Seasonal Report

2023 Fine Particles ($PM_{2.5}$)

OVERVIEW

Fine Particle pollution, or **$PM_{2.5}$**, is one of six **criteria pollutants** to have National Ambient Air Quality Standards (**NAAQS**) set by the Environmental Protection Agency (**EPA**). $PM_{2.5}$ comes from many different sources including vehicle exhaust, power plants, industrial activity, sea salt, wildfires, and can form through chemical reactions in the atmosphere. Since 2005, there has been a downward trend in fine particle pollution in Maryland; while 2023 was generally a continuation of this trend, the state experienced unprecedented smoke from Canadian wildfires in the spring and summer, resulting in five days when $PM_{2.5}$ levels exceeded the NAAQS.

Due to its small size (**Figure 1**), $PM_{2.5}$ can travel deeply into the respiratory tract, reaching the lungs and causing adverse health effects and increased hospital admissions. Many scientific studies have found associations between $PM_{2.5}$ exposure and a variety of health problems, including heart disease, chronic kidney disease, diabetes, hypertension, lung cancer, pneumonia, aggravated asthma, and other respiratory symptoms like coughing. (See EPA and CDC for more on $PM_{2.5}$ and health)

When midnight-to-midnight average $PM_{2.5}$ concentrations exceed 35.4 micrograms per cubic meter (**µg/m³**), or the equivalent of 100 on the Air Quality Index (**AQI**) (see color bar on bottom of page) air quality is deemed Unhealthy for Sensitive Groups (USG) and is otherwise known as an "exceedance day". Maryland has seen a steady decrease in the number of $PM_{2.5}$ exceedance days over the past 15+ years (**Figure 2**), due largely to the adoption of regulations to reduce emissions.

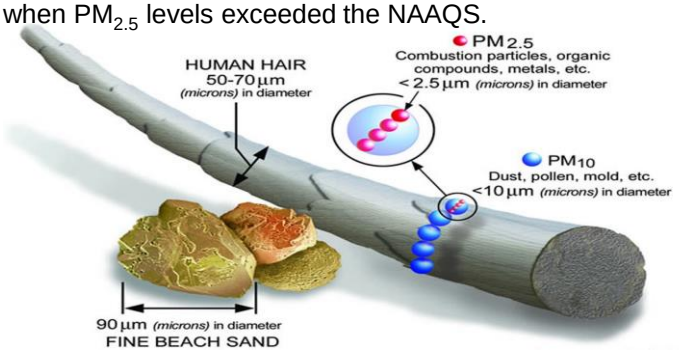

***Figure 1**: Particulate matter size comparison. (Image courtesy of EPA)*

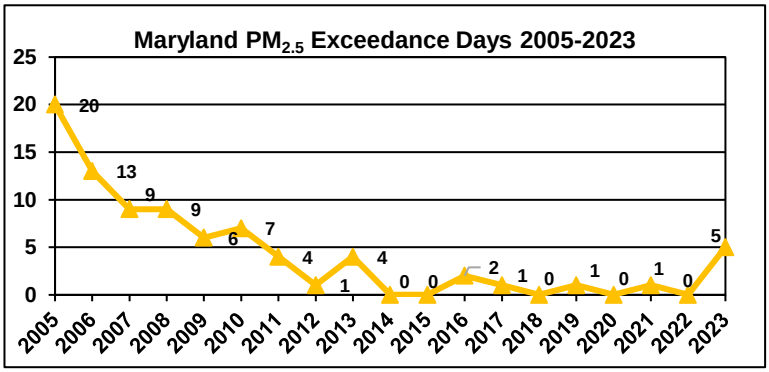

***Figure 2**: Annual no. of days AQI surpassed 100 at any $PM_{2.5}$ monitor in Maryland, 2005-2023.*

SEASONAL HIGHLIGHTS & STATS

Based on maximum daily $PM_{2.5}$ concentrations, Maryland had 275 "Good" AQI days in 2023, or 75% of the year. (**Figure 3**) Though there were fewer Good days compared to the exceptionally clean year of 2020, it generally follows the increasing trend of annual Good days over the past 15+ years. With the number of $PM_{2.5}$ exceedance days in Maryland generally decreasing, a good alternative is to look at the number of "haze days". A haze day is defined as when the $PM_{2.5}$ daily maximum concentration exceeds 25 µg/m³ (78 AQI). On these days, the air can be perceptibly hazy. As seen in **Figure 4**, Maryland saw ten days that fit this criterion in 2023, the most occurring in state since 2015. A visual comparison of a Good day with clear visibility vs. an Unhealthy haze day can be seen below in **Figures 5 & 6**.

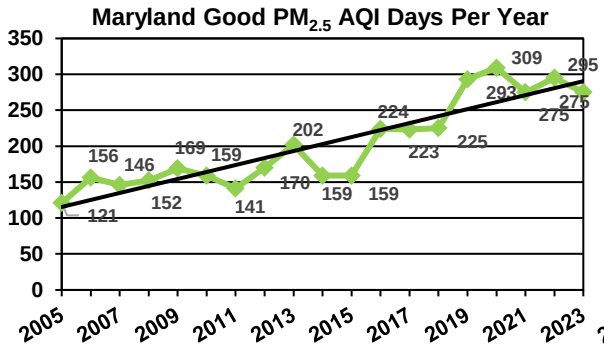

***Figure 3**: Number of days where the highest $PM_{2.5}$ monitor remained at or below an AQI of 50 (Good) in Maryland, 2005-2023. Black trend line is included.*

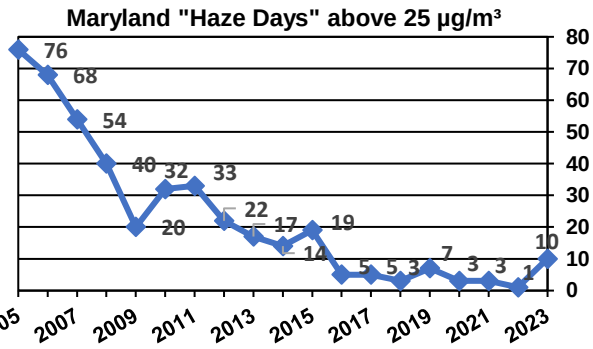

***Figure 4**: Number of days where $PM_{2.5}$ concentrations reached 25 µg/m³ or greater at any monitor in Maryland, 2005-2023.*

***Figures 5 & 6:** AQI & visibility demonstrated using drone photos taken over Northeast Baltimore. Left, Good AQI of 33 vs. Right, Unhealthy AQI of 172.*

AQI	0-50 Good	51-100 Moderate	101-150 USG*	151-200 Unhealthy	201-300 Very Unhealthy	301-500 Hazardous

*USG: Unhealthy for Sensitive Groups

MARYLAND DEPARTMENT OF THE ENVIRONMENT
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Seasonal Report

2023 Fine Particles ($PM_{2.5}$)

FEATURED EPISODE: June 7th - 8th, 2023

Summertime $PM_{2.5}$ exceedances had largely become a thing of the past in Maryland, due to regulation and reductions in atmospheric pollutants, primarily sulfur dioxide and nitrogen oxides. Elevated $PM_{2.5}$ concentrations in recent years have primarily been driven by meteorological impacts, specifically, cases of **temperature inversions** (See 2017 PM Annual Report), with the impacts mostly seen in winter months. Despite consistent reductions in particle pollution, as climate conditions have become hotter and drier, wildfires have become more intense, and the smoke from these fires has brought back summertime $PM_{2.5}$ exceedances in the region.

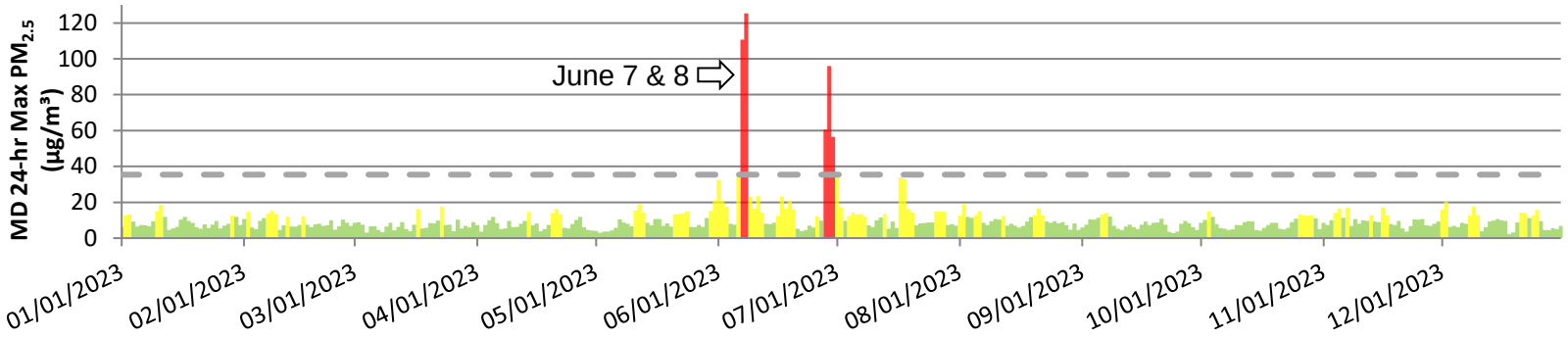

Figure 7: *Maximum daily 24-hour $PM_{2.5}$ (µg/m³) in Maryland from January 1 – December 31, 2023. Bars are color coded by AQI. Exceedance day level threshold is noted by the dashed line. The June 7th & 8th 24-hour maximum $PM_{2.5}$ is annotated in the chart above, center.*

Despite low concentrations over the season, historically high events occurred due to Canadian forest fires (**Figure 7**). High $PM_{2.5}$ levels on June 7-8 were the result of abundant smoke brought to the Mid-Atlantic from the Canadian fires by favorable weather conditions. On June 1st, wildfires broke out due to lightning strikes in an unusually dry, forested region in western Quebec. Strong northerly winds pushed a smoke column south towards the northeastern US, starting on June 2nd. Smoke was initially light over the region, but additional columns of smoke arrived over Maryland late on June 7th (**Figure 8**) and the early morning of the 8th. Meteorological conditions kept smoke over the central and eastern portions of Maryland until midday on the 8th, pushing the daily AQI to 187 (~125 µg/m³ 24-hour average) - close to the Very Unhealthy range and the *highest recorded 24-hour AQI for $PM_{2.5}$ in state history!*

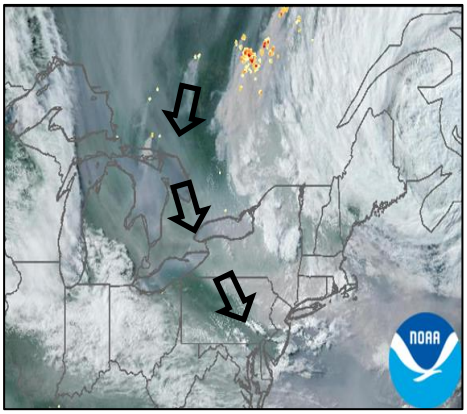

Figure 8 (above)*: GOES-16 satellite image showing smoke (grey area, following arrows) moving towards Maryland on the afternoon of June 7, 2023. Active fires (yellow/red dots) visible in Quebec. (Photo courtesy NOAA)*

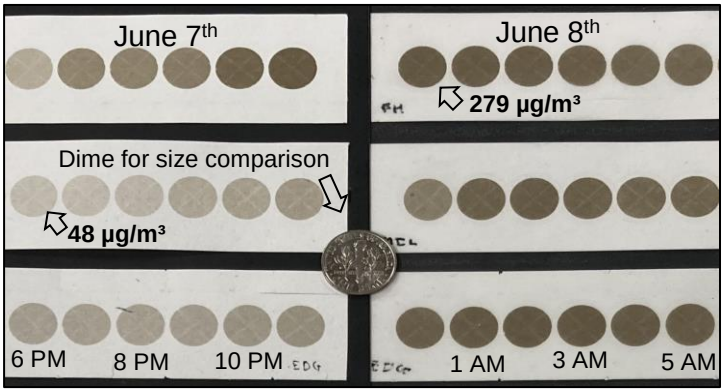

Figure 9 (left)*: Filters from three hourly $PM_{2.5}$ monitors at (top to bottom) Fair Hill, Millington, and Edgewood, on the evening of June 7th (left) into June 8th (right): each circle represents one hour. The highest hourly concentration of $PM_{2.5}$ (279 µg/m³ at Edgewood) can be seen around midnight on the 8th, as heavy smoke arrives in Maryland, clearing later in the day.*

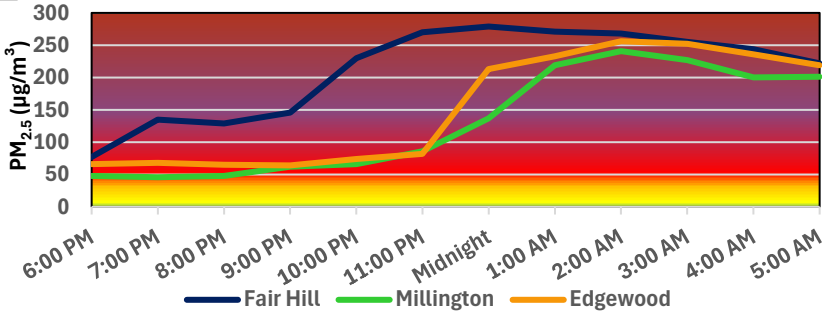

Figure 10 (left)*: Time series of $PM_{2.5}$ concentrations on June 7-8, to compare with the three monitors with filters pictured above in Figure 6, Fair Hill (blue), Millington (green), and Edgewood (orange); background colored according to AQI (see colored band at bottom of page).*

There are several EPA-approved methods currently in use to measure fine particle pollution. One method used by Maryland to measure $PM_{2.5}$ is trapping particle pollution on filters inside a monitor. Ambient air drawn from outside the monitor, passes through a coarse filter, removing particles larger than 2.5 microns, leaving only $PM_{2.5}$ in the air sample. This sampled air is then drawn through spool of special, glass fiber filter paper to capture the remaining fine particles. Each hour, electrons in a **beta ray** are shot through the filter and counted by a detector. Since a dirtier filter (**Figure 9**) will block more electrons, $PM_{2.5}$ concentrations can be interpreted by the number of electrons reaching the detector. Hourly concentrations corresponding to the filters in **Figure 9**, can be seen in **Figure 10** for comparison. Maryland has eight monitors that take hourly $PM_{2.5}$ measurements, which is done each day to create the 24-hour averages used to determine daily Air Quality Index levels.

AQI	0-50 Good	51-100 Moderate	101-150 USG*	151-200 Unhealthy	201-300 Very Unhealthy	301-500 Hazardous

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