# DRAFT
# 2021 Delaware Ambient Air Monitoring Network Plan for Criteria Pollutants

Division of Air Quality


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June 30, 2021

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## List of Acronyms

AQS – Air Quality System
CAA – Clean Air Act
CFR – Code of Federal Regulations
CO – carbon monoxide
CSA – combined statistical area
DNREC – Department of Natural Resources and Environmental Control
EPA – Environmental Protection Agency
FEM – Federal Equivalent Method
FRM – Federal Reference Method
lpm – liters per minute
MSA – metropolitan statistical area
NAAQS – National Ambient Air Quality Standards
NO – nitric oxide
$NO_2$ – nitrogen dioxide
NOx – nitrogen oxides
$O_3$ – ozone
PAMS – Photochemical Assessment Monitoring System
Pb - lead
$PM_{2.5}$ – fine particulate matter (2.5 microns)
$PM_{10}$ – respirable particulate matter (10 microns)
$PM_{10\text{-}2.5}$ – coarse particulate matter (PM10 – PM2.5)
SLAMS – state and local monitoring stations
$SO_2$ – sulfur dioxide
SPM – Special Purpose Monitor
UFP – ultrafine particles
WS/WD – wind speed/wind direction

## Introduction

In 1970, Congress passed the Clean Air Act 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, and buildings, etc.).

Seven pollutants currently have NAAQS: ozone ($O_3$), carbon monoxide (CO), sulfur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), particulate matter less than 10 microns ($PM_{10}$), particulate matter less than 2.5 microns ($PM_{2.5}$) and lead (Pb). These are commonly called the "criteria" pollutants. When air quality does not meet the NAAQS, the area is said to be in “nonattainment” with the NAAQS.

## Requirements for Monitoring Network Plan

In October 2006, the EPA issued final regulations concerning state and local agency ambient air monitoring networks (see 71 FR 61298). These regulations are codified at 40 CFR Part 58 and require periodic assessments of the monitoring networks including the information described below.

§58.10 Annual monitoring network plan and periodic network assessment, Section §58.10 (a) requires for each existing and proposed monitoring site:

1) A statement that the operation of each monitor meets the requirements of appendices A, C, D, and E of 40 CFR Part 58, where applicable.
2) Proposals for any State and Local Air Monitoring station (SLAMS) network modifications.

Section §58.10 (b) The annual monitoring network plan must contain the following information for each existing and proposed site:

1) The Air Quality System (AQS) site identification number.
2) The location, including street address and geographical coordinates.
3) The sampling and analysis method(s) for each measured parameter.
4) The operating schedules for each monitor.
5) Any proposals to remove or move a monitoring station within a period of 18 months following plan submittal.
6) The monitoring objective and spatial scale of representativeness for each monitor as defined in Appendix D to 40 CFR Part 58.
7) The identification of any sites that are suitable and sites that are not suitable for comparison against the annual $PM_{2.5}$ NAAQS as described in §58.30.
8) The Metropolitan Statistical Area (MSA), Core Based Statistical Area (CBSA), Combined Statistical Area (CSA) or other area represented by the monitor.
9) The identification of required $NO_2$ monitors as either near-road or area-wide sites in accordance with Appendix D to 40 CFR Part 58.

All proposed changes to SLAMS monitors in the annual monitoring network plans and periodic network assessments are subject to EPA Regional approval according to 40 CFR Part 58.14.

# Delaware Ambient Air Monitoring Network Assessment 2020

## Executive Summary from Assessment

40 CFR Part 58.10(d) requires Delaware to perform and submit to the EPA Regional Administrator an assessment of the air quality surveillance system every 5 years to determine, at a minimum, if the network meets the monitoring objectives defined in Appendix D of this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and where new technologies are appropriate for incorporation in the ambient air monitoring network.

This report serves as Delaware's 2020 assessment under this requirement.
For this 5-Year Monitoring Network Assessment (Assessment), the Division of Air Quality (DAQ) performed a technical review of the data collected in the ambient monitoring network. To conduct this review, DAQ performed the following:

a. Population data was summarized for all three counties in Delaware. This information was used to determine the appropriateness of monitoring for population exposure.
b. Meteorological parameters were reviewed to establish upwind / downwind relationships between a monitor site and surrounding emission sources.
c. Emission inventory summary data was reviewed. This information was used to determine if a monitor is sited appropriately to represent maximum pollution concentrations or specific ambient source impacts quantification.
d. Historical data collected at each site was reviewed for trends and comparison to the current National Ambient Air Quality Standards. This is helpful to determine if Delaware is achieving air quality improvements and meeting air quality standards.
e. Site by site correlation analysis was performed using tools supplied by EPA for appropriate monitors. This information is used to determine if information collected at sites is redundant and if the site may be considered for elimination.
f. A bias calculation was performed to determine impacts that may occur if a monitor is removed from the network.

DAQ evaluated the data from this technical review according to defined performance measures. We also expanded performance measures beyond application of this technical information. Performance measures were organized into the following categories:

a. Data Criteria
b. Statistical Criteria
c. Situational Criteria
d. Future Needs and Special Considerations

Specific performance measures used in this Assessment are detailed in the Delaware Air Monitoring Network – Current Network Description section. Not all performance measures were applicable to every monitor / site. Based upon the evaluation of these performance measures, DAQ determined the importance (critical, credible, marginal, new site required) of each monitor in the network:

- **Critical sites** are of high value and will be continued.
- **Credible sites** are expected to continue but may not be the design value location at or above the NAAQS.
- **Marginal sites** or **monitors** are subject for removal or movement.
- **New site required** represent potential areas of investment.

**Network Assessment Results**

The results of this Assessment indicate that the network contains only critical or credible sites. Issues that may impact future network design include new monitoring requirements associated with new or revised NAAQS, aging equipment/maintenance issues, and resource availability. When any future monitoring rules are promulgated, Delaware will work closely with EPA Region 3 to ensure that all new monitoring requirements are me

The annual network plan for 2021 incorporates the results of the 2020 Assessment. Since all monitors are rated critical or credible, no major changes are recommended for 2021.

# Delaware Air Monitoring Network

## History of air monitoring in Delaware

Air pollution monitoring in Delaware began in the 1950s, prior to the establishment of the US EPA. The first monitors were simple mechanisms or passive collectors such as dust-fall buckets and tape samplers. These were followed in the 1960s by wet-chemistry instruments, which were soon replaced by more advanced electronic instruments. The addition of computer technology in operating monitoring systems and air pollution data collection in the late 1970s and early 1980s was critical to the development of the core-monitoring network that exists today.

The earliest monitors were placed near pollution sources to measure direct impact of pollution emissions. As ambient air pollution standards became established and monitoring methods standardized, the monitoring network expanded to include monitors in both urban and suburban areas. Monitoring goals shifted to include measuring high pollution concentrations in population centers, detecting trends, and determining compliance with the new national and ambient air quality standards, as well as establishing background levels and measuring pollution transported from areas outside of Delaware.

With the passage of the Clean Air Act in 1970, and the Clean Air Act Amendments in 1990, various control measures implemented by the federal and state governments resulted in major improvements in air quality, particularly regarding major industrial sources. Pollutants of concern today come from a variety of sources including mobile (both on-road and off-road vehicles) sources, large industrial facilities, and smaller industries and business. Delaware continues to use its ambient monitoring network to track changes in air quality across the state and evaluate compliance with ambient air quality standards.

## Network Overview

The State of Delaware has established an air monitoring network to determine the ambient levels of the pollutants for which NAAQS have been established. The Delaware Air Monitoring Network consists of the sites and monitors throughout the state, which are listed and described in this document. This network is maintained and operated by the Ambient Monitoring Group of the Division of Air Quality, DNREC.

## National Core Monitoring Strategy – NCore

In October 2006 the United States Environmental Protection Agency (EPA) issued final amendments to the ambient air monitoring regulations for criteria pollutants. These amendments are codified in 40 CFR parts 53 and 58. The purpose of the amendments was to enhance ambient air quality monitoring to better serve current and future air quality needs. One of the most significant changes in the regulations was the requirement to establish National Core (NCore) multi-pollutant monitoring stations. These stations provide data on several pollutants at lower detection limits and replace the National Air Monitoring Station (NAMS) networks that have existed for several years. The final network plan was submitted to EPA on July 1, 2009 and the station was fully operational on January 1, 2011.

The NCore Network addresses the following monitoring objectives:

- timely reporting of data to the public through AirNow, air quality forecasting, and other public reporting mechanisms
- support development of emission strategies through air quality model evaluation and other observational methods
- accountability of emission strategy progress through tracking long-term trends of criteria and non-criteria pollutants and their precursors
- support long-term health assessments that contribute to ongoing reviews of the National Ambient Air Quality Standards (NAAQS)
- compliance through establishing nonattainment/attainment areas by comparison with the NAAQS
- support multiple disciplines of scientific research, including; public health, atmospheric and ecological

The NCore sites must measure, at a minimum, $PM_{2.5}$ particle mass using continuous and integrated/filter-based samplers, speciated $PM_{2.5}$, $PM_{10-2.5}$ particle mass, $O_3$, $SO_2$, CO, NO/NOy, lead, wind speed, wind direction, relative humidity, and ambient temperature.

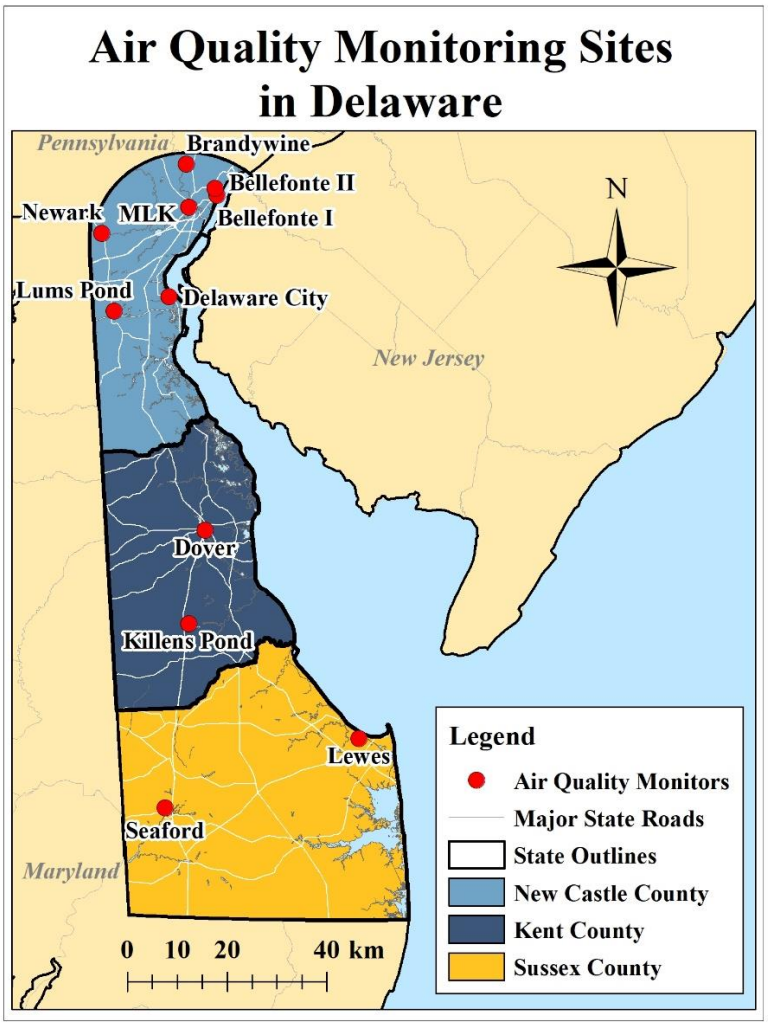
Each State is required to operate at least one NCore site. The objective is to locate sites in broadly representative urban (about 50 sites) and rural or regional (about 20 sites) locations throughout the country to help characterize urban- and regional-scale patterns of air pollution. Monitoring agencies are encouraged by EPA to collocate NCore sites with existing sites already measuring ozone precursors, air toxics, or $PM_{2.5}$ speciation components. By combining these monitoring programs at a single location, stakeholders can maximize the multi-pollutant information available. This approach not only leverages existing resources but also notably enhances the foundation for future health studies and NAAQS revisions.

In 2009, EPA provided funding to begin the process of establishing an NCore station in Delaware. After evaluating the existing network, historical data, census data, meteorology, and topography, Delaware's proposal for the existing MLK monitoring site as Delaware's NCore site was accepted by EPA.

Delaware's NCore monitoring, including PMcoarse, ozone, and NOy, became operational on January 1, 2011.

**Monitoring Site Network Map and Information**

Following is the Delaware ambient air monitoring site network map as of June 2021.




On the following page is a table with summary information on every SLAMS site in Delaware. Information includes site name and AQS ID, active parameters as of June 2021, the date when each monitor began collecting information, the scale of representativeness for each parameter, the monitoring objective, and any other comments relating to the site or monitor. Street address and geographic coordinates are included for each site in Appendix A.

All monitoring sites that are part of a CBSA/MSA meet the minimum monitoring requirements specified in 40 CFR Part 58 Appendix D.

There are no major monitoring site changes from the 2020 Monitoring Plan. Changes to specific monitors are highlighted in yellow.

**Monitoring Network Sites and Monitor Information Table**

| Site Name & AQS ID | Parameter | Start Date | Objective | Comments |
|---|---|---|---|---|
| Killens Pond 10-001-0002 | $O_3$ | 4/1/1995 | General/ Background | Rural site |
| | $PM_{2.5}$ | 1/1/1999 | General/ Background | |
| | WS/WD | 4/1/1995 | | |
| Dover 10-001-0003 | $PM_{2.5}$ | 1/1/1999 | Population Exposure | Manual $PM_{2.5}$ FRM To be replaced by continuous FEM |
| Brandywine 10-003-1010 | $O_3$ | 7/1/1994 | Population Exposure | Secondary downwind of Wilmington |
| | WS/WD | 11/1/2013 | | |
| Bellefonte II 10-003-1013 | $O_3$ | 4/1/2001 | Population Exposure | Primary downwind of Wilmington |
| | $SO_2$ | 3/1/2003 | Population Exposure | |
| Bellefonte I 10-003-1003 | $PM_{2.5}$ | 1/1/1999 | Population Exposure | Manual $PM_{2.5}$ FRM To be replaced by continuous FEM |
| MLK 10-003-2004 | $SO_2$ | 1/1/1999 | Population Exposure | Urban NCore Site<br>Full PAMS Site implementation by summer 2022 |
| | CO | 1/1/1999 | Population Exposure | |
| | $NO_2$ | 1/1/2001 | Population Exposure/ Maximum Concentration | |
| | NOy | 1/1/2011 | Population Exposure | |
| | $O_3$ | 1/1/2011 | Population Exposure/ NCore | |
| | $PM_{2.5}$ | 1/1/1999 | Population Exposure/ Maximum Concentration | |
| | $PM_{2.5}$ speciation | 6/1/2001 | Population Exposure/ NCore | |
| | $PM_{10}$ (LC) and $PM_{coarse}$ | 1/1/2011 | Population Exposure/ NCore | |
| | BC | 1/1/2001 | | |
| | VOCs | 1/1/1999 | | |
| | Metals | 1/1/2003 | | |
| | WS/WD | 6/1/2000 | | |
| | Temp/RH | 1/1/2011 | | |

| Site Name & AQS ID | Parameter | Start Date | Objective | Comments |
|---|---|---|---|---|
| Newark 10-003-1012 | $PM_{2.5}$ | 12/15/1999 | Population Exposure | Manual $PM_{2.5}$ FRM To be replaced by continuous FEM. FEM deployed under evaluation. |
| Lums Pond 10-003-1007 | $O_3$ | 1/1/1992 | Upwind Background/ Population Exposure | Rural/suburban, upwind of Wilmington during ozone season |
| | $SO_2$ | 1/1/2000 | General Background/ Population Exposure | |
| | $PM_{2.5}$ | 1/1/1999 | Regional Transport/ Population Exposure | |
| | WS/WD | 6/1/2013 | | |
| Delaware City (Route 9) 10-003-1008 | $SO_2$ | 2/1/1992 | Population Exposure/ Source Oriented | Point source dominated site |
| | $PM_{2.5}$ | 6/1/2013 | Population Exposure/ Source Oriented | |
| | WS/WD | 5/1/2011 | | |
| Seaford 10-005-1002 | $O_3$ | 3/1/1990 | Population Exposure | |
| | $PM_{2.5}$ | 1/1/1999 | Population Exposure | |
| | WS/WD | 5/1/2011 | Population Exposure | |
| Lewes 10-005-1003 | $O_3$ | 5/1/1997 | Population Exposure | Coastal site |
| | $SO_2$ | 1/1/2013 | Population Exposure | |
| | WS/WD | 6/1/1997 | | |
| 11 Total Sites – 12 Different Parameters | | | | |

N/A – not applicable

# Criteria Pollutant Network Description by Parameter

**Ozone ($O_3$)**

Ozone is measured by ultraviolet absorption photometry. Air is drawn through a sample cell where ultraviolet light (254 nm wavelength) passes through it. Light not absorbed by the ozone is converted into an electrical signal proportional to the ozone concentration.

***Monitoring Requirements***

Within an $O_3$ network, at least one $O_3$ site for each MSA, or CSA if multiple MSAs are involved, must be designed to record the maximum concentration for that metropolitan area. More than one maximum concentration site may be necessary in some areas. Other types of monitoring sites are needed to determine maximum population exposure, background concentrations, and concentrations being transported into an area (boundary conditions). In Delaware, New Castle County is part of the larger Philadelphia CSA, Kent County is covered by the Dover MSA, and Sussex County is part of the Salisbury MSA.

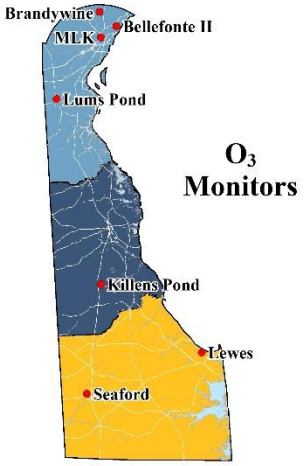
**Number of Ozone SLAMS Sites Required (based on Table D–2, Appendix D to 40 CFR Part 58, Ozone minimum monitoring requirements)**

| CSA/MSA Name | County in Delaware | Population | Delaware Monitors | Total Required Monitors |
|---|---|---|---|---|
| Philadelphia-Camden Wilmington, PA-NJ-DE-MD | New Castle | 6,018,800<br>538,479 | **4** | 3 |
| Dover, DE | Kent | 162.310 | **1** | 1 |
| Salisbury, MD-DE | Sussex | 381,868<br>197,145 | **2** | 1 |
| Total in DE | | | **7** | 4 |

The appropriate spatial scales for $O_3$ sites are neighborhood, urban, and regional. Since $O_3$ requires appreciable formation time, the mixing of reactants and products occurs over large volumes of air, and this reduces the importance of monitoring for small-scale spatial variability.

The prospective maximum concentration monitor site should be selected in a direction from the city that is most likely to observe the highest $O_3$ concentrations, more specifically, downwind during periods of photochemical activity. Since $O_3$ levels decrease significantly in the colder parts of the year in many areas, $O_3$ is required to be monitored only during the "ozone season" as designated in the 40 CFR Part 58 Appendix D, which in Delaware is March 1 through October 31.

Delaware operates seven ozone monitoring sites, including sites for population exposure, background concentrations, upwind and downwind directions for the Wilmington area, and NCore monitoring. Monitoring objectives for each site are included in the detailed site description section of this document. The monitors began operating year-round in 2011 although the official EPA ozone monitoring season for Delaware runs from April through October.




Hourly data is sent to the AirNow website to generate the daily Air Quality Index and to be used in mapping ozone concentrations throughout the region.

More detailed information on the $O_3$ standard and monitoring requirements can be found on the EPA website at: https://www.epa.gov/ground-level-ozone-pollution.

Operation of all ozone monitors in Delaware meets the requirements of 40 CFR Part 58 appendices A, C, D, and E as applicable.

***Ozone Design Values***

The table below shows the most recent (2018 – 2020) design value for each ozone monitor in Delaware. Ozone design values are calculated by taking the 3-year average of the annual 4th maximum daily maximum 8-hr ozone averages. The 8-hr ozone standard established in 2015 is 0.070 ppm.

**Ozone 8-hour design values in ppm, 2018 – 2020**

| Site | Design Value in ppm |
|---|---|
| Brandywine (BCSP) | 0.063* |
| Bellefonte II | 0.066 |
| Lums Pond | 0.065 |
| Killens Pond | 0.063 |
| Seaford | 0.063 |
| Lewes | 0.062 |
| MLK NCore | 0.067 |
| NAAQS | 0.070 |

* One or more years with less than 75% data completeness

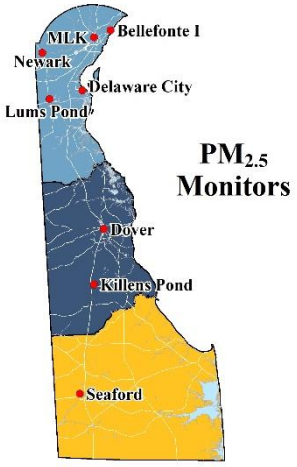
## Particulate Matter - Fine ($PM_{2.5}$)

The federal reference method (FRM) monitors for $PM_{2.5}$ operate by drawing air through a specially designed inlet that excludes particles larger than 2.5 microns in diameter. The particles are collected on a Teflon microfiber filter that is weighed to determine the particulate mass.

### *Monitoring Requirements*

State agencies must operate at least the minimum number of required $PM_{2.5}$ sites listed in 40 CFR Part 58 Appendix D Table D-5. These required monitoring stations or sites must be sited to represent community-wide air quality. In addition, the following specific criteria apply:

(1) At least one monitoring station is to be sited in a population-oriented area of expected maximum concentration.
(2) For areas with more than one required station, a monitoring station is to be sited in an area of poor air quality.
(3) Each State shall install and operate at least one $PM_{2.5}$ site to monitor for regional background and at least one $PM_{2.5}$ site to monitor regional transport.




**Number of $PM_{2.5}$ SLAMS Sites Required (based on Table D–5, Appendix D to 40 CFR Part 58, $PM_{2.5}$ minimum monitoring requirements)**

| MSA Name | County in Delaware | Population | Design Value Daily/Annual NAAQS: 35 / 12 | Delaware Monitors | Total Required Monitors |
|---|---|---|---|---|---|
| Philadelphia-Camden Wilmington, PA-NJ-DE-MD | | 6,018,800 | | | 3 |
| | New Castle | 538,479 | **19 / 7.6** | **4** | |
| Dover, DE | Kent | 162.310 | **15 / 7.0** | **2** | |
| Salisbury, MD-DE | | 381,868 | | | 0 |
| | Sussex | 197,145 | **16 / 7.0** | **1** | |
| Total in DE | | | | **7** | 3 |

Delaware operates more than the minimum number of required $PM_{2.5}$ monitors at seven sites throughout the state. All monitors operate year-round. There is one collocated site at MLK in Wilmington. The normal sampling schedule for the FRM manual method monitors is 24 hours every third day, however, at MLK samples are collected every day.

More detailed information on the PM and $PM_{2.5}$ standards and monitoring requirements can be found on the EPA website at: https://www.epa.gov/pm-pollution.

Operation of all $PM_{2.5}$ monitors in Delaware meets the requirements of 40 CFR Part 58 appendices A, C, D, and E as applicable.

***Continuous $PM_{2.5}$***

Delaware operates a designated FEM continuous $PM_{2.5}$ monitor for hourly and 24-hour data at the MLK, Lums Pond, Delaware City, Killens Pond, and Seaford sites. These monitors operate year-round and are collocated with an FRM $PM_{2.5}$ monitor at MLK and Lums Pond.

***Correlation of continuous $PM_{2.5}$ FEM data with collocated FRM data***:

Under the most recent revisions to the 40 CFR, Part 50, Appendix N data handling requirements, the data capture requirement for annual and daily Design Values is 75% of scheduled samples per quarter. "Creditable" data includes all $PM_{2.5}$ data from scheduled sampling days, valid make-ups and collocated suitable monitors. This data is acceptable for comparison to the annual and daily NAAQS and computations are based on a "combined site record". "Suitable" monitors are all monitors designated as either FRM or FEM. The $PM_{2.5}$ data from the designated primary monitor is therefore supplemented with the average of daily data from all collocated "suitable" monitors, including continuous FEM monitors, for any missing primary monitor days.

In 2019, Delaware began replacing $PM_{2.5}$ FRM manual method monitors with continuous $PM_{2.5}$ FEM monitors at some sites. The NCore site at MLK in Wilmington will continue to have both FRM and FEM monitors, with the FRM monitor designated as the primary monitor. In order to meet EPA 40 CFR Part 58 appendix A requirements for FEM primary monitor collocation, in 2019 the continuous FEM at Lums Pond was designated as the primary monitor and the FRM maintained at that site as the collocated monitor.

***$PM_{2.5}$ Design Values***

Below are the design values for $PM_{2.5}$ using 2018 - 2020 data. $PM_{2.5}$ annual design values are calculated using the 3-year average of the respective annual averages. The current annual $PM_{2.5}$ standard is 12 $\mu g/m^3$. $PM_{2.5}$ daily design values are calculated using the 3-year average of the annual 98$^{th}$ percentile values. The daily $PM_{2.5}$ standard is 35 $\mu g/m^3$.

| Site | Annual Design Value $\mu g/m^3$ | Daily Design Value $\mu g/m^3$ |
|---|---|---|
| Bellefonte I | 7.4 * | 17 * |
| MLK NCore | 7.6 | 19 |
| Newark | 7.1 * | 17 * |
| Delaware City (Rt 9) | 7.0 | 17 |
| Lums Pond | 7.4 | 17 |
| Dover | 5.7 * | 14 * |
| Killens Pond | 7.0 * | 15 * |
| Seaford | 7.0 | 16 |
| **NAAQS** | **12** | **35** |

* One or more years with less than 75% data completeness

Currently, all Delaware monitors are measuring attainment for both the annual and daily $PM_{2.5}$ standards.

### *$PM_{2.5}$ Chemical Speciation*

Chemical speciation is encouraged at sites where the chemically resolved data would be useful in developing State implementation plans and supporting atmospheric or health effects related studies. The sites in Delaware were established at MLK in Wilmington and Dover in Kent County.

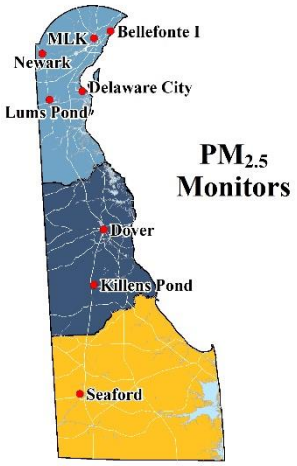
In 2014 EPA completed the process of assessing the national speciation network. The purpose of the assessment was to create a network that is sustainable going forward with the current situation of reduced federal funding by redistributing resources to new or high priorities from those of low-priority or low-benefit. As part of this process, EPA developed a scoring metric to identify existing speciation sites of lower value for defunding, and the Dover site was identified as low-value due to redundancy. Speciation monitoring at the Dover site therefore ended in 2014 in response to termination of support from the EPA. Speciation monitoring continues at the MLK site in Wilmington on a 1-in-three day schedule.

## Particulate Matter ($PM_{10}$)

$PM_{10}$ is sampled using the federal reference method (FRM) monitor similar to $PM_{2.5}$ that operates by drawing air through a specially designed inlet that excludes particles larger than 10 microns in diameter. The particles are collected on a Teflon microfiber filter that is weighed to determine the particulate mass.

### *Monitoring Requirements*

State, and where applicable local, agencies must operate the minimum number of required $PM_{10}$ monitoring sites listed in Table D-4 of 40 CFR Part 58 Appendix D. For the Philadelphia-Camden-Wilmington-Newark, PA-DE-MD MSA, the requirements are met by monitors installed in the Philadelphia urban area. No other $PM_{10}$ monitors are required in Delaware.




Although microscale monitoring may be appropriate in some circumstances, the most important spatial scales to effectively characterize the emissions of $PM_{10}$ from both mobile and stationary sources are the middle scales and neighborhood scales.

Delaware operates one $PM_{10}$ monitor at MLK in Wilmington to calculate the PMcoarse concentrations; therefore, the $PM_{10}$ data is reported at Local, not Standard, temperature and pressure for consistency with the $PM_{2.5}$ collocated data.

### *Particulate Matter (PMcoarse)*

PMcoarse is calculated as the difference between concentrations of $PM_{10}$ and $PM_{2.5}$ at collocated monitors. PMcoarse is part of the NCore monitoring at the Wilmington MLK site. Monitoring began on January 1, 2011. There are no ambient air quality standards for PMcoarse.

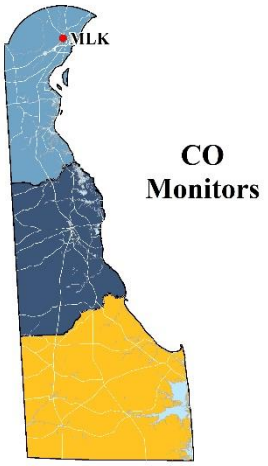
Operation of all $PM_{10}$ and PMcoarse monitors in Delaware meet the requirements of 40 CFR Part 58 appendices A, C, D, and E as applicable.

## Carbon Monoxide (CO)

Carbon monoxide is measured by infrared absorption photometry. Air is drawn continuously through a sample cell where infrared light passes through it. Carbon monoxide molecules in the air absorb part of the infrared light, reducing the intensity of the light reaching a light sensor. The light is converted into an electrical signal related to the concentration of carbon monoxide in the sample cell.

### *Monitoring Requirements*

EPA revised the minimum number of required CO monitoring sites on August 12, 2011. Since Delaware does not operate a near-road urban monitoring site with a population of 1 million or more and does not have a Photochemical Air Monitoring Site (PAMS), Delaware is only required to monitor CO at its urban NCore MLK monitoring site in Wilmington. For the larger Philadelphia-Camden-Wilmington-Newark, PA-DE-MD MSA, the requirements are met by monitors installed in the urban Philadelphia area.




More detailed information on the CO standards and monitoring requirements can be found on the EPA website at: https://www.epa.gov/co-pollution.

Operation of the CO monitor at the MLK site meets the requirements of 40 CFR Part 58 appendices A, C, D, and E as applicable. The CO values are well below the ambient standards and close to the minimum detectable limits of the monitor.

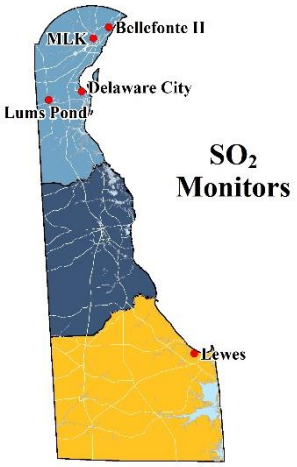
**Sulfur Dioxide ($SO_2$)**

Sulfur dioxide is measured with a fluorescence analyzer. Air is drawn through a sample cell where it is subjected to high intensity ultraviolet light. This causes the sulfur dioxide molecules in the air to fluoresce and release light. The fluorescence is detected with a photo multiplier tube and converted to an electrical signal proportional to the $SO_2$ concentration.

***Monitoring Requirements***

On June 2, 2010, EPA strengthened the primary National Ambient Air Quality Standard (NAAQS) for sulfur dioxide ($SO_2$). The primary $SO_2$ standard was revised by establishing a new 1-hour standard at a level of 75 parts per billion (ppb). The new form of the standard is the 3-year average of the 99$^{th}$ percentile of the annual distribution of daily maximum 1-hour average concentrations.

EPA also revised the ambient air monitoring requirements for $SO_2$. For Delaware, the new standard requires one additional monitoring site be established in Sussex County. This monitor fulfills the requirement for monitoring in the Sussex County portion of the Salisbury metropolitan statistical area (MSA).




On August 10, 2015, the U.S. Environmental Protection Agency initialized requirements for air agencies to monitor or model ambient sulfur dioxide ($SO_2$) levels in areas with large sources of $SO_2$ emissions to help implement the 1-hour $SO_2$ National Air Ambient Quality Standard (NAAQS). This final rule established that, at a minimum, air agencies must characterize air quality around sources that emit 2,000 tons per year (tpy) or more of $SO_2$. Delaware has determined that there are no sources within the state above this threshold emissions total.

EPA also made changes to data reporting requirements for $SO_2$. State and local agencies are now required to report two data values for every hour of monitoring conducted:

- the 1-hour average $SO_2$ concentration; and
- the maximum 5-minute block average $SO_2$ concentration of each hour.

More detailed information on the $SO_2$ standards and monitoring requirements can be found on the EPA website at: https://www.epa.gov/so2-pollution.

Delaware currently operates four $SO_2$ monitoring sites in New Castle County, which operate year-round. The fifth site in Sussex County became operational as a SPM in late summer 2012 and a SLAMS on January 1, 2013. Operation of all $SO_2$ monitors in Delaware meets the requirements of 40 CFR Part 58 appendices A, C, D, and E as applicable.

**$SO_2$ design values for 2018 – 2020: 3-year average of 99th percentile 1-hour averages**

| Site | Design Value in ppb |
|---|---|
| Bellefonte II | 4 * |
| MLK NCore | 8 |
| Delaware City (Rt 9) | 5 |
| Lums Pond | 3 |
| Lewes | 1 * |
| NAAQS | 75 |

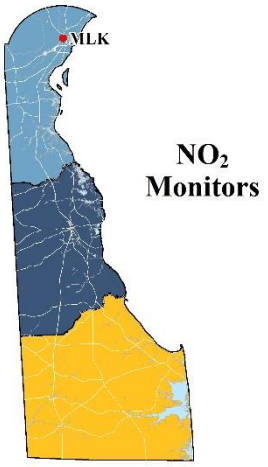
* One or more years with less than 75% data completeness

**Nitrogen Dioxide ($NO_2$)**

Nitrogen oxides are measured using the chemiluminescence reaction of nitric oxide (NO) with ozone ($O_3$). Air is drawn into a reaction chamber where it is mixed with a high concentration of ozone from an internal ozone generator. Any NO in the air reacts with the ozone to produce $NO_2$. Light emitted from this reaction is detected with a photo multiplier tube and converted to an electrical signal proportional to the NO concentration. $NO_2$ must be measured indirectly. $NO_X$ is measured by passing the air through a converter where any $NO_2$ in the air is reduced to NO before the air is passed to the reaction chamber. By alternately passing the air directly to the reaction chamber, and through the converter before the reaction chamber, the analyzer alternately measures NO and $NO_X$. The $NO_2$ concentration is equal to the difference between NO and $NO_X$.

***Monitoring Requirements***

On January 22, 2010, EPA strengthened the health-based National Ambient Air Quality Standard (NAAQS) for nitrogen dioxide ($NO_2$). EPA set a new 1-hour $NO_2$ standard at the level of 100 parts per billion (ppb). The form for the 1-hour $NO_2$ standard is the 3-year average of the 98th percentile of the annual distribution of daily maximum 1-hour average concentrations. EPA also retained, with no change, the current annual average $NO_2$ standard of 53 ppb.




On March 14, 2013, EPA published revised monitoring requirements for $NO_2$. Monitoring for $NO_2$ is now required at near road sites in CBSAs with populations greater than 500,000, in CBSAs with populations greater than 1 million, and at NCore sites. In accordance with the new rule, Delaware is required to monitor $NO_2$ only at its NCore MLK site in Wilmington. For the larger Philadelphia-Camden-Wilmington-Newark, PA-DE-MD MSA, the requirements are met by monitors installed by the Pennsylvania Department of Environmental Protection (PADEP).

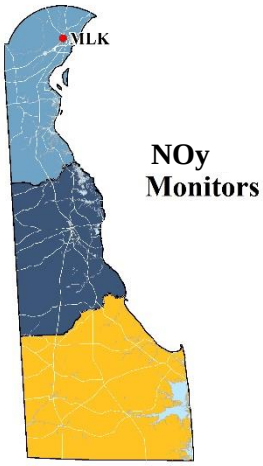
The 2018-2020 one-hour $NO_2$ design value based on the MLK monitor data is 42 ppb.

Operation of all $NO_2$ monitors in Delaware meets the requirements of 40 CFR Part 58 appendices A, C, D, and E as applicable.

More detailed information on the $NO_2$ standards and monitoring requirements can be found on the EPA website at: https://www.epa.gov/no2-pollution.

**Total Reactive Oxides of Nitrogen ($NO_Y$)**

Oxides of Nitrogen are measured using the chemiluminescence reaction of nitric oxide (NO) with ozone ($O_3$). Air is drawn into a reaction chamber where it is mixed with a high concentration of ozone from an internal ozone generator. Any NO in the air reacts with the ozone to produce $NO_2$. Light emitted from this reaction is detected with a photo multiplier tube and converted to an electrical signal proportional to the NO concentration. $NO_{(Diff)}$ must be measured indirectly. $NO_Y$ is measured by passing the air through a converter that is mounted 10 meters from ground level. Reactive Oxides of Nitrogen in the air are reduced to NO in the convertor before the air is passed to the reaction chamber. By alternately passing the air directly to the reaction chamber, and through the converter before the reaction chamber, the analyzer alternately measures NO and $NO_Y$. The $NO_{(Diff)}$ concentration is equal to the difference between NO and $NO_Y$.




On January 1, 2011 $NO_y$ monitoring began at the MLK site as part of the NCore program. Operation of all $NO_Y$ monitors in Delaware meets the requirements of 40 CFR Part 58 appendices A, C, D, and E as applicable.

There are no NAAQS for $NO_Y$.

## Air Toxics Pollutant Monitors

Toxic air pollutants, also called air toxics or hazardous air pollutants (HAPs) are pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects.

As part of the EPA Region III Cooperative Toxic Monitoring Program, Delaware operates one air toxic monitoring station to assess general urban levels. Toxics are sampled every sixth day year-round at the MLK site in Wilmington. The compounds measured are shown in the Monitoring Method table.

The two main classes of air toxics compounds currently monitored in Delaware are volatile organic compounds (VOCs) and heavy metals. VOC samples are collected for 24 hours in canisters with an evacuated canister sampler. The canisters are returned to the Maryland Department of the Environment laboratory for analysis on an Entech/Agilent gas chromatograph mass spectrometer system.

The heavy metals are collected for 24 hours on a total suspended particulate quartz filter, which is sent to the West Virginia Department of Environmental Protection laboratory for analysis using Inductively Coupled Plasma/Mass Spectrometry (ICP/MS). Results of the monitoring are submitted to the national Air Quality System (AQS) database.

Delaware previously included carbonyl monitoring as part of the EPA Region III program but monitoring ended in 2015 due to problems with data quality and aging monitoring equipment. Carbonyl sampling will be included as part of the PAMS Site implementation for 2022, see the next section for more details.

No changes to the program are planned for 2021.

## Photochemical Assessment Monitoring System (PAMS) Monitors

The Clean Air Act (CAA) of 1990, Section 182 (c)(1), required the EPA to promulgate rules for enhanced monitoring of $O_3$, NOx, and volatile organic compounds (VOCs) for $O_3$ nonattainment areas based on their classification with the goal of obtaining more comprehensive and representative data on $O_3$ air pollution.

The following information is taken (and condensed) from the document "PAMS Required Quality Assurance Implementation Plan", U.S. Environmental Protection Agency, October 2016.

In 2011, the EPA initiated an effort to re-evaluate the PAMS requirements in light of changes in the needs of PAMS data users and the improvements in monitoring technology. The EPA consulted with the Clean Air Science Advisory Committee (CASAC), Air Monitoring and Methods Subcommittee (AMMS) to seek advice on potential revisions to the technical and regulatory aspects of the PAMS program, including changes to required measurements and associated network design requirements. The EPA also requested advice on appropriate technology, sampling frequency, and overall program objectives in the context of the most recently revised O3 NAAQS and changes to atmospheric chemistry that have occurred over the previous 10 to 15 years in the significantly impacted areas.

Based on the findings of the PAMS evaluation and the consultations with the CASAC, AMMS, and National Association of Clean Air Agencies Monitoring Steering Committee (NACAA MSC), the EPA proposed to revise several aspects of the PAMS monitoring requirements. The current objective of the PAMS air monitoring program is to provide data to evaluate and support the development of air quality models and track trends in ozone precursor concentrations so as to aid ongoing efforts to attain the ozone NAAQS.

**Network Design** - The first part of the network design change involved EPA requiring PAMS measurements minimally during the PAMS (summer) sampling season, which is June 1 through August 31, at all NCore sites in Core-Based Statistical Areas (CBSAs) with a population of 1,000,000 people or more. The final network design will result in approximately 40 "Required" PAMS sites,

The new regulations specify that the following parameters will be measured at PAMS Required sites:

- **Volatile organic compounds (VOCs) –** It is strongly suggested that all Required PAMS sites take hourly speciated VOC measurements with auto-gas chromatographs (GCs).
- **Carbonyls -** All Required PAMS sites will conduct carbonyl sampling with a frequency of three 8-hour samples on a one-in-three-day basis (~90 samples per PAMS sampling season).
- **Nitrogen Oxides -** All Required PAMS sites must monitor for NO and NOy (total oxides of nitrogen) in addition to true direct reading $NO_2$, where the latter must be measured with a cavity attenuated phase shift (CAPS) spectroscopy direct-reading $NO_2$ instrument or a photolytic-converter NOx analyzer.
- **Meteorology Measurements -** All Required PAMS sites must measure wind speed and direction, temperature, humidity, atmospheric pressure, precipitation, solar radiation, ultraviolet radiation, and mixing height. A ceilometer will be used to determine the height of a cloud ceiling or cloud base (mixing height).

As part of the Philadelphia CBSA and OTR Delaware is required to establish a PAMS site at the NCore site in Wilmington (MLK AQS ID 10-003-2004). As part of the PAMS network, the following measurements are required:

1. Hourly speciated VOC measurements with auto-GCs
2. Carbonyl sampling (three 8-hour samples on a one-in-three-day sampling frequency)
3. NO, true direct reading $NO_2$, and NOy measurements
4. Surface meteorology measurements including mixing height

Based on 40 CFR part 58, Appendix D, state air monitoring agencies are required to begin making PAMS measurements at their NCore location(s) by the amended June 1, 2021 date (Extension granted 12/20/2019). Due to impacts from COVID-19 lockdown DE DAQ has had to delay 2021 implementation. DE DAQ is working closely with the EPA to ensure plans to begin making PAMS measurements at the MLK NCore location can be met by June 1, 2022.

Planned equipment is included in Appendix A. Purchasing of equipment began in 2017 and is continuing as funding becomes available.

## **Enhanced Monitoring Program (EMP) -** for OTR states

EPA developed a Technical Note "Guidance for Photochemical Assessment Monitoring Stations (PAMS) Required Network Implementation Plans and Enhanced Monitoring Plans (EMPs)" that recommends monitoring organizations submit the EMP by July 1, 2018 along with the annual network plan. The actual regulatory requirement for EMP contained in 50CFR58, Appendix D.5(h) states that "the EMP shall be submitted to the EPA Regional Administrator no later than October 1, 2019" for states in the Ozone Transport Region.

In recognition of EPAs guidance recommending an earlier EMP submittal DE is proposing the following measurements be considered basic elements of the required EMP:

- Year-round $NO_2$ monitoring either via NOx or true direct reading $NO_2$ monitors at the Lewes site beginning in 2021.

Collection and reporting of these measurements will be contingent on receipt of sufficient additional EPA funding directed specifically towards these EMP activities.

# Summary of Changes

## Changes from 2020

Mandatory lockdowns and work-from-home orders as a response to COVID-19 began in March of 2020. As a result, implementation of planned network changes from the 2020 plan were delayed. Shipments of equipment, parts, on-site maintenance contracts, were all impacted over the course of the year and into 2021.

Following are the changes to the monitoring network in 2020:

- No site changes from 2020.
- Monitor changes:
    - FEM $PM_{2.5}$ T640 Monitor installed at Newark site and is undergoing evaluation
    - FRM $PM_{2.5}$ 2025i Monitor installed (Purchased 2020, installed early 2021) at Lums Pond to replace aging monitor to fulfill collocation requirements.

## Changes anticipated for 2021-2022

Following are the changes anticipated to occur in 2021:

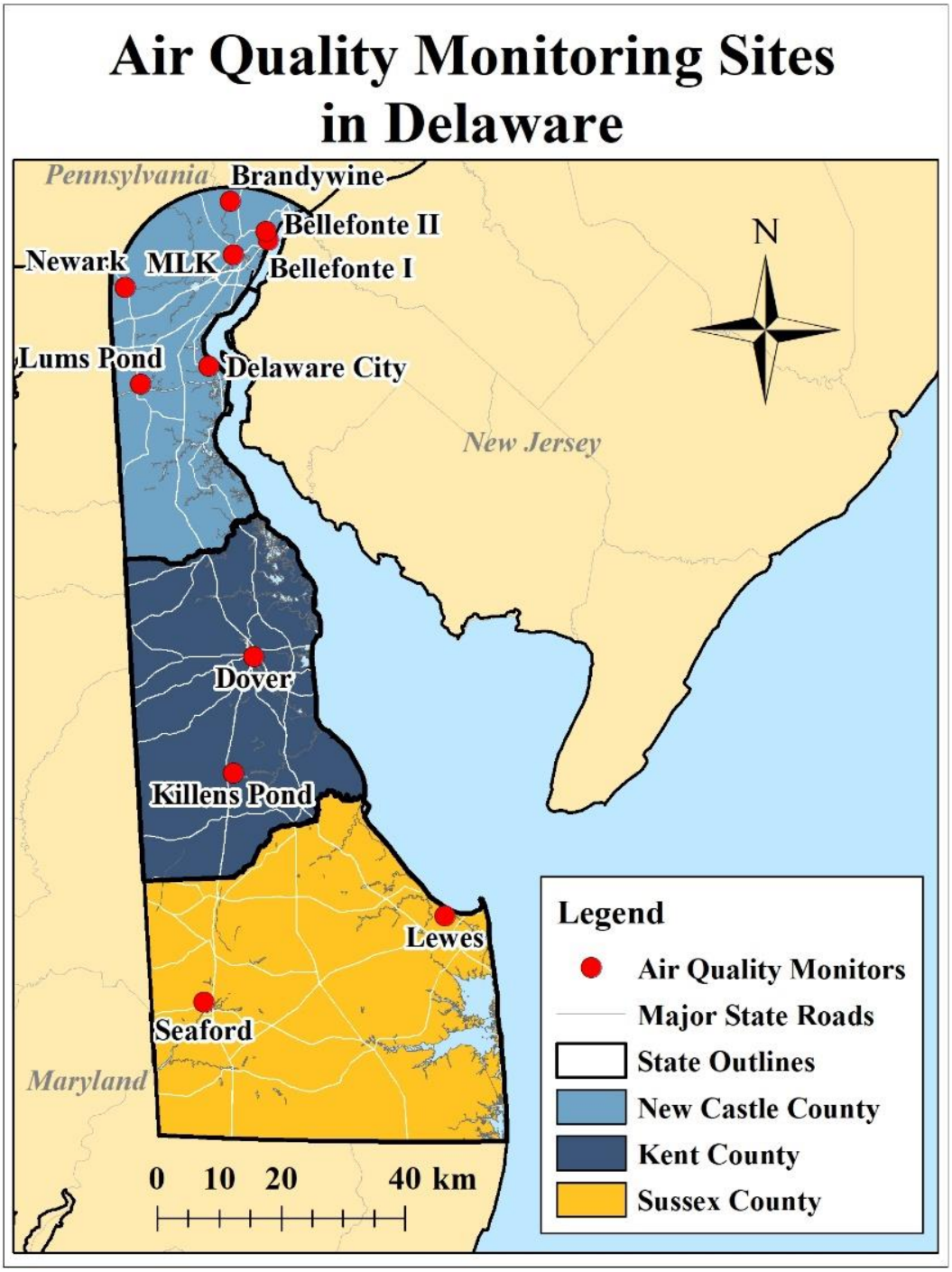
- Delaware plans to replace the FRM $PM_{2.5}$ monitors with new continuous FEM monitors (Teledyne API T640 at 5.0 lpm) at the stand-alone FRM monitor sites:
    - Bellefonte 10-003-1003
    - Newark 10-003-1012
    - Dover 10-001-0003

Monitors will be replaced when funding becomes available for the stand-alone monitor enclosures, data acquisition systems, wireless modem communications, and once testing is completed.

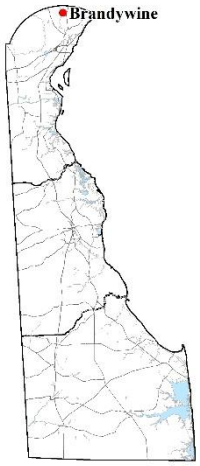
Delaware will continue to comply with all relevant EPA collocation, siting and data handling requirements for the new FEM continuous monitors. FRM monitoring will continue at the NCore site at MLK site 10-003-2004 in Wilmington and the Lums Pond monitoring site 10-003-1007.

## Detailed Site Descriptions

The following pages contain additional site-specific information on all active SLAMS monitoring sites in Delaware.



# Site: Brandywine (BCSP)




**AQS Site ID:** 10-003-1010
**State:** Delaware
**County:** New Castle
**Address:** Brandywine Creek State Park, Wilmington

**Latitude:** 39.8172
**Longitude:** -75.5639

**Spatial Scale:** Neighborhood
**Area Represented:** Philadelphia-Camden-Wilmington,
**(MSA)** PA-NJ-DE-MD

**Year Established:** 1994

**Monitored Parameters**

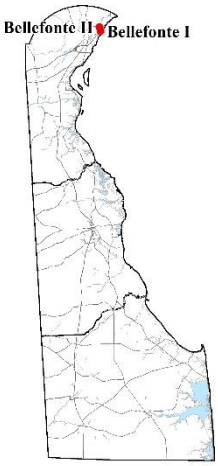
| | |
|---|---|
| **$O_3$** | Ozone |
| **WS / WD** | Wind Speed & Direction |
| **T / Rh** | Temperature & Relative Humidity |

**Site Description**
The Brandywine site is located in Brandywine Creek State Park and was established when a secondary downwind site in Claymont was discontinued due to changes in nearby land use and ownership. This is a neighborhood scale site for $O_3$ monitoring. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

**Monitoring Objectives**
Population exposure, maximum concentration, $O_3$ NAAQS compliance, and trends.

**Planned Changes through 2021**
No changes planned.

# Site: Bellefonte I (Platform) & II




**AQS Site ID:** BF I – 10-003-1003
BF II – 10-003-1013
**State:** Delaware
**County:** New Castle
**Address:** BF I – River Road Park
BF II – Bellevue State Park

**Latitude:** BF I – 39.7613
BF II – 39.7739
**Longitude:** BF I – -75.4920
BF II – -75.4965

**Spatial Scale:** Neighborhood
**Area Represented:** Philadelphia-Camden-Wilmington,
**(MSA)** PA-NJ-DE-MD

**Year Established:** BF I – 1969
BF II – 2001

← Bellefonte II

↓ Bellefonte I

**Monitored Parameters**

| | | |
|---|---|---|
| **Bellefonte I** | **$PM_{2.5}$** | Particulate Matter: 24-hour (Microns < 2.5) |
| **Bellefonte II** | **$O_3$** | Ozone |
| | **$SO_2$** | Sulfur Dioxide |

**Site Description**

Bellefonte was originally established in 1969 to monitor $O_3$ (primary downwind direction from Wilmington) and $SO_2$. $PM_{2.5}$ was added in 1999. When changing site characteristics began to interfere with ozone monitoring, a new site (Bellefonte II) was established in 2001, less than a mile to the north. The $O_3$ and $SO_2$ monitors were relocated to the new site, while the $PM_{2.5}$ monitor remained at the original site to provide data continuity. Both sites meet all EPA 40 CFR Part 58 App D and E siting criteria.

**Monitoring Objectives**

Monitoring objectives are NAAQS compliance, population exposures, and trends. Bellefonte II is the $O_3$ maximum downwind concentration site for Wilmington. The $SO_2$ monitor is sited for general population exposure and trends, with major point sources located to the northeast in Marcus Hook, PA and to the south in Edgemoor.

**Planned Changes through 2021**

Replace existing $PM_{2.5}$ FRM with new $PM_{2.5}$ FEM at Bellefonte I when resources become available.

# Site: MLK NCore (Wilmington)

**AQS Site ID:** 10-003-2004
**State:** Delaware
**County:** New Castle
**Address:** Justison St. & MLK Blvd., Wilmington

**Latitude:** 39.7395
**Longitude:** -75.5575

**Spatial Scale:** Neighborhood
**Area Represented:** Philadelphia-Camden-Wilmington,
**(MSA)** PA-NJ-DE-MD

**Year Established:** 1999

**Monitored Parameters**

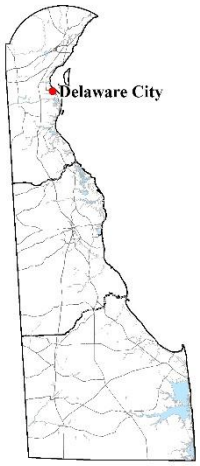
| | |
|---|---|
| **$O_3$** | Ozone |
| **$SO_2$** | Sulfur Dioxide |
| **CO** | Carbon Monoxide |
| **$NO_2$** | Nitrogen Dioxide |
| **$NO_y$** | Total Reactive Oxides of Nitrogen |
| **$PM_{2.5}$, $PM_{10}$, $PM_{10\text{-}2.5}$** | Particulate Matter: Hourly & 24-hour (Microns < 2.5, 10, & Coarse =10-2.5) |
| **$PM_{2.5}$ Spec.** | Particulate Matter 2.5 Speciation |
| **WS / WD** | Wind Speed & Direction |
| **T / Rh** | Temperature & Relative Humidity |

**Site Description**
The MLK site is within the city of Wilmington, DE at the intersection of Justison St. and MLK Blvd. It replaced another urban site at 12th and King Streets that had operated at that location for over 20 years and was discontinued due to a change in land ownership. The MLK site is the state National Core (NCore) site and represents urban population exposure to multiple pollution sources. This site meets all EPA 40 CFR Part 58 App D and E siting criteria

**Monitoring Objectives**
Population exposure, maximum concentration, NAAQS compliance, NCore, and trends.

**Planned Changes through 2021**
Implementation of the PAMS program by summer of 2022 will require additional equipment including: PAMS Auto GC, Carbonyl Sampler, Ceilometer, Pyrometer, and Tipping Bucket Rain Gauge.

# Site: Delaware City (Rt 9)




**AQS Site ID:** 10-003-1008
**State:** Delaware
**County:** New Castle
**Address:** Route 9, Delaware City

**Latitude:** 39.5777
**Longitude:** -75.6306

**Spatial Scale:** Neighborhood
**Area Represented:** Philadelphia-Camden-Wilmington,
**(MSA)** PA-NJ-DE-MD

**Year Established:** 1992

**Monitored Parameters**

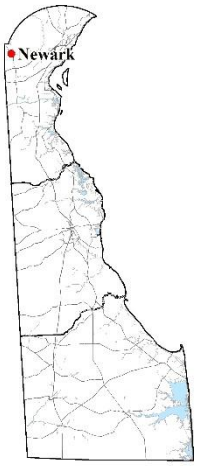
| | |
|---|---|
| **$SO_2$** | Sulfur Dioxide |
| **$PM_{2.5}$** | Particulate Matter: Hourly (Microns < 2.5) |
| **WS / WD** | Wind Speed & Direction |
| **T / Rh** | Temperature & Relative Humidity |

**Site Description**
The Delaware City site was established at a location along Route 9 that is between the Delaware City industrial complex and the nearest populated area (Delaware City) in the predominant downwind direction. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

**Monitoring Objectives**
This monitoring site is a stationary source-impacted site for $SO_2$. The monitoring objectives are population exposure, compliance with the NAAQS, and trends.

**Planned Changes through 2021**
No changes planned.

# Site: Newark (Platform)




**AQS Site ID:** 10-003-1012
**State:** Delaware
**County:** New Castle
**Address:** University of Delaware North Campus, Newark

**Latitude:** 39.6916
**Longitude:** -75.7617

**Spatial Scale:** Neighborhood
**Area Represented:** Philadelphia-Camden-Wilmington,
**(MSA)** PA-NJ-DE-MD

**Year Established:** 1999

**Monitored Parameters**

**$PM_{2.5}$** Particulate Matter: 24-hour (Microns < 2.5)

**Site Description**

The Newark site is a platform only and was established to understand $PM_{2.5}$ concentrations in the Newark area and potentially transported $PM_{2.5}$ from upwind areas to the west. It is a $PM_{2.5}$ neighborhood scale site. The location is suburban and generally impacted by mobile sources and regional transport. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

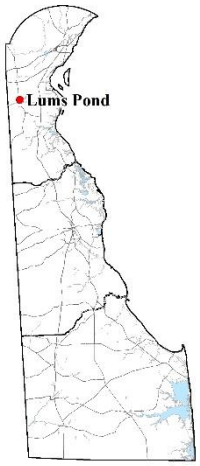
**Monitoring Objectives**

Population exposure, $PM_{2.5}$ NAAQS compliance, regional transport, and trends.

**Planned Changes through 2021**

Replace existing $PM_{2.5}$ FRM with new $PM_{2.5}$ FEM when testing is complete.

# Site: Lums Pond




**AQS Site ID:** 10-003-1007
**State:** Delaware
**County:** New Castle
**Address:** Lums Pond State Park, Bear

**Latitude:** 39.5513
**Longitude:** -75.7320

**Spatial Scale:** Urban
**Area Represented: (MSA)** Not in and urban area

**Year Established:** 1991

**Monitored Parameters**

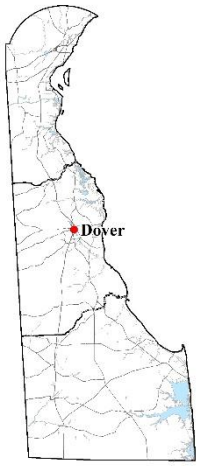
| | |
|---|---|
| **$O_3$** | Ozone |
| **$SO_2$** | Sulfur Dioxide |
| **$PM_{2.5}$** | Particulate Matter: Hourly & 24-hour (Microns < 2.5) |
| **WS / WD** | Wind Speed & Direction |
| **T / Rh** | Temperature & Relative Humidity |

**Site Description**
The Lums Pond site was originally neighborhood scale located in a general upwind direction from Wilmington. The scale of representation was changed to Urban (4 – 50 km) to reflect the background and transport monitoring objectives. The immediate area is rural. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

**Monitoring Objectives**
The site objectives for $O_3$ are upwind background for the Wilmington area, population exposure, NAAQS compliance, and trends. This site was originally planned to monitor $O_3$ transported into Delaware from the Baltimore/Washington area, and continues to serve this purpose. The $SO_2$ monitor was added in 2000 to detect impacts from major point sources directly to the east. $PM_{2.5}$ monitoring began in 1999 as both a regional transport and general population exposure site, as well as for NAAQS compliance.

**Planned Changes through 2021**
No changes planned.

# Site: Dover (Platform)

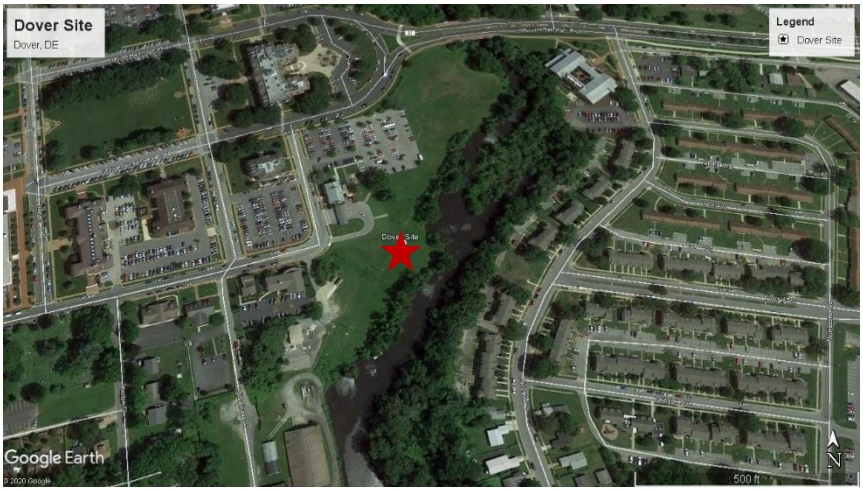



**AQS Site ID:** 10-001-0003
**State:** Delaware
**County:** Kent
**Address:** Water St., Dover

**Latitude:** 39.1556
**Longitude:** -75.5182

**Spatial Scale:** Neighborhood
**Area Represented:** Dover
**(MSA)** DE

**Year Established:** 1999



**Monitored Parameters**

**$PM_{2.5}$** Particulate Matter: 24-hour (Microns < 2.5)

**Site Description**

The Dover site is a platform only and was established to understand fine particulate concentrations in the Dover area. It is a neighborhood scale site representative of the Dover MSA impacted by a combination of source types including mobile, large and small point sources. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

**Monitoring Objectives**

Population exposure, $PM_{2.5}$ NAAQS compliance, and trends.

**Planned Changes through 2021**

Replace existing $PM_{2.5}$ FRM with new $PM_{2.5}$ FEM when resources become available.

# Site: Killens Pond

**AQS Site ID:** 10-001-0002
**State:** Delaware
**County:** Kent
**Address:** Killens Pond State Park, Felton

**Latitude:** 38.9867
**Longitude:** -75.5568

**Spatial Scale:** Urban
**Area Represented:** Not in an urban area
**(MSA)**

**Year Established:** 1995

**Monitored Parameters**

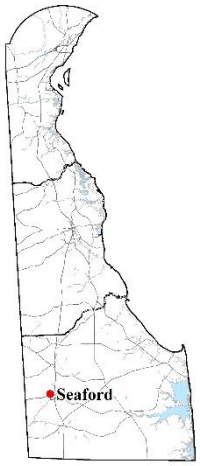
| | |
|---|---|
| **$O_3$** | Ozone |
| **$PM_{2.5}$** | Particulate Matter: Hourly (Microns < 2.5) |
| **WS / WD** | Wind Speed & Direction |

**Site Description**
The Killens Pond site is located in a rural area that is part of Killens Pond State Park. It was established to understand background concentrations of $O_3$ and $PM_{2.5}$. The scale of representation was changed to Urban (4 – 50 km) to reflect the background monitoring objective. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

**Monitoring Objectives**
Background concentrations, NAAQS compliance, and trends.

**Planned Changes through 2021**
No changes planned.

# Site: Seaford




**AQS Site ID:** 10-005-1002
**State:** Delaware
**County:** Sussex
**Address:** 350 Virginia Ave., Seaford

**Latitude:** 38.6539
**Longitude:** -75.6106

**Spatial Scale:** Neighborhood
**Area Represented:** Salisbury,
**(MSA)** MD-DE

**Year Established:** 1990

**Monitored Parameters**

| | |
|---|---|
| **$O_3$** | Ozone |
| **$PM_{2.5}$** | Particulate Matter: Hourly (Microns < 2.5) |
| **WS / WD** | Wind Speed & Direction |

**Site Description**

The Seaford site was originally located to monitor pollutant concentrations in the Seaford area. The original site was located further south, near the Seaford water tower. It was relocated to the present location in 1990 due to deteriorating conditions at the original site. The current site is neighborhood scale and is suburban. The site is impacted by local point sources, mobile sources, and regional transport. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

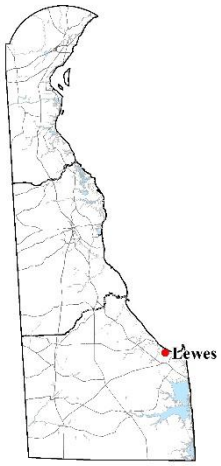
**Monitoring Objectives**

Population exposure, NAAQS compliance, and trends.

**Planned Changes through 2021**

No changes planned.

# Site: Lewes




**AQS Site ID:** 10-005-1003
**State:** Delaware
**County:** Sussex
**Address:** University of Delaware: College of Earth, Ocean, & Environment - Hugh R. Sharp Campus, Lewes
**Latitude:** 38.7791
**Longitude:** -75.1632

**Spatial Scale:** Neighborhood
**Area Represented:** Salisbury,
**(MSA)** MD-DE

**Year Established:** 1991

## Monitored Parameters

| | |
|---|---|
| **$O_3$** | Ozone |
| **$SO_2$** | Sulfur Dioxide |
| **WS / WD** | Wind Speed & Direction |
| **T / Rh** | Temperature & Relative Humidity |

## Site Description

The Lewes site is neighborhood scale established to understand $O_3$ concentrations in the coastal area where population increases significantly in the summer months. $SO_2$ was added in 2012 in response to the new $SO_2$ NAAQS monitoring requirements. It is representative of the coastal Sussex County area. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

## Monitoring Objectives

Population exposure, NAAQS compliance, and trends.

## Planned Changes through 2021

No changes planned. A $NO_2$ monitor will be added as part of EMP when implemented.

# Monitoring method information

## List of Monitor Methods & AQS Codes

Monitoring methods and associated AQS codes used in the Delaware ambient air monitoring network:

| Parameter AQS code | AQS Method Code | Method Description/ Analysis Method |
|---|---|---|
| $O_3$ - 44201 | 047 – TE 49i<br>087 – TAPI T400 Teledyne | UV Absorption |
| $SO_2$ - 42401 | 560 - TE 43i-TLE | UV Fluorescence |
| CO - 42101 | 554 – TE 48i-TLE<br>593 – TAPI Trace CO | Non-dispersive Infrared |
| $NO_2$ - 42602 | 574 – TE 42i-TL<br>599 –TAPI T200 NO, NOx<br>600 –TAPI T200 $NO_2$<br>256 - TAPI N500 $NO_2$ | Chemiluminescence<br><br>Cavity Attenuated Phase Shift (CAPS) Spectroscopy |
| NOy - 42600 | 674 – TE 42i-Y NOy | Chemiluminescence |
| $PM_{2.5}$ - 88101 | 145 – TE Partisol 2025 VSCC Inlet<br>236 – TAPI T640 (continuous) | Gravimetric<br>Continuous broadband spectroscopy |
| *$PM_{2.5}$ Speciation – Ions | 812 – Met One SASS | Nylon filter, Ion chromatography |
| *$PM_{2.5}$ Speciation – Metals | 811 – Met One SASS | Teflon filter, energy dispersive XRF |
| *$PM_{2.5}$ Speciation – Carbon | 839 – URG 3000N | Quartz filer and cyclone inlet; IMPROVE carbon Thermal Optical Reflectance (TOR) analysis method |
| $PM_{10}$ – 85101 local conditions | 127 – TE Partisol 2025 Sequential | Gravimetric |
| PMcoarse – 86101 PM10-2.5 local conditions | 176 – TE Partisol 2025 Sequential Pair | Calculated from paired samplers |
| *Air Toxics – VOCs* | 150 – SS 6L – Pressurized Canister | Cryogenic pre-concentration: GC/MS |
| *Air Toxics – Metals | 089 – High-Volume TSP | ICP/MS Quartz filters |
| WS – 61103<br>WD - 61104 | 020 – Vaisala vector method | Ultrasonic |

* Multiple parameters in this group; see next table for list of compounds.

Parameters with multiple compounds.
Note that all parameter codes can be found online:
https://aqs.epa.gov/aqsweb/documents/codetables/methods_all.html

| Group | Compounds |
|---|---|
| VOCs | Dichlorodifluoromethane, Chloromethane, 1,2-Dichloro-1,1,2,2,tetrafluoroleth, Chloroethene, 1,3-Butadiene, Trichlorofluoromethane, Acetone, Methylene Chloride, 1,1,2-Trichloro-1,2,2-trifluoroethane, 2-methoxy-2-methyl-Propane, Hexane, Chloroform, Tetrahydrofuran, 1,2-Dichloroethane, 1,1,1-Trichloroethane, Benzene, Carbon tetrachloride, Cyclohexane, 1,2-Dichloropropane, Trichloroethene, Heptane, Cis-1,3-Dichloro-1-Propene, Trans-1,3-Dichloro-1-Propene, Toluene, 1,2-Dibromoethane, Tetrachloroethylene, Chlorobenzene, Ethylbenzene, m & p-Xylene, Styrene, 1,1,2,2-Tetrachloroethane, o-Xylene, 1-Ethyl-4-Methylbenzene, 1,3,5-Trimethylbenzene, 1,2,4-Trimethylbenzene, 1,4-Dichlorobenzene |
| Metals | Arsenic (12103), Cadmium (12110), Chromium (12112), Lead (12128), Manganese (12132), Nickel (12136) |
| $PM_{2.5}$ Speciation | Ions:<br>Ammonium, Nitrate, Sulfate, Potassium, Sodium<br><br>Carbon:<br>Elemental carbon (E1 IMPROVE, E2 IMPROVE, E3 IMPROVE, EC IMPROVE TOR, EC IMPROVE TOT) Organic carbon (O1 IMPROVE, O2 IMPROVE, O3 IMPROVE, O4 IMPROVE, OC IMPROVE TOR, OC IMPROVE TOT, OP IMPROVE TOR), OP IMPROVE TOT, TC IMPROVE<br><br>Elements:<br>Aluminum, Antimony, Arsenic, Barium, Bromine, Cadmium, Calcium, Cerium, Cesium, Chlorine, Chromium, Cobalt, Copper, Europium, Gallium, Gold, Hafnium, Indium, Iridium, Iron, Lanthanum, Lead, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Niobium, Phosphorus, Potassium, Rubidium, Samarium, Scandium, Selenium, Silicon, Silver, Sodium, Strontium, Sulfur, Tantalum, Terbium, Tin, Titanium, Vanadium, Wolfram, Yttrium, Zinc, and Zirconium |

**Ozone ($O_3$)**
Ozone is measured by ultraviolet absorption photometry. Air is drawn through a sample cell where ultraviolet light (254 nm wavelength) passes through it. Light not absorbed by the ozone is converted into an electrical signal proportional to the ozone concentration.

**Sulfur Dioxide ($SO_2$)**
Sulfur dioxide is measured with a fluorescence analyzer. Air is drawn through a sample cell where it is subjected to high intensity ultraviolet light. This causes the sulfur dioxide molecules in the air to fluoresce and release light. The fluorescence is detected with a photo multiplier tube and converted to an electrical signal proportional to the $SO_2$ concentration.

**Carbon Monoxide (CO)**
Carbon monoxide is measured by infrared absorption photometry. Air is drawn continuously through a sample cell where infrared light passes through it. Carbon monoxide molecules in the air absorb part of the infrared light, reducing the intensity of the light reaching a light sensor. The light is converted into an electrical signal related to the concentration of carbon monoxide in the sample cell.

**Nitrogen Dioxide ($NO_2$)**

- **Chemiluminescence Reaction**
  Nitrogen oxides are measured using the chemiluminescence reaction of NO with $O_3$. Air is drawn into a reaction chamber where it is mixed with a high concentration of ozone from an internal ozone generator. Any NO in the air reacts with the ozone to produce $NO_2$. Light emitted from this reaction is detected with a photo multiplier tube and converted to an electrical signal proportional to the NO concentration. $NO_2$ must be measured indirectly.

  $NO_2$ is measured by passing the air through a converter where any $NO_2$ in the air is reduced to NO before the air is passed to the reaction chamber. By alternately passing the air directly to the reaction chamber, and through the converter before the reaction chamber, the analyzer alternately measures NO and $NO_X$. The $NO_2$ concentration is equal to the difference between NO and $NO_X$.

- **Cavity Attenuated Phase Shift Spectroscopy (CAPS)**
  Ambient air is drawn into the true $NO_2$ analyzer inlet with a vacuum pump. Particulates are removed to prevent deposition of particulate matter (PM) on the analyzer optics. The particulate scrubbed air then enters the sample cell, which includes highly reflective mirrors to produce a considerable path length within the cell. $NO_2$ in the sampled atmosphere absorbs light at 450 nm. Rather than a traditional absorbance method, where a reduction in intensity of the light to the detector is proportional to concentration, a CAPS monitor uses the average time spent in the cell by the 450-nm light to quantify the $NO_2$ concentration in the cell. The presence of $NO_2$ in the cell causes the average time to decrease as the $NO_2$ concentration increases – due to the absorption. This reduction in time spent in the cell by the 450 nm light absorbed is proportional to the concentration of $NO_2$ in the sampled atmosphere.

**Total Reactive Oxides of Nitrogen (NOy)**
NOy is measured by the same method as NOx with the exception that the converter is at the

sample inlet mounted 10 meters above ground level instead of at the instrument's reaction chamber. This position is used because the NOy compounds are too unstable to be measured when taken in through the entire length of the typical ambient air sampling inlet system. Placing the converter at the inlet allows the catalytic reaction to convert most of the NOy species (approximately 30 nitroxyl compounds) to NO very close to the point where ambient air is sampled. The more stable NO can then be detected as described previously.

**Particulate Matter - Fine ($PM_{2.5}$), $PM_{10}$, and PMcoarse**

$PM_{2.5}$ is sampled by drawing air through a specially designed inlet that excludes particles larger than 2.5 microns in diameter. The particles are collected on a Teflon7 microfiber filter that is weighed to determine the particulate mass. The normal sampling schedule is 24 hours every third day, however, at one site (Wilmington-MLK) $PM_{2.5}$ samples are collected for 24 hours every day.

$PM_{2.5}$ with the Teledyne T640 continuously measures particulate mass using a light-scattering spectroscopy method.

$PM_{10}$ samples are collected using the same general method as $PM_{2.5}$ with a specially designed inlet that excludes particles larger than 10 microns in diameter. Samples are collected every third day.

PMcoarse is calculated by subtracting the $PM_{2.5}$ concentration from the collocated $PM_{10}$ concentration for the same day.

**$PM_{2.5}$ Speciation**

Some of the gravimetric $PM_{2.5}$ monitors are specially equipped to collect $PM_{2.5}$ samples which are later analyzed into concentrations of the samples' chemical constituents or species. MetOne Super SAAS samplers and URG 3000N samplers are used for the collection of samples for the chemical speciation of $PM_{2.5}$. The samplers collect 3 samples simultaneously every third day for a period of 24 hours. These samples are then sent to an EPA contract laboratory for chemical analyses. There are over 50 species consisting of ions, elements, and carbon species quantified by the analyses.

**VOCs**

Air toxics samples are collected for 24 hours in canisters with an ATEC 2200 canister sampler on a one in sixth day schedule. A duplicate sample is collected every one-in-twelve days. The canisters are returned to the Maryland Department of the Environment laboratory for analysis on an Entech/Agilent gas chromatograph mass spectrometer system.

**Metals**

Metals are collected for 24 hours with a high-volume TSP sampler on a quartz filter. The filter is sent to the West Virginia Division of Air Quality laboratory for analysis using ICP/MS.

# Appendix A

## PAMS Monitoring Implementation Network Plan - Delaware

Delaware Division of Air Quality (DAQ) plans to operate one Photochemical Assessment Monitoring Stations (PAMS) site in the air monitoring network in 2022, at the Delaware NCore MLK site in Wilmington in accordance with the recently revised monitoring rule (80 FR 65292; October 26, 2015) which requires PAMS measurements June 1 through August 31 at NCore sites that are located in Core-Based Statistical Areas (CBSAs) with populations of 1,000,000 or more.

**Network Decision**

☐ The NCore site located at MLK site id 10-003-2004 will serve as the location of the required PAMS site and will measure the following parameters described below. An Inventory of equipment used at the site is provided in Attachment **1.**

☐ ~~We request a waiver from implementing PAMS at an otherwise required NCore site entirely, or to make PAMS measurements at alternative locations such as existing PAMS sites or existing NATTS sites. Rationale for this waiver is provided in Waiver attachment~~

**Auto GC Decision**

**Volatile organic compounds (VOCs) –** A complete list of the targeted compounds are found in Table 1.

☐ We will measure hourly speciated VOC measurements with an auto-gas chromatograph (GC) using the Consolidated Analytical Systems integrated Chromatotec AirmOzone Auto-Gas Chromatograph with Flame Ionization Detection (Auto-GC-FID).

☐ ~~We request a waiver to allow three 8-hour samples every third day as an alternative to daily hourly speciated VOC measurements at locations *(insert locations)*. Rationale for this waiver is provided in Waiver Attachment~~

**Meteorology Measurements Decision – Note: EPA is suggesting the use of ceilometers for determining mixing height, however other types of meteorological equipment that provide for an indication of mixing height can be proposed**

☐ Will measure wind direction, wind speed, temperature, humidity, atmospheric pressure, precipitation, solar radiation, ultraviolet radiation, and mixing height. We have elected to use the following instrumentation to measure the parameters described above: *Vaisala WXT620 – WS/WD, Tem, Humidity, Pressure, Precipitation*
*Vaisala CL51 – Mixing Height*
*Kipp & Zonen SUV5-V Smart Broadband UV– UV Radiation*
*Kipp & Zonen SMP10-V Smart Pyranometer – Solar Radiation*
*RM Young 52202 – Tipping rain gauge*

☐ ~~We request a waiver to allow meteorological measurements to be obtained from other nearby sites. Rationale for this waiver is provided in Waiver attachment~~

**Other Required Measurements**

- **Carbonyls -** Carbonyl sampling at a frequency of three 8-hour samples on a one-in-three day basis (~90 samples per PAMS sampling season) using *ATEC Model 8000-2 Eight Port Carbonyl Sampler with additional Duplicate Channel*. A complete list of the target carbonyl compounds may be found in Table 1. The TO-11A test method, as used in the National Air Toxics Trends (NATTS) program[1] will be used.
- **Nitrogen Oxides –** Will monitor for NO and $NO_y$ (total oxides of nitrogen) in addition to true $NO_2$. The true $NO_2$ is required to be measured with a direct reading $NO_2$ analyzer, cavity attenuated phase shift (CAPS) spectroscopy or photolytic-converter $NO_x$ analyzer. We have elected to use a Teledyne Model *N500 CAPS $NO_2$* Analyzer for the true $NO_2$ measurement. NO and NOy will be measured using a *Thermo Environmental Instruments 42i-Y Chemiluminescent analyzer.*

**Table 1: PAMS Target Compound List**

| Priority Compounds | | | | Optional Compounds | | | |
|---|---|---|---|---|---|---|---|
| 1 | 1,2,3-trimethylbenzene [a] | 19 | n-hexane [b] | 1 | 1,3,5-trimethylbenzene | 19 | m-diethlybenzene |
| 2 | 1,2,4-trimethylbenzene [a] | 20 | n-pentane | 2 | 1-pentene | 20 | methylcyclohexane |
| 3 | 1-butene | 21 | o-ethyltoluene [a] | 3 | 2,2-dimethylbutane | 21 | methylcyclopentane |
| 4 | 2,2,4-trimethylpentane [b] | 22 | o-xylene [a,b] | 4 | 2,3,4-trimethylpentane | 22 | n-decane |
| 5 | acetaldehyde [b,c] | 23 | p-ethyltoluene [a] | 5 | 2,3-dimethylbutane | 23 | n-heptane |
| 6 | acetone [c,d] | 24 | Propane | 6 | 2,3-dimethylpentane | 24 | n-nonane |
| 7 | benzene [a,b] | 25 | propylene | 7 | 2,4-dimethylpentane | 25 | n-octane |
| 8 | c-2-butene | 26 | styrene [a,b] | 8 | 2-methylheptane | 26 | n-propylbenzene [a] |
| 9 | ethane [d] | 27 | toluene [a,b] | 9 | 2-methylhexane | 27 | n-undecane |
| 10 | ethylbenzene [a,b] | 28 | t-2-butene | 10 | 2-methylpentane | 28 | p-diethylbenzene |
| 11 | Ethylene | | | 11 | 3-methylheptane | 29 | t-2-pentene |
| 12 | formaldehyde [b,c] | | | 12 | 3-methylhexane | 30 | α/β-pinene |
| 13 | Isobutane | | | 13 | 3-methylpentane | 31 | 1,3 butadiene [b] |
| 14 | Isopentane | | | 14 | Acetylene | 32 | benzaldehyde [c] |
| 15 | Isoprene | | | 15 | c-2-pentene | 33 | carbon tetrachloride [b] |
| 16 | m&p-xylenes [a,b] | | | 16 | cyclohexane | 34 | Ethanol |
| 17 | m-ethyltoluene [a] | | | 17 | cyclopentane | 35 | Tetrachloroethylene [b] |
| 18 | n-butane | | | 18 | isopropylbenzene [b] | | |

Source: Revisions to the Photochemical Assessment Monitoring Stations Compound Target List. U.S. EPA, November 20, 2013

[a] Important SOAP (Secondary Organic Aerosols Precursor) Compounds
[b] HAP (Hazardous Air Pollutant) Compounds
[c] Carbonyl compounds
[d] Non-reactive compounds, not considered to be VOC for regulatory purposes

[1] See NATTS Technical Assistance Document for TO-11A method.

## Attachment 1 Equipment Inventory
## (*specific manufacturers/models subject to change*)

| | | |
|---|---|---|
| **Region** | 3 | |
| **State** | Delaware | |
| **AQS ID** | 10-003-2004 | |
| **CBSA** | Philadelphia-Camden-Wilmington | |
| **Parameter** | **Category** | **Detail** |
| **Site** | Is the AQS site listed above the expected PAMS Core site? | **Yes** |
| | What is the status of the decision for the expected PAMS Core site location (not started, draft, or final)? | **Final** |
| | Is there an alternate PAMS Core site location selected? | **No** |
| | Identify type of alternative site (existing PAMS, NATTS, etc.) | |
| | Alternate site AQS ID (if known) | |
| **Mixing Height** | Is there an existing functional ceilometer o other similar instrument available for use? | **No** |
| | Current location (at future PAMS Core site, at other site, not applicable) | |
| | Instrument type (ceilometer, radar profiler, etc.) | |
| | Manufacturer | **Vaisala** |
| | Model | **CL-51** |
| | Date purchased | |
| | Comments | **Awaiting installation** |
| **Auto GC** | Is there an existing Auto GC available for use? | **No** |
| | Current location (at future PAMS Core site, at other site, not applicable) | |
| | Manufacturer | **CAS** |
| | Model | **Chromatotec (FID)** |
| | Date purchased | |
| | Does it have a service contract? | **Yes** |
| | Comments | **Installed; Awaiting service contract fulfillment delayed by COVID 19** |
| **True NO2** | Is there an existing true NO2 instrument available for use? | **No** |
| | Current location (at future PAMS Core site, at other site, not applicable) | |
| | Instrument type (photolytic conversion, cavity ringdown, CAPS, etc.) | |
| | Manufacturer | **Teledyne** |
| | Model | **N500** |
| | Date purchased | |
| | Comments | **Awaiting calibration equipment** |
| **Carbonyls Sampling** | Is there an existing sequential carbonyls sampling unit or similar instrument available for use? | **No** |
| | Current location (at future PAMS Core site, at other site, not applicable) | |
| | Instrument type (photolytic conversion, cavity ringdown, CAPS, etc.) | **Cartridge Sampler** |
| | Manufacturer | **ATEC** |
| | Model | **8000** |
| | Date purchased | |
| | Comments | **Installed; data collection on hold** |
| **Carbonyls Analysis** | Does the site currently have a support laboratory for carbonyls? | **Yes** |
| | Laboratory name | **ERG National Contract** |
| | Comments | **Test samples collected 2020** |
| **Barometric Pressure** | Instrument type (aneroid barometer, etc.) | **capacitive silicon** |
| | Manufacturer | **Vaisala** |
| | Model | **WXT 620** |
| | Date purchased | |
| | Comments | **Installed** |
| **UV Radiation** | Instrument type (UV radiometer, etc.) | **UV Radiometer** |
| | Manufacturer | **Kipp & Zonen** |
| | Model | **SUV5-V** |
| | Date purchased | |
| | Comments | **Awaiting installation** |
| **Solar Radiation** | Instrument type (pyranometer, etc.) | **Pyranometer** |
| | Manufacturer | **Kipp & Zonen** |
| | Model | **SMP10-V** |
| | Date purchased | |
| | Comments | **Awaiting installation** |
| **Precipitation** | Instrument type (tipping bucket, weighing, etc.) | **Tipping Rain Gauge** |
| | Manufacturer | **RM Young** |
| | Model | **52202** |
| | Date purchased | |
| | Comments | **Awaiting installation** |