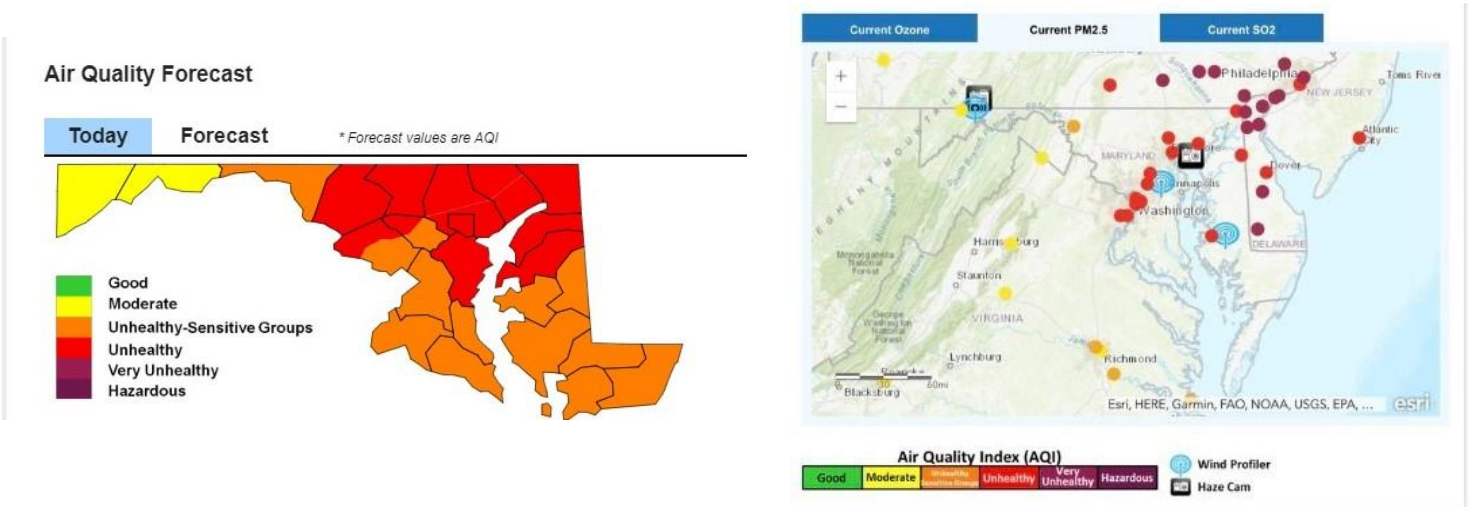
Finally, health protection is the primary purpose of air quality forecasting. Current air quality exceedance days typically only occur at one or two, often adjacent, monitors. These typical circumstances we have been experiencing for the past 8-10 years do not justify broad poor air quality health alerts, and do not reflect regional changes in air quality. Air quality alerts do not eliminate traffic jams or shut down industry; however, the new forecast region format can detail

where those activities may produce poor air quality. These ten regions enable a health focused approach to air quality forecasting and can facilitate action on a personal level to protect health and wellbeing for all Maryland's citizens. Below is a map naming all the regions as well as an example forecast map from this past summer with a few smaller regions having different forecasts.



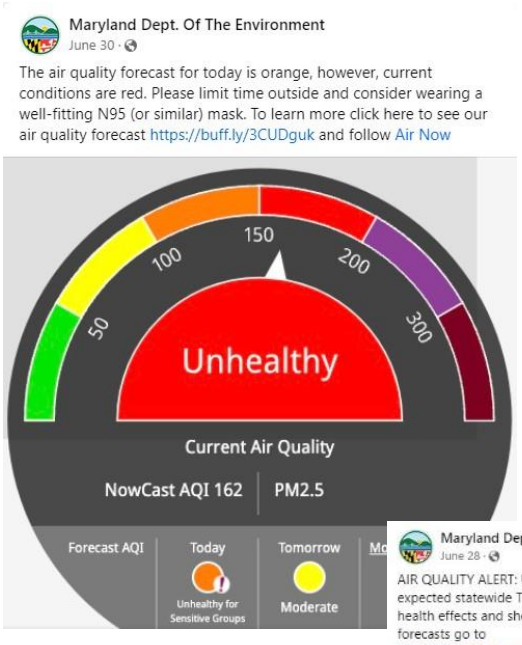
b. 2023 Summer Wildfire Smoke in Maryland

The expanded forecast regions served the State well over this past summer. Dry conditions and warmer than normal temperatures contributed to many wildfires in the US and Canada in 2023. Smoke traveled into Maryland from wildfires burning in many areas of the U.S., including the midwest, south, and northeast. Large amounts of smoke also came into Maryland from eastern and far western Canada. The wildfire smoke led to record setting PM2.5 events in Maryland in June. These concentrations were the worst network wide PM2.5 levels ever recorded in Maryland. Levels were so elevated, a code Red air quality forecast for PM2.5 was issued multiple times in June. These were the first ever code Red forecasts for PM2.5 in Maryland, and the first code Red for any pollutant since 2016, when one was issued for elevated O3.

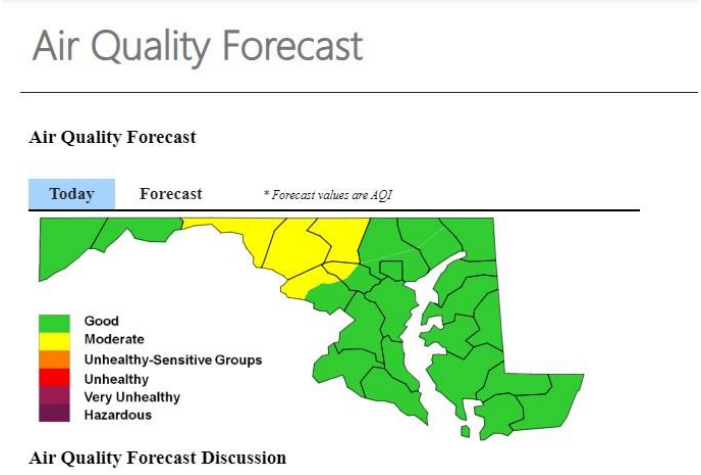


In addition to the high PM2.5 levels, the abundant smoke caused O3 pollution to be elevated as well. Maryland experienced twenty O3 exceedance days this summer, with most of these O3 exceedance days having enhanced levels due to the smoke in the atmosphere. By comparison, 2022 only had three O3 exceedance days.

As previously stated, air quality forecasts are updated daily. However, with the extreme smoke events over this summer, MDE went against normal procedures on several occasions updating the forecast as conditions were changing. In addition, the meteorologists forecasted air quality conditions based on 24-hour periods from noon to noon instead of from midnight to midnight (per EPA regulations for daily pollutant concentration calculations). In doing so, changes in procedure helped to better inform and protect the public during the highest PM2.5 concentrations. MDE meteorologists and communications staff were sending out notices of worsening air quality constantly, posting alerts and safety information on Facebook and X as well as on the MDE website. MDE meteorologists also worked closely with the National Weather Service to provide the updated information on air quality that can be sent out via alerts to smart phones.



Smoke induced air quality events unfortunately have not been limited to the summertime. On 11/16/23, the below air quality alert was issued and posted due to elevated PM2.5 caused by wildfires in northern Virginia.



c. National Early Alert Monitoring Programs

The BioWatch Program was established in 2003 to provide early preparation, detection and response to a bioterrorism event. The Biowatch network was established in 30 metropolitan areas in the U.S, with Baltimore being one of them. This Program involves stakeholders from public health, emergency management, law enforcement, laboratory, scientific, and environmental health organizations around the country who collaborate and prepare a coordinated response to a bioterrorism attack.

MDE began running a dozen or so Biowatch sites around Baltimore in 2003, operating the analyzers and transporting exposed filter media to Walter Reed Medical Center for analysis daily. Since then, the Department of Homeland Security took over the program with a federal contractor now performing the daily operations. However, MDE still supports the infrastructure and electrical needs of the program.

Since 1956, EPA has measured radiation in ambient air as an early alert system. This radiation monitoring network, or RADNET is used to determine normal background levels of radiation as well as a way to track radiation in the air due to weapons usage or nuclear reactor accidents. RADNET has continued to expand over the years to approximately 140 sites nationally. In 2006, MDE received a monitoring site as part of a new initiative to measure gamma radiation in real time. The newer site collects and sends radiation data to the National Analytical Radiation Environmental Laboratory (NAREL) in Alabama. MDE continues to operate this site, in Baltimore City at MDE headquarters.

VI. Research Initiatives and Community Based Hyper Local Monitoring Efforts

a. Ongoing / Upcoming Air Quality Research involving MDE

Regional Atmospheric Measurement Modeling Prediction Program (RAMMPP)

For over 30 years, MDE and the University of Maryland College Park (UMCP) have worked in partnership to conduct policy-relevant research on air quality and climate change. This partnership has often involved collaboration with other states and partners like the National Aeronautics and Space Administration (NASA), the National Institute of Standards and Technology (NIST), the National Oceanic and Atmospheric Administration (NOAA) and other universities like the University of Maryland Baltimore County (UMBC) and Howard University (HU). This collaborative research effort has led to some of the states' and the nation's most successful efforts to reduce air pollution and protect public health.

The partnership, known as the Regional Atmospheric Measurement Modeling and Prediction Program (RAMMPP) has been focused on science-based air quality modeling using aloft air pollution measurements gathered using an aircraft. For the past three decades RAMMPP research has shown that approximately 70 percent of Maryland's ozone problem on certain days originates from upwind states and the cutting-edge air quality modeling has demonstrated that reducing power plant emissions in upwind states will dramatically reduce ozone and fine particulate pollution in Maryland. This research has directly influenced and improved Federal programs driving pollution reduction across the country.

Laser based measurement research

In 2002, MDE started collaborating with UMBC. This collaboration focused on using lidar (light detection and ranging) to better understand how particles mix in the atmosphere and are transported into Maryland. More recently in 2020 Maryland was one of the first states to participate in the Unified Ceilometer Network (UCN) being developed through a combined effort between UMBC, EPA, NASA and NOAA. The ceilometer is a meteorological instrument that can be used to measure aloft aerosol profiles to determine the mixing layer height (MLH). This data is being used to improve air quality models to better predict surface pollutant concentrations. More information on the ceilometer network can be found here.

Ozonesondes measurements

MDE started its successful collaboration with HU in 2005. Over the past 15 plus years, HU has launched hundreds of ozonesonde balloons as part of a research effort to better understand and measure how much O3 is present over Maryland in the late night or early morning hours. This research led to the discovery of the nocturnal low-level jet (NLLJ) and its ability to transport O3 into Maryland at night and in the early morning hours.

Multi-Agency Efforts involving Air Quality and the Chesapeake Bay

The Ozone Water-Land Environmental Transition Study (OWLETS – 2) was an intensive collaborative effort during the summer of 2018 to study air quality in and around the northern Chesapeake Bay region. MDE and scientists from NASA, NOAA, and several local universities participated in the study. The study was designed to help understand why O3 monitors near large water bodies in Maryland and other eastern states are the most problematic, why O3 is high over water bodies, how bay breezes push high O3 over the bay inland and what sources contribute to the high O3 readings over the bay.

Air quality measurement instrumentation was deployed at various locations in and around the bay from June 6 through July 6, 2018. These measurements provided a much needed three–dimensional look at air pollution over and surrounding the bay and will help scientists better understand how O3 is affected by the land–water interface issue.

Surface and aloft pollutant measurements were taken by an assortment of instrumentation. The MDE air monitoring network provided a foundation for surface O3 measurements. Aloft O3 measurement technologies included lidar remote sensing, ozonesondes, tethered balloons, aircraft, satellites, a wind lidar called a wind cube, radiometers, and ceilometers. Additional surface measurements included fine particles, carbon monoxide, NO_x, mercury, SO_2, and volatile organic compounds. These instruments were located at sites from approximately the Bay Bridge to Aberdeen Proving Grounds. Hart-Miller Island (HMI) and UMBC served as the study's super sites within the greater experimental network. OWLETS – 2 provided a much needed and unique opportunity to take a combination of air quality measurements over and around the Chesapeake Bay.

BSEC, CoURAGE, Grand Challenge – University based projects

MDE has recently become involved with several other research projects, one being the Baltimore Social Environmental Collaborative or BSEC. BSEC is a five-year study funded by the US Department of Energy (DOE) and lead by the Johns Hopkins University. The project goal is 'to produce the urban climate science needed to inform community guided potential equitable pathways for climate action'. This coordinated effort includes local universities and community organizations combining research in four climate related areas; heating, flooding, indoor / outdoor air quality and greenhouse gas emissions. For the air quality portion, a new air quality monitoring site will be installed in Baltimore City. Episodic mobile measurements will also be used. Additionally, this effort will leverage MDE's existing air monitoring network as well as the SEARCH network (a low-cost sensor network configured and operated by the Johns Hopkins University).

Another DOE funded project currently underway in Maryland is the Coast-Urban-Rural Atmospheric Gradient Experiment or CoURAGE. The project is led by Penn State University with many other university partners including locally Johns Hopkins, Morgan State, Howard University, and UMBC. Areas of research with this project include atmospheric boundary layer and land – atmosphere interactions, atmospheric composition, clouds, radiation and precipitation in hopes to better understand the coast-urban-rural gradients that affect Baltimore's atmospheric environment. Four air monitoring sites will be established, some of them possibly collocated with current MDE sites, leveraging current site infrastructure and existing measurements.

The University of Maryland Grand Challenge is another project, a 3-year effort to address the effect climate change is having on extreme weather and natural disasters, agriculture and food security as well as air and water quality. The scope of this project is focused on research-to-implementation translation, applied science with immediate societal outcomes. MDE's existing air monitoring network will be utilized as part of this project.

b. Projects involving Hyperlocal Networks in overburdened communities and the Eastern Shore

Cheverly Community Hyper Local Network and Initiatives

MDE is collaborating with several communities to identify, address, and mitigate local sources of air pollution. One such project is with the Town of Cheverly to help monitor air quality in the area and to use collected data to drive decisions on where MDE can focus its limited resources to help reduce local emissions. Cheverly is a suburb of Washington, D.C., surrounded by many roads and highways. Being in an urban/industrial location, the area is subject to a significant level of car and truck (diesel) emissions, light industrial operations, idling vehicles, truck traffic from warehouses and transportation depots, and a handful of stationary sources.

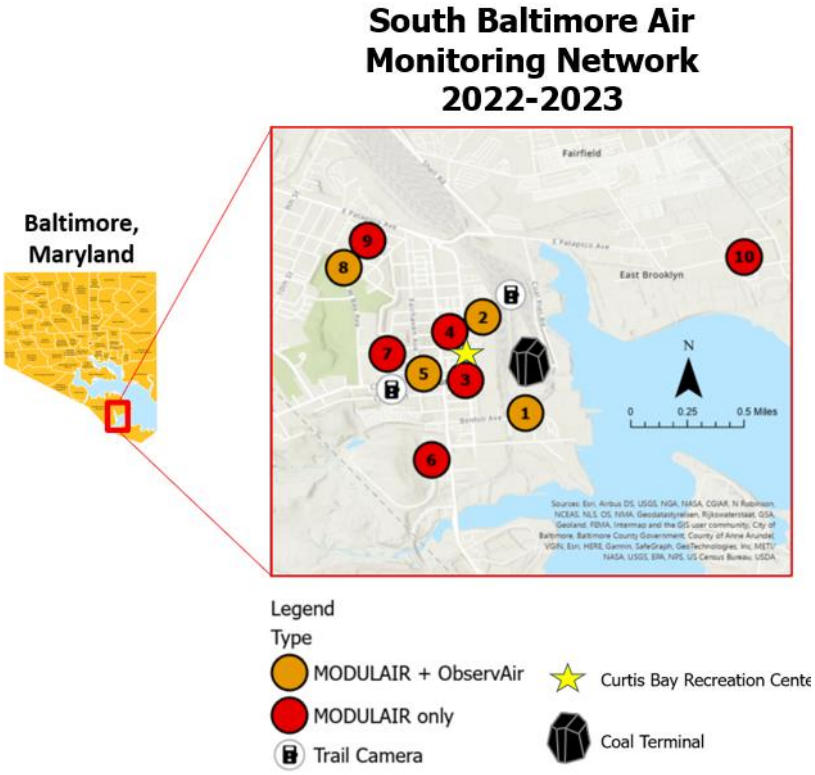
MDE partnered with the Town of Cheverly and UMD's Center for Community Engagement, Environmental Justice, and Health (CEEJH) to monitor hyper-local air quality affecting a specific community. CEEJH worked with Cheverly and the Town of Capitol Heights to incorporate an air sensor network to examine local air quality, with a focus on particulate matter (PM2.5).

MDE aided in this effort by studying observations made through the project and by increasing inspection efforts to help identify potential sources of pollution that may be affecting the community. In summer 2021, thorough daily assessments of PM2.5 concentrations throughout the community were provided by MDE inspectors, who conducted an intensive targeted inspection initiative in and around the Cheverly area, following up on any pollution hot spots identified by the sensor network. During the two-month inspection initiative, PM2.5 concentrations were within normal limits for regional areas and were similar to other urban communities. MDE inspectors did not identify any single source of air pollution that was out of compliance with air quality laws and regulations. No singular source of elevated pollution was shown to be affecting Cheverly, aside from the area being near high volumes of truck traffic and idling buses. The Cheverly area appeared to be more strongly affected by being downwind of broader, regional sources of pollution. MDE plans to continue this partnership, to seek opportunities to engage other communities, and to improve local air quality when possible. For more information on the initiative in 2021, please see the Air Quality Partnership Project Report on MDE's website here: https://mde.maryland.gov/programs/Air/Pages/index.aspx.

Curtis Bay Community Hyper Local Network and Initiatives

Curtis Bay is a residential, commercial, and industrial community in the southwest section of Baltimore City. The Curtis Bay Community Association, the South Baltimore Community Land Trust (SBCLT), the Johns Hopkins University School of Public Health (JHU SPH), and the University of Maryland Department of Atmospheric and Oceanic Science, among others have for almost the past two years been configuring an extensive hyperlocal air sensor network to measure air pollutants and fugitive dust samples throughout this overburdened community.

Below is a sensor location map for the Curtis Bay network. Measurements across this network include PM1, PM2.5, PM10, TSP, Black Carbon, NO2, NO, CO, O3 as well as several meteorological parameters.

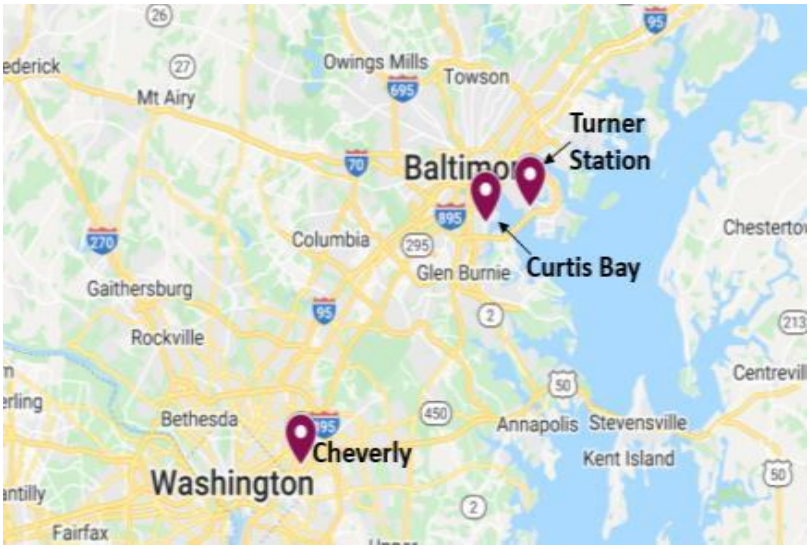


MDE has been engaged since early on in this monitoring effort through various capacities, such as: attending bi-weekly data analysis stakeholder calls, providing sensor siting guidance and sensor collocation testing at existing MDE federal reference air monitoring stations (see site pictures below), sharing data wrangling methods to compile all sensor data together as well as offering analysis techniques to help determine / pinpoint pollutant emission sources.

MDE and its research partners published a report on December 14 detailing how windblown coal dust from the nearby coal export terminal as well as pollutants from other area sources are affecting air quality in the community.

American Rescue Plan (ARP)/Inflation Reduction Act (IRA) Competitive Grant project

In 2022, MDE along with community associations from Curtis Bay, Turner Station and Cheverly as well as other partners including the University of Maryland College Park (UMCP), UMD's Center for Community Engagement, Environmental Justice, and Health (CEEJH) and Johns Hopkins University (JHU) applied for an ARP competitive grant for 'Enhanced AQ Monitoring for Communities'. The grant proposal was submitted in March of 2022 with the project title of '*Community Partnership Program to Monitor and Mitigate Cumulative Air Pollution Concentrations in Communities with Environmental Justice (EJ) Concerns'*. EPA approved the grant project in November, and funding was received in June of 2023. Below is a map of the three overburdened communities involved in this project:



The objective of this project is to identify and characterize cumulative air pollution levels in communities with significant and disproportionate air pollution burdens. The plan is to deploy a package of meteorology equipment and air quality sensors capable of measuring criteria and hazardous air pollutants (HAPs) as well as variables that help indicate which air pollution sources in or near that community are adversely affecting those who live there. Bi-weekly Partnership Steering Committee Meetings with community members and university partners started in early 2023 and will be ongoing throughout the project The Partnership Steering Committee discussions informed which sensors should be purchased based on community feedback on the pollution sources of concern in each community, where the sensor packages should be located, and outreach opportunities with community members. In addition to sensor packages being deployed in each of the three communities discussed above, an identical package of various low-cost sensors will be deployed in a baseline community in the Annapolis area for the purpose of comparing data.

UMCP/CEEJH will deploy the sensors to all the communities/sites participating in the project. UMCP/CEEJH will do a weekly data comparison of all the sensors to ensure that they are operating normally and collecting reliable data. All data collected and analyzed will be presented to MDE and the Partnership Steering Committee in an effort to maintain total transparency.

The partnership of community representatives and research institutions will lead and carry out this project, overseen by the Partnership Steering Committee composed of their representatives. Technical experts, including the universities, non-profit organizations, and MDE will provide advice and recommendations to the Steering Committee based on the data reviewed and analyzed. The three communities will drive the project in all aspects. Below is the timeline for the project that was submitted as part of the grant project plan. Phase 1 of the grant officially began in June of 2023 when the grant award was received from EPA, but Partnership Steering

Committee meetings began at the beginning of 2023. The project is currently on schedule and monitoring equipment is being procured and community outreach meetings and training workshops are underway.

ARP Competitive Timeline – Phase 1: Months 1-6	***Month(s)***
Establish Steering Committee, set up meeting schedule	1
Develop plan for community outreach meetings, workshops, training sessions, and workforce development	1
Select project communities, select monitoring equipment and select monitoring sites	1-6
Procure monitoring equipment	3-6
Conduct community outreach meetings, workshops, and workforce development/ trainings	2-6
Phase 2: Months 7-24	***Month(s)***
Deploy equipment and start collecting data in collaboration w/community scientists	6-9
Prepare 1st Mid-Phase report	12
Conduct data analyses including cumulative impacts with community leaders' input	14-18
Prepare 2nd Mid-Phase report	18
Develop and expand mitigation measures; implement related community education and training	19-22
Preparation and production of final report including recommendations for next project phase under future funding and expansion of community partnerships	23-29

MDE's role in the grant is overall project administration with project workplan and quality assurance project plan (QAPP) review, submission of quarterly grant updates to EPA, participating in Partnership Steering Committee meetings, helping CEEJH with community engagement and other training activities, and providing technical air monitoring support.

Lower Eastern Shore (LES) Air Monitoring Project

Through the collective efforts of the MDE, the Keith Campbell Foundation for the Environment, and the Delmarva Chicken Association, an air monitoring project was undertaken on Maryland's Lower Eastern Shore (LES) to collect data on ambient air quality to learn more about how air quality near poultry houses compares to other areas of Maryland. Ambient air quality monitoring equipment for ammonia (NH3) and particulate matter (PM2.5 and PM10) was purchased and installed at two new monitoring sites – one near a higher-than-average density of poultry houses and one near a lower density of poultry houses. Additional NH3 monitoring equipment was purchased and installed in two existing monitoring sites operated by the MDE – one, an urban site at Oldtown in Baltimore City and the other, an isolated rural site at Horn Point in Dorchester County. These existing sites were in locations that allowed them to serve as background monitors for both NH3 and particulate matter. Ambient air quality data collection for this project officially began on April 1, 2020. According to U.S. Environmental Protection Agency's (EPA) environmental mapping and screening tool (EJ Screen), about one-third of the population within the portion of the study area that includes a higher-than-average density of poultry houses is

considered low income and one-quarter of the population is above the age of 64. Both measures are higher than the statewide average. About 10% of the population has less than a high school education, which is equal to the statewide average. Thirty-four percent of the population are people of color, which is less than the statewide average of 49%. After the completion of one full year of data collection, there were no measured violations of federal air quality standards for particulate matter and no exceedances of a conservative health benchmark for NH3. Concentrations of all parameters remained quite low overall throughout the year. To protect public health, MDE uses the National Ambient Air Quality Standards (NAAQS). As NH3 does not have a health based national ambient standard, MDE chose a conservative comparison metric, a one-hour air toxics screening level of 350 parts per billion(ppb). Below is a map showing the location of the LES sites as well as a map showing the CAFO density around each LES site:

- Almost 900,000 chickens within a 2 mile radius and about half that number within 1 mile.
- Impacted from multiple directions.
- Many more chicken houses outside of 2 mile radius.
- 29 broiler houses within a 1 mile radius and 70 houses within a 2 mile radius.

- Much less impacted by poultry operations within a 2 mile radius.
- Approximately 14 miles to the NE of Pocomoke City site.
- No broiler houses within a 1 mile radius and 7 houses within a 2 mile radius.

This project continues with almost four years of data collected to date. Progress on a third LES site, further north in Caroline County, is ongoing. University of Maryland Eastern Shore (UMES) is taking the lead and MDE is providing technical support and oversight.

VII. Observations Based on Previous Initiatives / Suggestions Moving Forward

a. Observations based on Previous Initiatives

As noted above, MDE has participated in several low-cost air quality sensor projects over the last few years. Based on MDE's partnership in these projects, we offer the following observations and information:

- PM2.5 sensors might not be the best gauge of local air quality in terms of determining impacts and, especially disproportionate impacts, due to PM2.5 being a regional pollutant that travels far distances in the atmosphere and thus generally has consistent concentrations spatially across the entire State (unless directly adjacent to a source)
- Over-reliance on PM2.5 sensors could create risks for individuals who are more vulnerable to air pollution, as most problematic air quality periods in Maryland are driven by Ozone. Managers of sensor projects should be careful to direct community members to state and Federal resources for air quality data and forecasting that account for multiple pollutants, not just PM2.5, including MDE's website forecast and AirNow.
- In order to get a clearer picture of overall air quality and to effectively determine the pollutants and the sources of those pollutants that may have a high potential for impacting the health of local residents, utilizing multiple sensors that can measure multiple pollutants, including black carbon (a diesel smoke signature) is integral.
- The resource needs, both financial and staffing, to purchase, install and manage a network of local multi-pollutant sensors are significant, and well beyond the current capacity of MDE. Additionally, developing scientifically defendable conclusions on pollutant sources and pollution impacts can take well over a year once data begins to be collected, and there is no guarantee that such conclusions can be made.
- Blanketing an area with sensors solely based on metrics other than known or suspected emission sources may not show much of a difference relative to the existing regulatory network of reference analyzers.
- Projects that have a set objective from the start, such as determining if a community is experiencing excess pollution from certain sources, seem to be more successful in obtaining overall outcomes, vs. projects that just have broad data collection parameters.

a. Suggestions Moving Forward

MDE is prioritizing making the air cleaner for all Marylanders, especially those living in overburdened and underserved communities. As part of this focus, MDE has been partnering with various universities and communities who are deploying hyperlocal air monitoring networks. However, MDE does not have the staffing resources or funding to scale this work across the state. MDE's suggestion for expanding local low-cost sensor monitoring moving forward is to provide more funding and staffing resources to the Department, so we can effectively engage with more communities and partners who are pursuing local air monitoring.

Counties and universities across Maryland have also played an important role in local low-cost sensor work. In addition to providing MDE with more staff and funding, creating more opportunities for counties and universities to take the lead on local monitoring efforts, with assistance from MDE in various capacities, would also alleviate some of the funding/staffing resource issue for MDE.

e. County-initiated air quality projects

Several Maryland counties have initiated hyperlocal monitoring projects of their own. Counties often have local support and knowledge of community concerns. Below are some examples of counties performing air quality work.

St. Mary's County –

St. Mary's County has established their own PM2.5 sensor network and a local air quality dashboard to share real time air quality data and recommend protective health actions for community members. This is a good way to supplement MDE's air monitoring network, filling gaps in the regulatory network. Other than providing initial sensor use and guidance, MDE has not been involved in the creation or operation of this network.

Carroll County School System –

Carroll County Schools, partnering the UMD is working on a similar project, using PM2.5 sensors, but installing them at all high schools within the county. MDE worked with representatives of the school system to collocate sensors on the roof of MDE's Padonia air monitoring station. This type of collocation testing is important to determine a sensors' operational health and accuracy compared to a federal reference analyzer prior to installing the sensors in the field.

Frederick County –

The Frederick County Department of Energy and Environment has reached out to MDE recently to share their plans for an air quality sensor project they are planning to install. Their project will be to collect data at approximately twelve sites, with a good portion of the sites being located in overburdened and underserved areas. The project will start with PM2.5 sensors and expand to other sensors (other pollutants) as the need and or resources allow. MDE's Frederick air monitoring site can be utilized as a sensor site and contribute additional measurements to this project.

f. Universities partnerships for air quality projects

In addition to county led air sensor projects, local universities have been and currently are a critical partner in many of these sensor projects that have taken place in Maryland. MDE lacks the resources necessary to independently complete these types of projects, including funding and personnel needs to site and operate the sensors as well as to analyze the data to determine actionable change for community benefit. However, MDE can contribute positively to these efforts by leveraging aspects of the regulatory based Air Monitoring Program. Speifically, MDE has the following monitoring related resources to utilize as needed when collaborating with others:

- An extensive air monitoring network of criteria pollutant analyzers, several research grade / industry standard analyzers for monitoring of non-criteria pollutants, full calibration systems
- An existing network infrastructure that includes property access agreements (transversing much of the State) and MOUs for maintaining sites, climate-controlled shelters with electricity) that can be used to site additional research / special study monitoring and or provide collocation testing for new and experimental equipment
- Historical data with some sites existing since the early 1980s
- A talented air monitoring staff with extensive knowledge of current best practices for ambient air monitoring, regulatory requirements for siting and data collection, modelling, quality assurance / quality control and air quality analysis on ambient air quality data

Universities can fill many if not all these resource gaps. Partnering with local universities can provide a resource friendly and cost-effective means of completing air quality sensor projects, particularly with efforts focused on mobile and or fenceline monitoring around emission sources or suspected emission sources. Universities often have existing equipment (federal reference and or industry leading / research grade equipment) and monitoring capabilities, the technical knowhow on the operation of this equipment as well as the knowledge of the analytical methods and techniques for analysis on all data collected as well as the personnel to carry out air quality monitoring projects.

Mobile or fenceline monitoring is becoming more popular as a means of characterizing an area's air quality. Monitoring in the areas of local emissions (rural or urban) by basically mapping an area's air quality and meteorological may be a better method for determining actionable conditions and local source attribution, possibly leading to better outcomes for the communities involved. Other than partnering with universities, private sensor companies can also assist with sensor monitoring efforts, both mobile and fenceline projects. Universities or private companies can assist by performing even full project objectives, from data collection and data analysis to forming project conclusions that confirm community needs and specify any actions that should occur moving forward.

VIII. Conclusion

In recent years, Maryland, and other states around the country, have seen an increase in various entities conducting local air monitoring using low-cost sensors. Per this JCR request, MDE has provided information on the following issues: the ambient air monitoring network that is already deployed statewide; how that network is used to mitigate exposure to pollutants, inform regulatory decision-making processes, and how that network can be used to help reduce the cumulative impact of certain air pollutants. In addition to the network that is already in place, MDE has provided information on several research initiatives and several local low-cost sensor networks that the Department is partnering on with universities and local communities. Finally, MDE has provided observations based on the Department's low-cost sensor work over the past few years and suggestions for what it would take to expand local low-cost sensor monitoring moving forward.