# Seasonal Report

## 2016 Fine Particles ($PM_{2.5}$)

Maryland Department of the Environment

## OVERVIEW

Fine particle pollution, also known as $PM_{2.5}$, is a potential health concern throughout the year in the state of Maryland. Due to its small size (*<2.5μm in diameter*), $PM_{2.5}$ can penetrate deep into the lungs resulting in adverse cardiovascular effects. Unlike surface ozone, $PM_{2.5}$ is not dependent on abundant sunshine and warm temperatures. When $PM_{2.5}$ monitoring began in 1999, fine particle pollution was a significant air quality issue most often during the summer months when higher dew points and generally weaker surface winds aided in its production. In recent years, the number of days with high $PM_{2.5}$ concentrations, also known as a $PM_{2.5}$ exceedance day, has significantly decreased due to the adoption of regulations to reduce emissions of $PM_{2.5}$ precursors such as $SO_2$ and $NO_x$ (*Figure 1*). In fact, $PM_{2.5}$ concentrations have dropped so much that Maryland is in attainment of the $PM_{2.5}$ standard. However, there continues to be spikes in $PM_{2.5}$ pollution during various times throughout the year. When $PM_{2.5}$ concentrations are high enough to cause potential health concerns in sensitive populations (USG), the Air Quality Index (AQI) exceeds 100. The best way to determine how bad $PM_{2.5}$ is in a given year, is by tracking the number of days the daily 24-hour average concentration of $PM_{2.5}$ (midnight to midnight) exceeds the AQI value of 100. In 2016 there were two $PM_{2.5}$ exceedance days in Maryland.

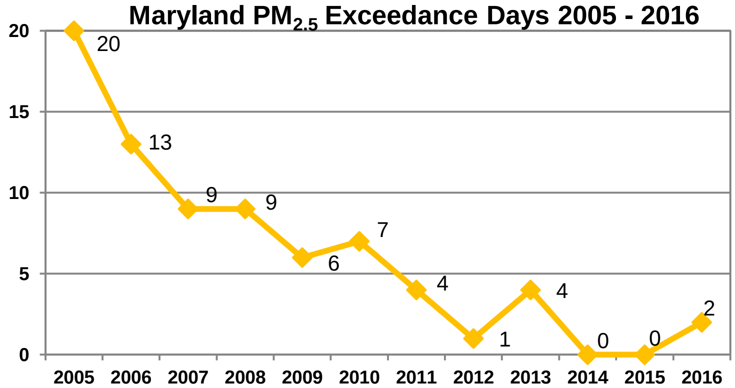


*Figure 1: Number of days where the AQI surpassed 100 at any $PM_{2.5}$ monitor in Maryland annually, 2005-2016.*

## SEASONAL SUMMARY

With 2014 and 2015 both having zero exceedance days, 2016 may look like a step in the wrong direction. However, a more detailed examination of 2016 suggests otherwise. Although total exceedance days are a good surrogate for how bad $PM_{2.5}$ was in a particular year, it does not paint the whole picture. When looking at the maximum daily $PM_{2.5}$ concentration across the state, Maryland had 224 Good AQI days. This is the highest number of annual Good days since measurements began back in 1999. The closest to this occurred back in 2013 with 202 Good days. 2016 is also much higher than the previous two years, both with 159 total (*Figure 2*).

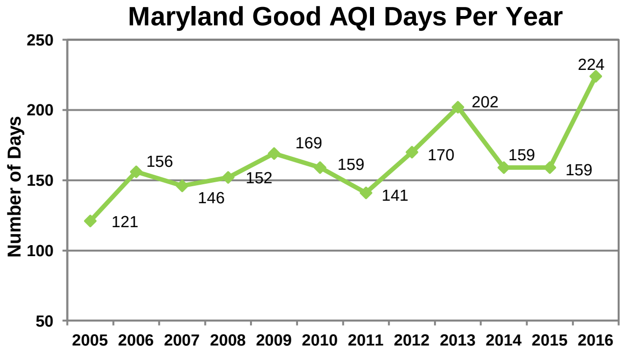


*Figure 2: Number of days where the highest $PM_{2.5}$ monitor remained at or below an AQI of 50 (Good) in Maryland, 2005-2016.*

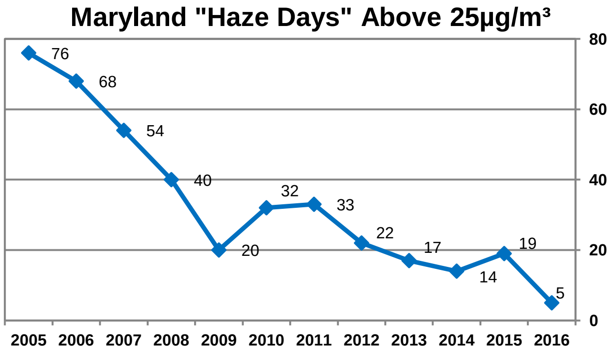


*Figure 3: Number of days where $PM_{2.5}$ concentration reached 25 μg/m³ or greater at any monitor in Maryland, 2005-2016.*

In addition to the high number of Good days, Maryland drastically decreased the number of yearly "peaks" in $PM_{2.5}$ concentrations. Since the number of $PM_{2.5}$ exceedance days in Maryland has been at all time lows in recent years, a good alternative is to look at the number of "haze days". The term haze days is defined as when the daily maximum $PM_{2.5}$ concentration exceeds 25 μg/m³ (78 AQI). On these days, the air is perceptibly hazy. As you can see in *Figure 3*, 2016 had by far the fewest number of haze days with only 5. In fact in the past 10 years, the number of haze days has dropped by over 92%!

## FEATURED EPISODE: January 22nd - 26th: "Post-Blizzard"

Light snow began to fall just after noon on Friday, January 22nd 2016. Winds and snowfall rates quickly increased in intensity with blizzard to near-blizzard conditions persisting overnight Friday through most of the day Saturday. By the time the snow ended late Saturday evening the 23rd, a historic snowfall blanketed the entire state *(Figure 4).* 29.2 inches of snow was reported at BWI airport, a new single storm record dating back to 1892. The highest snowfall totals occurred just west of the city with nearly 3 feet of snow in some locations!

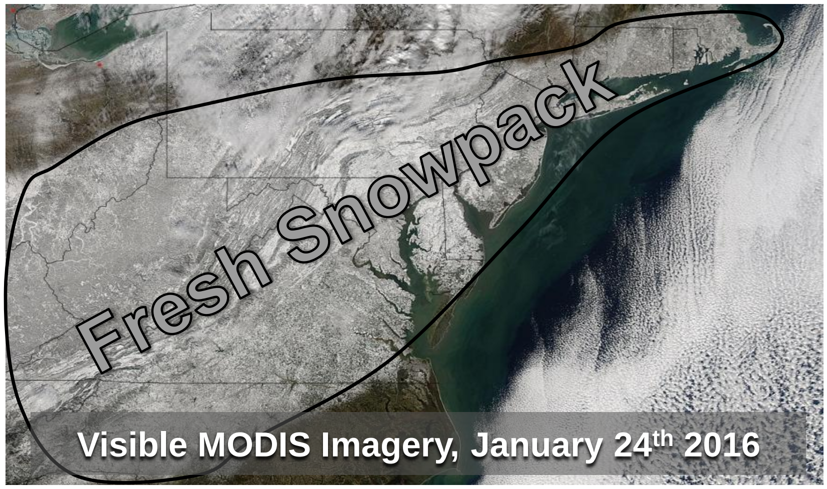


*Figure 4: Visible MODIS imagery on the afternoon of January 24th 2016. Area of fresh snowpack is noted and highlighted.*

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

*Unhealthy for Sensitive Groups


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## FEATURED EPISODE (*cont.*)

As people began to dig out on Sunday the 24th, high pressure began to quickly build into the area. During the same timeframe, many urban regions turned to wood burning as a source of heat. With high pressure directly overhead on the night of the 24th, clear skies and calm winds along with the fresh snowpack allowed surface temperatures to quickly dip into the low teens and single digits Fahrenheit. Just a few hundred feet above, the temperature was considerably warmer. This vertical profile where there is an increase in temperature with height is known meteorologically as an inversion. Inversions are important when it comes to air quality because it acts as a lid to trap pollutants. A sounding (*balloon that measures aloft temperatures*) from nearby Sterling, VA from the early morning hours on the 25th measured ground level temperatures to be 8.4°F (-13.1°C). When compared to just 700 feet above the surface, the temperature shot up to 32.7°F (0.4°C). This is an impressive 24.3°F (13.5°C) increase in temperature in only 700 feet! In the case of a strong surface inversion such as this, any wood smoke or other pollutants emitted become trapped and focused right at the immediate surface. It was this strong surface inversion which aided in the quick rise in $PM_{2.5}$ concentrations across the state during the overnight hours of the 24th into the 25th (*as seen in Figure 5 – "A")*. The highest fine particle concentrations were recorded at Rockville, where the 11pm hourly observation on the 24th measured 122 µg/m³! This hourly concentration is well into the Unhealthy AQI range if sustained for 24-hours and is more synonymous with an observation found near forest fires! Hourly concentrations remained elevated at Rockville as well as many other sites through the overnight hours. As the sun began to rise, surface temperatures quickly rose allowing the surface inversion to begin to break. This in turn brought fine particle concentrations down considerably as cleaner air above the inversion mixed down to the surface *(as seen in Figure 5 – "B"*).

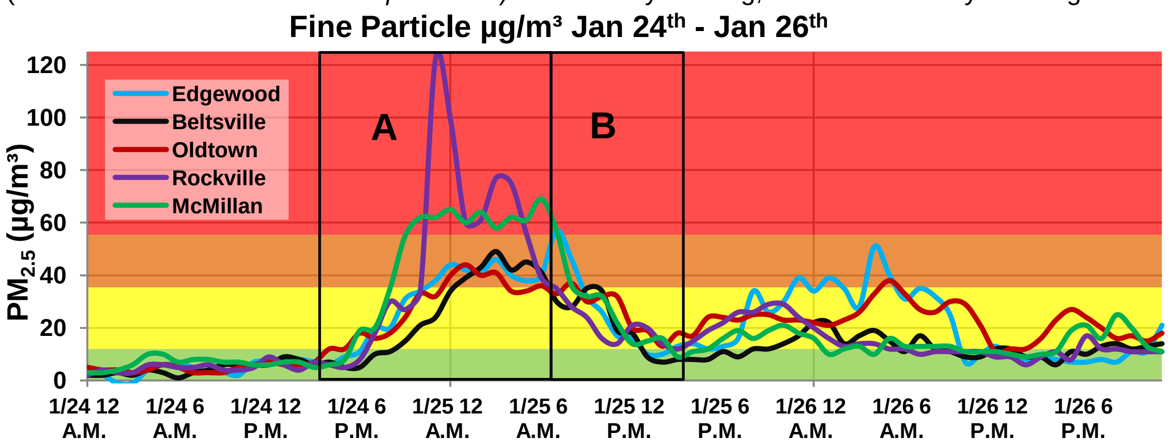


*Figure 5: $PM_{2.5}$ concentrations (µg/m³) for several monitors between the timeframe of January 24th – January 26th. Horizontal coloring matches with appropriate AQI ranges. Box "A" highlights the quick rise in $PM_{2.5}$ concentrations as surface temperatures cooled and inversions strengthened. Box "B" highlights the quick decent in concentrations as the surface inversions broke due to warming daytime temperatures.*

*Figure 6* shows the actual filter paper from the Rockville monitor during the overnight hours of the 24th into the 25th. Each "circle" represents an hour's worth of measurements of the ambient air. As $PM_{2.5}$ particles become trapped on the paper, the circle becomes "dirtier". Computed concentrations are shown above each hourly measurement. As you can see, between 11pm and 5am the filter paper was considerably "dirty" with hourly $PM_{2.5}$ concentrations well into the Unhealthy range. However, as the sun began to rise and temperatures warmed, $PM_{2.5}$ concentrations decreased and the filter paper became less "dirty". This same pattern persisted during the overnight hours of the 25th into the 26th. However with winds being a bit gustier, surface temperatures were not able to cool off as drastically and therefore a strong surface inversion was not able to develop.

Despite a 6-hour stretch of Unhealthy AQI values at Rockville on January 25th, there was no exceedance day measured. The midnight to midnight 24-hour average $PM_{2.5}$ concentration at Rockville was 35.04 µg/m³, just under the USG threshold of 35.4 µg/m³.

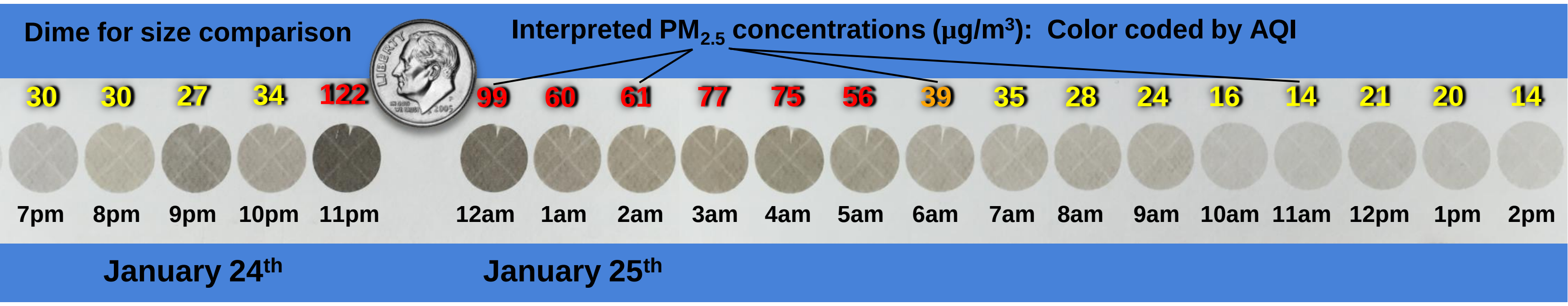


*Figure 6: The filter paper from January 24th - January 25th is displayed along with a dime for size comparison. The circles on the center of the white strip of filter paper represent hourly collections of fine particle ($PM_{2.5}$) pollution at Rockville in Montgomery county Maryland. Each "circle" is created over an hour as a pump forces air through the filter paper via a circular tube. Particles 2.5 microns or smaller are collected on the paper causing a discoloration dependent on the amount and type of pollution. The instrument then shoots a stream of electrons through the filter paper at a detector which then counts the number of electrons hitting it. The difference in the number of electrons passing through a clean and the dirtied filter is converted to an average $PM_{2.5}$ concentration over the past hour, giving the "mass of $PM_{2.5}$ in a volume of air" or simply "µg/m³." Interpreted $PM_{2.5}$ concentrations, color coded by AQI, along with measurement times are noted above and below each "circle".*

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