Supporting Materials Demonstrating Increased PM2.5 concentrations in Pennsylvania Resulting from Canadian Wildfire Influence in 2023-2025

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Summary

Based on the results of ongoing Alpine analyses of exceptional events influence and the widespread impact of wildfire and prescribed fire smoke on monitors throughout Pennsylvania, including areas within the broader regional airshed, it is recommended that regulatory agencies give full and consistent consideration to the treatment of affected PM2.5 data under the Exceptional Events Rule. The evidence developed and presented here for the 2023, 2024, and 2025 wildfire and prescribed fire smoke episodes demonstrates that transported smoke significantly elevated monitored concentrations across large portions of the region beyond what would reasonably be expected in the absence of wildfire conditions. These impacts were neither isolated nor localized but instead represented widespread regional air quality disturbances affecting both attainment and nonattainment areas alike.

Accordingly, each date and monitor identified as having experienced wildfire or prescribed fire smoke impacts during these periods, where PM2.5 concentrations were demonstrably enhanced by smoke intrusion, should be flagged as influenced by exceptional events and the associated concentration values removed from the regulatory record used in design value calculations and boundary designations. Importantly, the concept of "regulatory significance" should not be narrowly interpreted solely through the lens of whether the exclusion changes an attainment or nonattainment designation. Rather, any concentration demonstrably influenced by wildfire or prescribed fire smoke should be considered appropriate for exclusion regardless of the ultimate attainment outcome. Failure to recognize and remove these influenced concentrations risks embedding atypical and non-representative conditions into long-term regulatory datasets that support multiple Clean Air Act programs, including PSD compliance demonstrations, Good Neighbor State or Federal Implementation Plans (SIPs and FIPs), and State attainment demonstrations, to name a few.

The significance of this issue is illustrated clearly by monitor 421010057 (Fire Administration Building monitor) in Philadelphia County, Pennsylvania. Analysis indicates that this monitor experienced measurable enhancement on multiple dates from both wildfire and prescribed fire smoke intrusion during the 2023-2025 period. While the monitor's current annual design value remains above the annual PM2.5 National Ambient Air Quality Standard (NAAQS) at 9.4 µg/m^3, removal of all identified smoke-influenced[1] Tier 1 dates would reduce the annual design value sufficiently to bring the monitor into attainment (at 8.8 µg/m^3) with the current annual PM2.5 NAAQS. Figure 1 below shows these dates using EPA's PM2.5 Tiering Tool[2] while Table 1 provides the recalculated annual mean and design values absent these Tier 1 dates and noted overhead smoke.

When these dates and associated smoke-influenced Tier 1 observations were removed from the record and annual design values were recalculated, design values were lowered by an average of 0.5 µg/m³ across all analyzed monitors. These values for all monitors are presented in Table 1.

[1] https://www.ospo.noaa.gov/products/land/hms.html
[2] https://www.epa.gov/air-quality-analysis/pm25-tiering-tool-exceptional-events-analysis

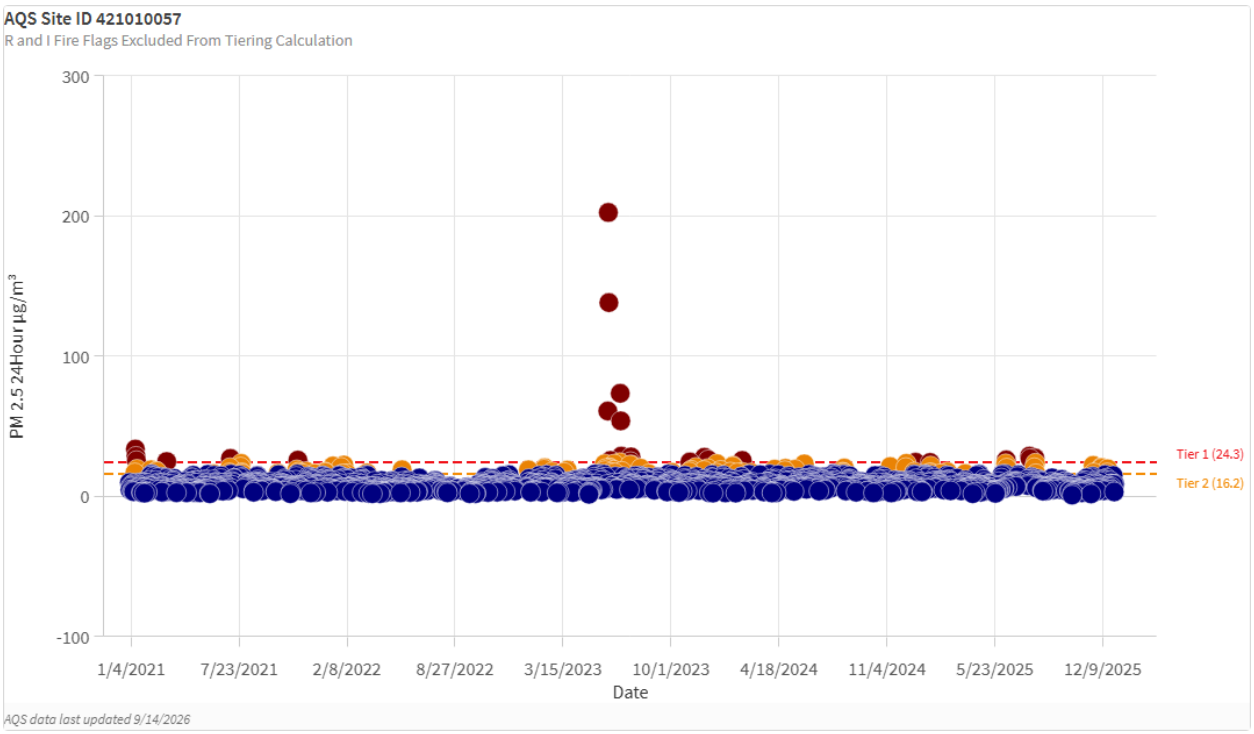


Figure 1. Five-year (2021-2025) time series of 24-hour PM2.5 concentrations, Tier 1 and Tier 2 threshold values at the Fire Administration Building monitor (421010057).

Table 1. Unadjusted and excluding smoke-influenced Tier 1 adjusted Pennsylvania PM2.5 monitor annual mean and design values.

				Excluding All Smoke-Influenced Tier 1 Date Concentrations			
County	**Site ID**	**Local Site Name**	**2023-2025 Annual DV (ug/m3)**	**2023 Annual Mean (ug/m3)**	**2024 Annual Mean (ug/m3)**	**2025 Annual Mean (ug/m3)**	**2023-2025 Annual DV (ug/m3)**
Allegheny	420030064	Liberty	10.1	11.44	8.96	9.43	9.9
Allegheny	420031301	North Braddock	9.5	9.75	8.43	9.20	9.1
Philadelphia	421010004	Air Management Services Laboratory	10.6	10.85	9.94	9.43	10.1
Philadelphia	421010048	North East Waste	9.2	10.24	7.17	8.32	8.6
Philadelphia	421010055	Ritner	9.4	9.81	8.31	7.87	8.7
Philadelphia	421010057	Fire Administration Building	9.4	9.16	8.87	8.46	8.8
Philadelphia	421010075	Torresdale Station	10.2	11.55	9.36	8.02	9.6

These examples demonstrate the substantial regulatory implications associated with smoke-influenced concentrations and underscores the magnitude of fully evaluating and excluding affected data where supported by technical evidence. The importance of proper data management increases as standards become increasingly stringent and closer to background levels. Beyond attainment determinations alone, retaining these concentrations within the regulatory record could influence future permitting requirements, transportation conformity analyses, State Implementation Plan obligations, emissions reduction strategies, and broader regulatory planning efforts tied to both PM2.5 and ozone programs.

Consideration should also be given to monitors located outside designated counties and CBSAs but within the same regional airshed that experienced impacts from the same smoke plumes during the 2023-2025 episodes. In many cases, smoke transport is regional in scale and crosses jurisdictional and programmatic boundaries. Therefore, states should be encouraged to reference and leverage existing exceptional events demonstrations prepared by neighboring states where proximal monitors were impacted by the same smoke episodes on the same dates. Such coordination would improve consistency, reduce redundant analytical burdens, and better reflect the regional nature of the wildfire and prescribed fire impacts observed during these events.

Finally, consideration should be given to allowing states, including Pennsylvania, flexibility in satisfying the clear causal relationship criterion for wildfire and prescribed fire dates associated with smoke episodes. The collective body of evidence developed here through satellite imagery, air mass trajectory analyses, smoke modeling, surface observations, and widespread concentration enhancements has already demonstrated that Canadian wildfire smoke and domestic prescribed fires significantly impacted PM2.5 concentrations across the region.

Given the extensive number of demonstrations currently being prepared nationwide for these episodes, it would be reasonable and appropriate for regulatory agencies to permit states to adopt and reference other state technical analyses and supporting evidence and related demonstrations to satisfy Tier 1 obligations. Such an approach would maintain technical rigor while promoting regulatory consistency and administrative efficiency in addressing these unprecedented regional smoke events.

Comparison of Fire-Influenced PM2.5 Exceedances with Historical Concentrations

U.S. EPA's Exceptional Events Guidance and supplemental materials indicate that a clear causal demonstration should include a comparison of the event-related exceedance with historical concentrations measured at each monitor requested for data exclusion. Examples of supporting documentation include time-series plots overlaying five years of data and five-year percentiles or alternate graphical representation of these data using EPA's Tiering Tool[3].

EPA's tiering approach helps tailor the amount of evidence needed in a wildland-fire PM2.5 exceptional-events demonstration. For each monitoring site, EPA sets a threshold using the lower of two statistics from the most recent complete five-year period: the month-specific 98th percentile of daily PM2.5 concentrations or the lowest annual 98th percentile. The event-day concentration is then compared with the site's threshold: Tier 1 is at least 1.5 times the threshold, Tier 2 is at least the threshold but less than 1.5 times it, and Tier 3 is below it.

Figure 2 shows the 24-hour PM2.5 concentrations for the Liberty monitor (170310022) using EPA's Tiering Tool with clear indication of Tier 1 and Tier 2 dates represented by the red and gold dots, respectively. Increased PM2.5 above the Tier 1 and Tier 2 thresholds is evident on multiple dates.

PM2.5 concentrations were elevated at all remaining reviewed sites in Pennsylvania during these dates (Figure 2 through Figure 7), demonstrating that the region was impacted by area-wide events.

All the reviewed monitors recorded multiple 24-hour PM2.5 concentrations above their Tier 1 threshold values during the period of 2023 through 2025, indicating rare PM2.5 episodes. At all monitors, the observations from many of these days were in the top five days of the five-year period between 2023 and 2025, in many locations they were the single top value.

[3] https://www.epa.gov/air-quality-analysis/pm25-tiering-tool-exceptional-events-analysis

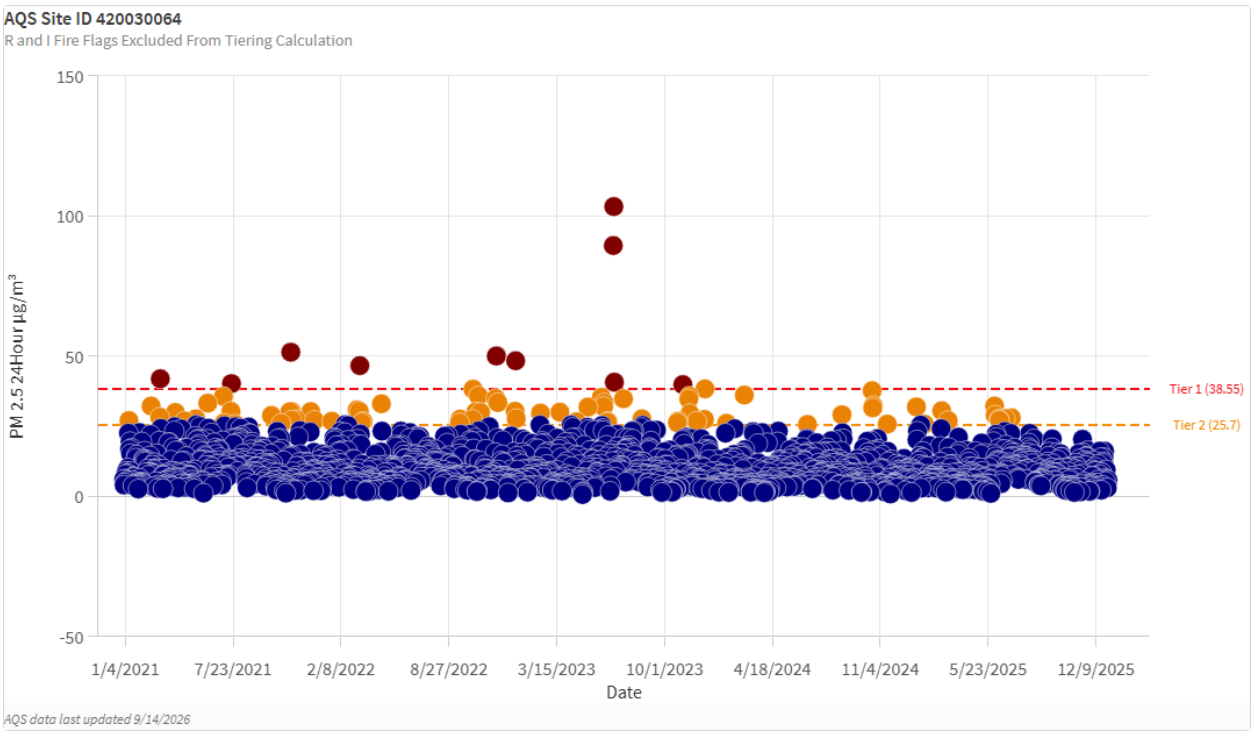


Figure 2. Five-year (2021-2025) time series of 24-hour PM2.5 concentrations, Tier 1 and Tier 2 threshold values at the Liberty monitor (420030064).

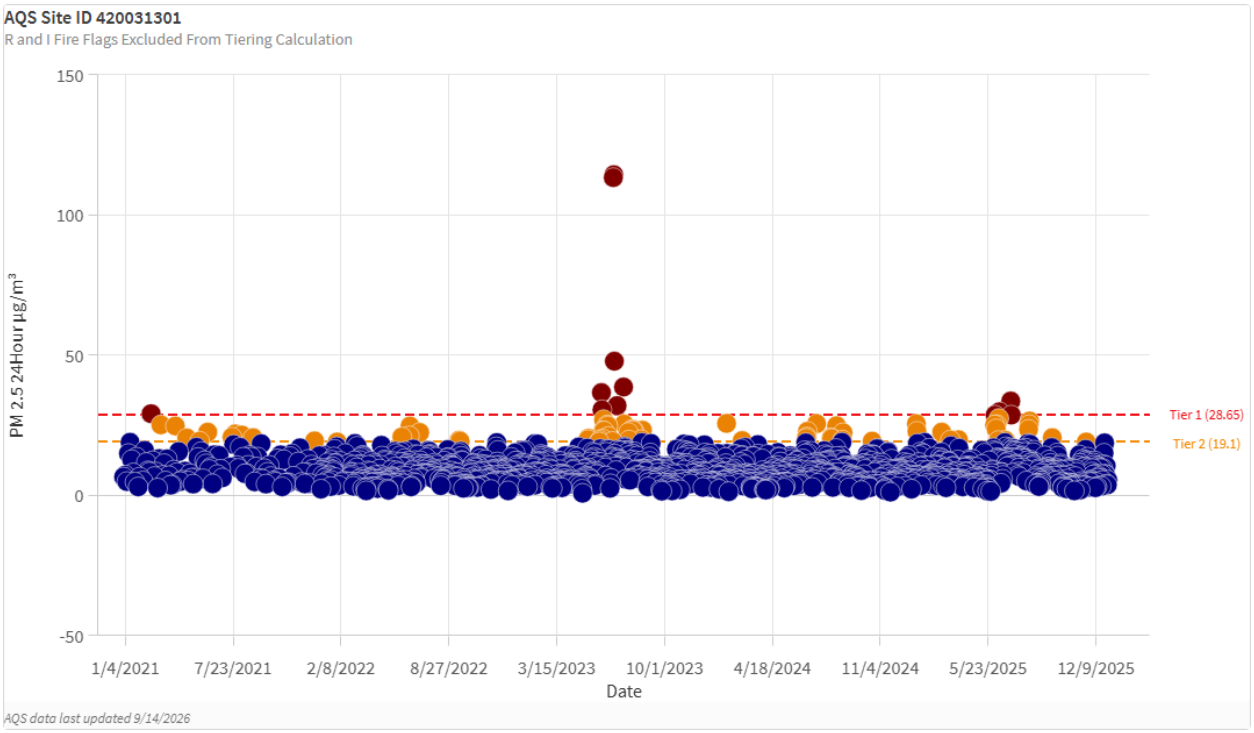


Figure 3. Five-year (2021-2025) time series of 24-hour PM2.5 concentrations, Tier 1 and Tier 2 threshold values at the North Braddock monitor (420031301).

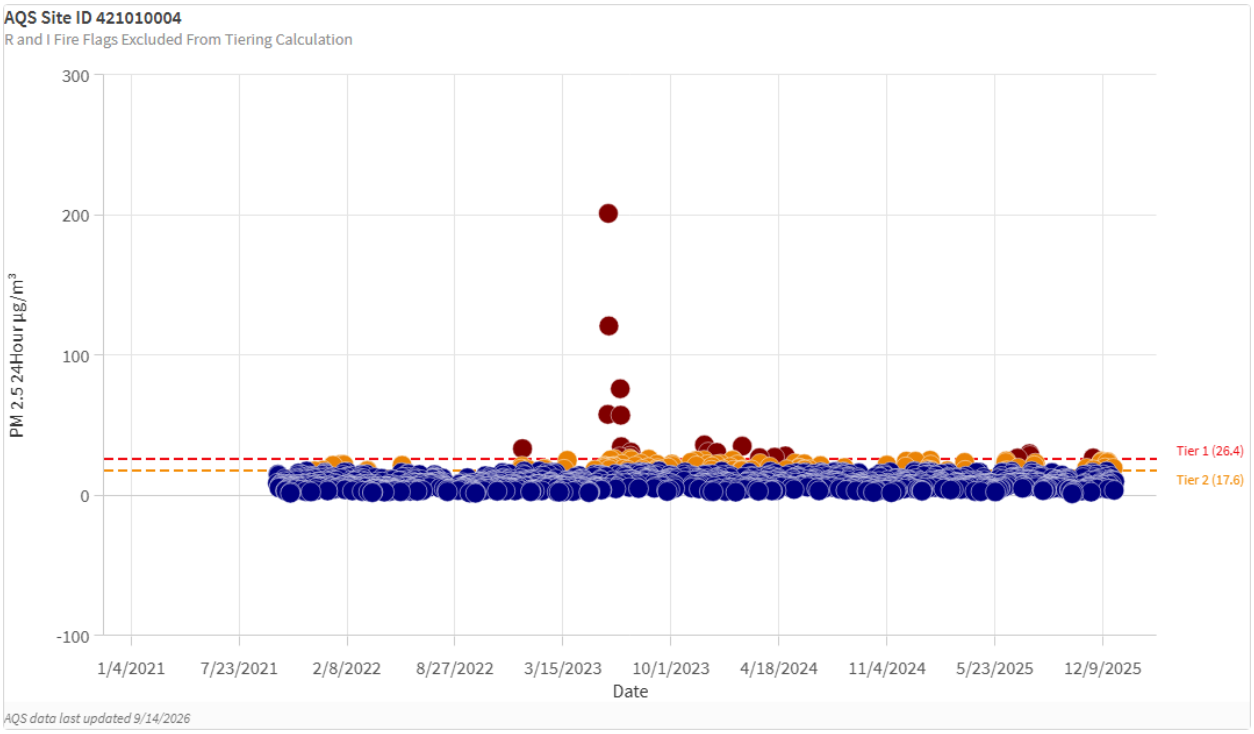


Figure 4. Five-year (2021-2025) time series of 24-hour PM2.5 concentrations, Tier 1 and Tier 2 threshold values at the Air Management Services Laboratory monitor (421010004).

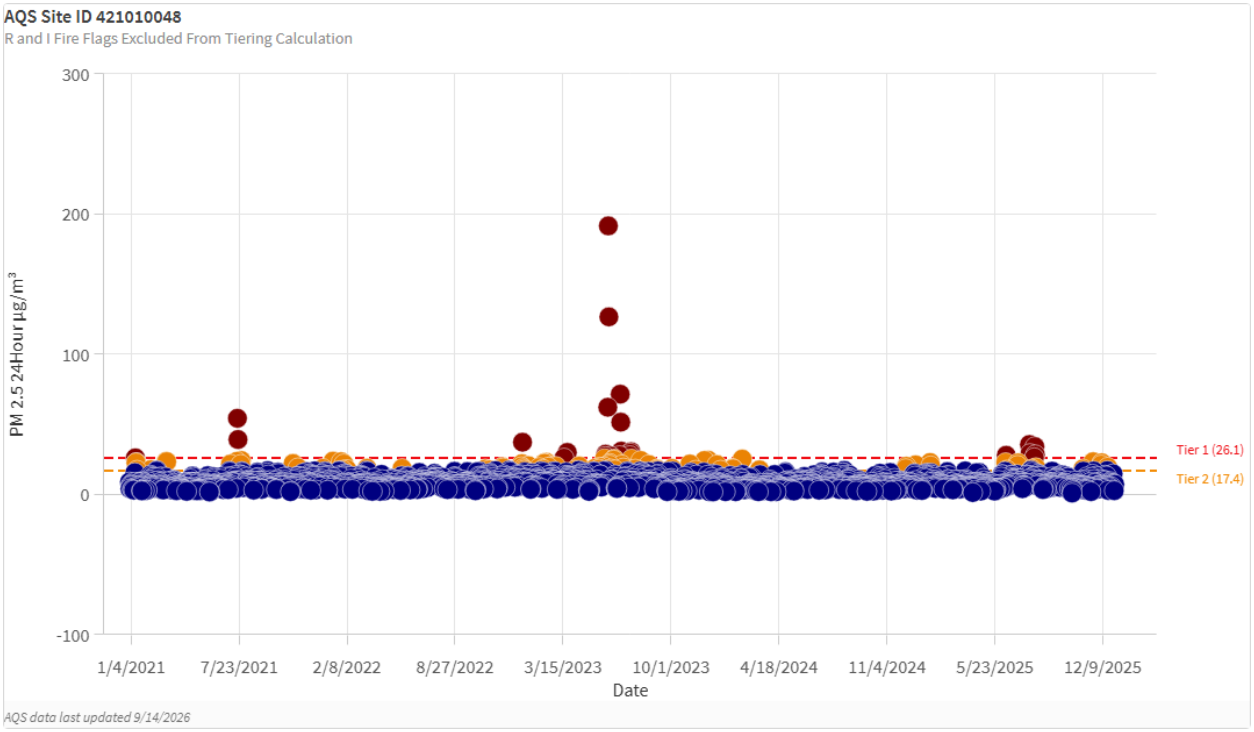


Figure 5. Five-year (2021-2025) time series of 24-hour PM2.5 concentrations, Tier 1 and Tier 2 threshold values at the North East Waste monitor (421010048).

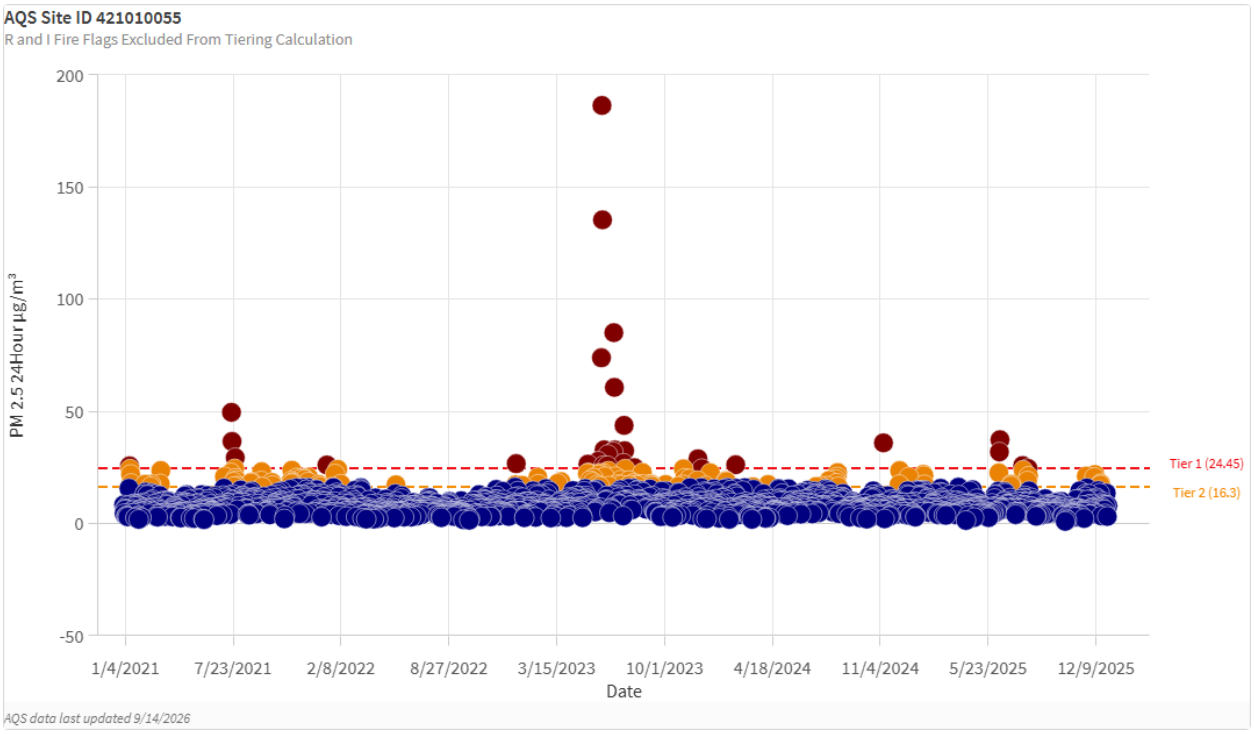


Figure 6. Five-year (2021-2025) time series of 24-hour PM2.5 concentrations, Tier 1 and Tier 2 threshold values at the Ritner monitor (421010055).

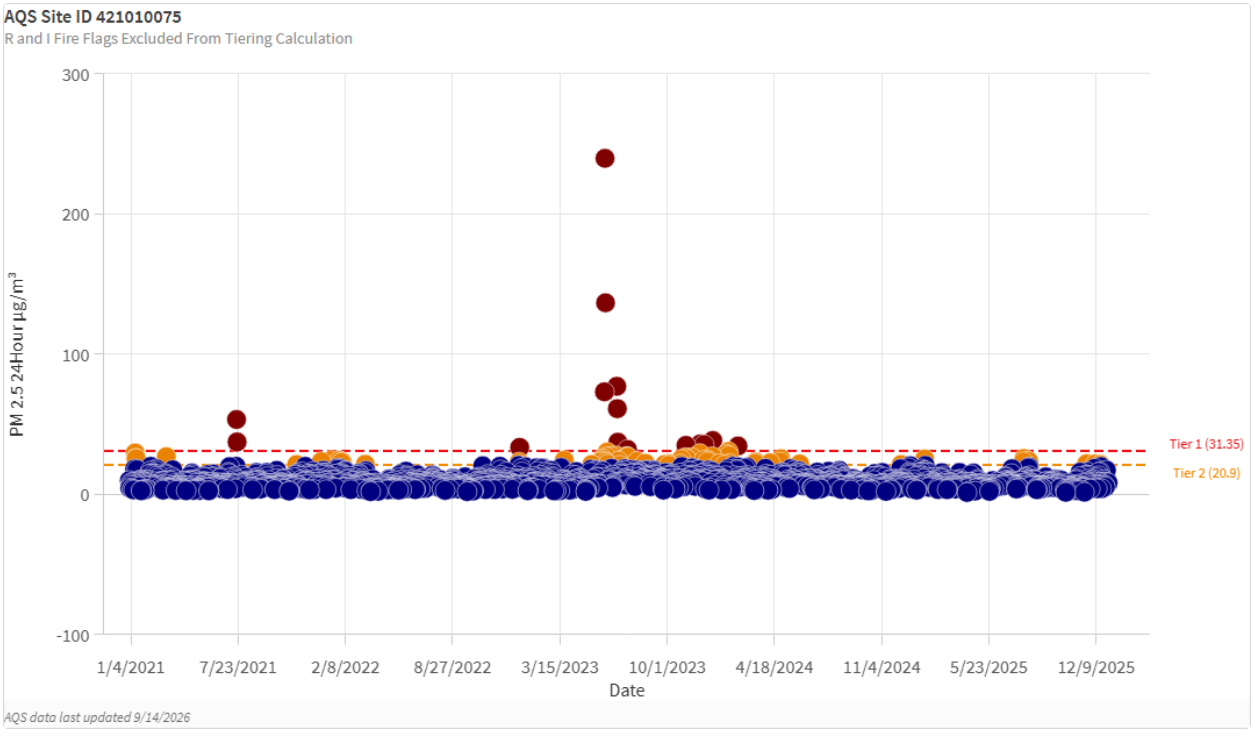


Figure 7. Five-year (2021-2025) time series of 24-hour PM2.5 concentrations, Tier 1 and Tier 2 threshold values at the Torresdale Station monitor (421010075).

Tier 1 / Tier 2 Dates Selected

Table 2 below provides a listing of 2023-2025 monitor-specific EPA Tiering Tool-identified Tier 1 (orange) and Tier 2 (yellow) 24-hour PM2.5 concentrations (µg/m^3) and dates[4] found to also have HMS smoke present during the episode. The values in this table are those removed from design value calculations in the next step of this analysis.

Table 2. Monitor-specific 24-hour PM2.5 concentrations (µg/m^3) and Tier 1 (orange) and Tier 2 (yellow) dates selected for removal from design value calculations.

	24-hour PM2.5 Concentrations (µg/m3)						
Date	**420030064**	**420031301**	**421010004**	**421010048**	**421010055**	**421010057**	**421010075**
2021-03-11							26.9
2021-07-20							53.5
2021-07-21							37.5
2023-04-13				17.3			
2023-04-14				20.3			
2023-04-21	26.7						
2023-05-11					22.4		
2023-05-12	31.9	19.9			26.5		18.1
2023-05-16					19.2		
2023-05-21				18.2	18.4		
2023-05-22				19.6	20.3	16.1	
2023-05-30				19.8	17.3		
2023-05-31			20.9	25.6	27.8	23.3	23.4
2023-06-01			19.4	27.1	21.7	18.5	24.3
2023-06-02		19.1	20.6	28.8	22.4	20	25.7
2023-06-03		19.7			16.6		
2023-06-06	35.4	36.7	57.9	62.3	73.9	61	73.3
2023-06-07		30.6	201.2	191.6	186.4	202.6	239.8
2023-06-08		20.2	121	126.7	135.4	138.3	136.8
2023-06-09		23.1	18.5	21.1	22.4	20.1	23
2023-06-10	32.1	27.1	20.3	22.2	25.9	20.4	26.8
2023-06-11	33.4	23	25.4	27.5	32.9	25.8	30.2
2023-06-17	26.5	25.2	20.8	24.6	25.8	18.8	
2023-06-18	26.8	24.8	26	25.4	30.8	23.2	27.2
2023-06-19		21.1	20.3	17.6	23.4	16.8	
2023-06-20					16.7		
2023-06-27		19.3					
2023-06-28	89.5	113.4	27.6	27.8	32	24.2	27.6
2023-06-29	103.4	114.4	76.2	71.6	85.1	73.6	77.2
2023-06-30	40.8	47.9	57.3	51.6	60.7	54	61.3
2023-07-01			34.8	31	32.8	28.8	37.3
2023-07-02			22.2	21.2	20.9	18	23.9
2023-07-05		32.1	18.8	19	17.4		20.9

[4] Data downloaded from EPA Tiering Tool on October 21, 2026.

	24-hour PM2.5 Concentrations (µg/m3)						
Date	**420030064**	**420031301**	**421010004**	**421010048**	**421010055**	**421010057**	**421010075**
2023-07-12					19.4		
2023-07-13			18		17.2		
2023-07-17	34.9	38.7	26.2	27.8	26.9	22.5	26.8
2023-07-18		25.5	28.2	29.6	43.8	24.9	27.2
2023-07-19			30.9	30.6	32.5	28.3	32.2
2023-07-20			25	25.4	24.3	22.5	26.7
2023-07-26		22.5					
2023-07-27		19.8	21	18.2	19.2		
2023-07-28					17.1		
2023-08-02		23.6					
2023-08-03		23.1					
2023-08-05		23.3			18		
2023-08-06			22.7	24.3	24.9	20.2	23.7
2023-08-09			18.6		17.2		
2023-08-11					17.1		
2023-08-19		19.9					
2023-08-20	27.7		20		17.5		
2023-08-21	25.4	23.3	25.9	21.4	22.7	16.2	22.3
2023-08-24							17.5
2023-09-04			17.7				
2023-09-05			22.2	18.2	17.5	13.7	17.4
2023-09-06			19.3	17.6	17.3		17.2
2023-09-07			17.8		17.5	13.8	
2023-09-08					16.6		
2023-09-16	23.7						
2023-09-26			19.8			16	21.4
2023-10-03			22.4	18.6	17.4	17.3	21.9
2023-10-04			21.1			15.4	20.9
2023-11-05				21.8	24.4	24.6	35.1
2023-11-06		18.4					
2023-11-07					20.2		
2023-11-16	35.8		24.8	17.4	19.9	20.8	26.4
2024-02-26	36.2						
2024-02-27			18.3			16.9	
2024-03-13			27	17.6	16.4		22.2
2024-03-14			22.8				23.2
2024-04-29					15.6	18.4	23.3
2024-05-25			19.7				
2024-05-26			19.4				
2024-06-03			18.4				
2024-06-04			22.6			23.3	21.8
2024-06-13			18.5				
2024-06-20		20.4					
2024-06-21		20.9					
2024-06-22	25.7	22.9					
2024-07-04			21.3				

	24-hour PM2.5 Concentrations (µg/m3)						
Date	**420030064**	**420031301**	**421010004**	**421010048**	**421010055**	**421010057**	**421010075**
2024-07-09		25.6					
2024-07-16					16.7		
2024-07-28					16.7		
2024-08-01					19.2		
2024-08-05		20.6					
2024-08-06		20.3					
2024-08-14					19.6	17.4	
2024-08-15		24.9			18		
2024-08-16					20.8	16.9	
2024-08-17			19.9		22.7	20.3	
2024-08-18					16.4		
2024-08-25	29.2						
2024-08-26		19.8					
2024-08-27		22.4					
2024-10-20	37.8	19.4					
2024-10-21	31.6						
2024-10-22	32.4						
2024-10-29		16.7					
2024-10-30		16.8					
2025-06-04	32.3	25.2					
2025-06-05	29	28.7					
2025-06-07		23.8					
2025-06-08		25.3					
2025-06-11		19.6					
2025-06-12	27.6	27.5	23.5	22.8	22.6	23.4	
2025-06-13		29.9	24.7	28	31.9	26.1	
2025-06-24	27.8	19.7					
2025-07-04		33.7	26.7	20.8	16.8		
2025-07-05	28.1	28.7	19.6	22.6	17.5		
2025-07-26			29.9	35.7	25.9	28.8	23.4
2025-07-27			28.6	29.3	23.8	27.1	25.7
2025-07-30				18.2			
2025-08-04			21.3	26.3	19	20.6	19
2025-08-05				34.2	24.6	27.5	23.9
2025-08-06		23.6	23.1	28.4	21.1	23.8	19.6
2025-08-07		25.3		19.2		16.3	
2025-08-08		26.6					
2025-09-19		20.6					
2025-12-18			24	19.5	17.8	19.8	

Complete Monitor Level Results

A substantial number of days in 2023 and 2025 were influenced by Canadian wildfire smoke, elevating PM2.5 observations across Pennsylvania. The smoke's effects extended beyond Pennsylvania, with elevated concentrations also observed in regional areas.

Using EPA tools, dates were identified when Canadian wildfire smoke affected PM2.5 observations. As can be seen in Table 4, when these dates and associated smoke-influenced Tier 1 observations were removed from the record and annual design values were recalculated, design values were lowered by an average of 0.5 µg/m³ across these monitors. When Tier 2 dates were also removed, design values were an average of 0.9 µg/m³ lower than the unadjusted values (Table 5). These comparisons show that wildfire-affected days contributed meaningfully to the measured design values.

Table 3. Annual unadjusted mean concentrations and 3-year design values (µg/m3) at Pennsylvania monitors, 2023-2025.

				Annual Mean (µg/m3)			2023-2025 Annual Design Value (µg/m3)
State	**County**	**Site ID**	**Local Site Name**	**2023**	**2024**	**2025**	
Pennsylvania	Allegheny	420030064	Liberty	11.98	8.96	9.43	10.1
Pennsylvania	Allegheny	420031301	North Braddock	10.70	8.43	9.42	9.5
Pennsylvania	Philadelphia	421010004	Air Management Services Laboratory	12.35	9.99	9.59	10.6
Pennsylvania	Philadelphia	421010048	North East Waste	11.87	7.17	8.66	9.2
Pennsylvania	Philadelphia	421010055	Ritner	11.90	8.31	8.03	9.4
Pennsylvania	Philadelphia	421010057	Fire Administration Building	10.72	8.87	8.70	9.4
Pennsylvania	Philadelphia	421010075	Torresdale Station	13.27	9.36	8.02	10.2

Table 4. Annual mean concentrations and 3-year design values (µg/m3) at Pennsylvania monitors with Tier 1 dates removed, 2023-2025.

				Annual Mean (µg/m3)			2023-2025 Annual Design Value (µg/m3)
State	**County**	**Site ID**	**Local Site Name**	**2023**	**2024**	**2025**	
Pennsylvania	Allegheny	420030064	Liberty	11.44	8.96	9.43	9.9
Pennsylvania	Allegheny	420031301	North Braddock	9.75	8.43	9.20	9.1
Pennsylvania	Philadelphia	421010004	Air Management Services Laboratory	10.85	9.94	9.43	10.1
Pennsylvania	Philadelphia	421010048	North East Waste	10.24	7.17	8.32	8.6
Pennsylvania	Philadelphia	421010055	Ritner	9.81	8.31	7.87	8.7
Pennsylvania	Philadelphia	421010057	Fire Administration Building	9.16	8.87	8.46	8.8
Pennsylvania	Philadelphia	421010075	Torresdale Station	11.55	9.36	8.02	9.6

Table 5. Annual mean concentrations and 3-year design values (µg/m3) at Pennsylvania monitors with Tier 1 and Tier 2 dates removed, 2023-2025.

				Annual Mean (µg/m3)			2023-2025 Annual Design Value (µg/m3)
State	**County**	**Site ID**	**Local Site Name**	**2023**	**2024**	**2025**	
Pennsylvania	Allegheny	420030064	Liberty	10.81	8.57	9.16	9.5
Pennsylvania	Allegheny	420031301	North Braddock	9.02	8.01	8.78	8.6
Pennsylvania	Philadelphia	421010004	Air Management Services Laboratory	9.95	9.68	9.19	9.6
Pennsylvania	Philadelphia	421010048	North East Waste	9.50	7.14	8.12	8.3
Pennsylvania	Philadelphia	421010055	Ritner	8.82	8.04	7.62	8.2
Pennsylvania	Philadelphia	421010057	Fire Administration Building	8.52	8.69	8.26	8.5
Pennsylvania	Philadelphia	421010075	Torresdale Station	10.71	9.22	7.85	9.3

Recommendations

Based on the results of this analysis and the widespread impact of Canadian wildfire smoke on Pennsylvania monitors and regionwide, the following action is recommended.

1. Each date at monitors within Pennsylvania identified as Tier 1 with wildfire smoke present should be recognized as having been influenced by that smoke during the 2023-2025 timeframe and found to have increased PM2.5 concentrations. As a result, each monitor-date should be flagged as influenced by exceptional events, and the associated pollutant concentration values should be removed from the regulatory record used to determine design values and attainment designations.
2. Given the duration and extent of the wildfires, there are numerous Tier 2 days that should also be flagged as influenced. The "regulatory significant" nomenclature typically applied to concurring with exceptional events demonstrations should not be limited to the attainment / nonattainment determination and instead should include any date or concentration that was enhanced by wildfire smoke, regardless of the attainment outcome of the exceptions.
3. Consideration should be given to excluding dates and concentrations at other monitors outside of Pennsylvania, but in the same regional airshed, that would have also been impacted by Canadian wildfire smoke during the same 2023-2025 episodes. This may include simply referencing other state exceptional events demonstrations when proximal monitors were impacted on the same dates and by the same wildfire plumes.
4. Consideration should be given to all regional states to allow limited information necessary to support the clear causal relationship criterion for any wildfire date that fell within the 2023-2025 Canadian wildfire episode. Ample evidence has been provided here and elsewhere to support the fact that smoke from Canadian wildfires in select episodes in 2023, 2024, and 2025 had significant impact on PM2.5 observations and enhanced concentrations beyond reasonable and typical conditions. As it is understood that many states are preparing exceptional events demonstrations for monitors and dates affected during the Canadian wildfire episodes of 2023 and 2025, it would be appropriate to allow for information in this document to be adopted to satisfy Tier 1 obligations in those demonstrations.
5. To the extent that EPA believes additional information is needed to remove exceptional event days related to Canadian wildfires to adequately assess air quality conditions and determine whether an area meets applicable NAAQS, areas should be designated as unclassifiable. Assigning an attainment or nonattainment designation without a complete and reliable evidentiary basis could result in an inaccurate characterization of the area's air quality status. An unclassifiable designation provides the opportunity to conduct additional monitoring, refine technical analyses, and resolve outstanding uncertainties, thereby supporting a scientifically defensible and appropriate designation.