



Upper Hunter Air Quality Monitoring Network Analysis Project

Annual Review for Calendar Year 2025

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Zephyr Environmental Pty Ltd
PO Box 41
Rozelle NSW 2039

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Acronyms and Abbreviations

Name	Description
BG	Background
CY	Calendar year
DG	Diagnostic
LP	Larger populations
NSWMC	NSW Minerals Council
(NSW) DCCEEW	(NSW) Department of Climate Change, Energy, the Environment and Water
PM _{2.5}	Particulate matter <2.5 µm
PM ₁₀	Particulate matter <10 µm
SC	Smaller communities
UHAQMN	Upper Hunter Air Quality Monitoring Network
UHMD	Upper Hunter Mining Dialogue

1 INTRODUCTION

1.1 Overview

Zephyr Environmental Pty Ltd (Zephyr) has been commissioned by the NSW Minerals Council (NSWMC) Upper Hunter Mining Dialogue (UHMD) to provide an updated air quality analysis, now incorporating the calendar year (CY) 2025, for the Upper Hunter following continued interest in air quality in the region.

The analysis of CY2025 air quality data follows on from the previous work prepared on air quality trends across NSW namely:

- Air Quality Monitoring Data Analysis Project ('the AQ Data Analysis Project', dated 16 November 2020).
- Upper Hunter Air Quality Monitoring Network Analysis Project ('0012 UHMD UHAQMN Annual Data Review L1 Final Update', dated 9 December 2021)
- Upper Hunter Air Quality Monitoring Network Analysis Project – Annual Review for 2021 and 2022 ('0130 NSWMC UHAQMP Annual Data Review Final, dated 26 October 2023)
- Upper Hunter Air Quality Monitoring Network Analysis Project – Annual Review for 2023 ('0205 NSWMC UHAQMP CY23 Annual Data Review Final, dated 26 April 2024)
- Upper Hunter Air Quality Monitoring Network Analysis Project – Annual Review for 2024 ('0275 NSWMC UHAQMP CY24 Annual Data Review Final, dated 26 February 2025)

1.2 Original AQ Data Analysis Project

Section 1 of the AQ Data Analysis Project provides background and context to this work, and confirms that the original project was designed to answer two specific air quality questions:

1. Has the air quality in the Upper Hunter Valley changed since monitoring began? and
2. Is the air quality in the Upper Hunter Valley measured at the monitoring stations different from air quality measured at other locations in NSW?

Section 2 of the AQ Data Analysis Project provides an overview of particulate matter size fractions and ambient air quality criteria, including definitions of the terms PM₁₀ and PM_{2.5} (particulate matter less than 10 and 2.5 micrometres in aerodynamic diameter, respectively).

Section 3 of the AQ Data Analysis Project provides detail on the 14 air quality monitoring stations that comprise the Upper Hunter Air Quality Monitoring Network (UHAQMN) and their grouping to reflect the following purposes:

- Larger populations
- Smaller communities
- Diagnostic
- Background

Table 1-1 presents a summary of station and the purpose of the stations within the UHAQMN.

Table 1-1: Summary of stations / purpose within the UHAQMN

Station type	Purpose	Stations
Larger populations	Monitoring air quality in the larger population centre	- Muswellbrook - Singleton - Aberdeen
Smaller communities	Monitoring air quality in the smaller communities	- Bulga - Camberwell - Jerrys Plains - Maison Dieu - Warkworth - Wybong
Diagnostic	Providing data that can help to diagnose the likely sources and movement of particles across the region as a whole; they do not provide information about air quality at population centres	- Mount Thorley - Muswellbrook NW - Singleton NW
Background	Provide background data; located at both ends of the valley they measure the quality of air entering and leaving the Upper Hunter Valley under predominant winds (south-easterlies and north-westerlies)	- Merriwa - Singleton South

Section 4 and Section 5 of the AQ Data Analysis Project provide a summary of the air quality monitoring data collected to date and their analysis respectively.

1.3 Annual Review for Calendar Year 2025

The focus of this report is to provide an update to the AQ Data Analysis Project, now including data from CY2025. This report has additionally considered overburden removed across the Hunter Valley and compared this against air quality data and rainfall data. This report provides the following:

- Section 2 – Monitoring data update
- Section 3 – Analysis
- Section 4 – Conclusion
- Appendix A: Additional data tables

2 MONITORING DATA UPDATE

The NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) provide available ambient air quality monitoring data for NSW via their data download facility. Data has been gathered for the most recent complete calendar year of CY2025.

This section provides a summary of annual and period average PM₁₀ and PM_{2.5} monitoring results (respectively) that have been averaged into regions/groups for comparison. Table 2-1 provides PM₁₀ results and Table 2-2 provides PM_{2.5} results.

Results have been shaded using a green to red colour relative gradient scheme with lowest values shown in green, and highest values shown in red, with the median value shown in yellow. This gradient scheme has been applied to the annual data and 'all years' groups separately.

For CY2025, the Central Tablelands region had insufficient data capture of PM₁₀ concentrations and therefore no data was available for comparison.

For the average across all years, the highest concentrations of PM₁₀ are measured at the UHAQMN Diagnostic stations, with the next highest observed at the Lower Hunter & Central Coast stations. The highest concentrations of PM_{2.5} are measured at the UHAQMN Large Population stations, with the next highest observed at the Sydney north-west stations. The lowest concentrations are measured at the Central Tablelands for PM₁₀ and Illawarra for PM_{2.5}, respectively.

There has been a mixture of increases and decreases in the annual average PM₁₀ concentrations from CY2024 to CY2025. There have been increases in the annual average PM₁₀ concentrations at the North West slopes, South West slopes, Sydney North West, and all the UHAQMN locations (background, diagnostic, large populations and smaller communities). There have been decreases in the annual average PM₁₀ concentrations at Illawarra, Lower Hunter & Central Coast, Sydney East, and Sydney South West. The CY2025 averages for PM₁₀ remain below the 'all years' average for all regions/groups except for the South West slopes (CY2025 = 20.6 µg/m³ and 'all Years' = 18.5µg/m³).

There has been a mixture of increases and decreases in the annual average PM_{2.5} concentrations from CY2024 to CY2025. There has been an increase in the annual average PM_{2.5} concentrations at the South West slopes, whereas all other regions/groups have seen a decrease. The CY2025 average PM_{2.5} concentrations remain below the 'all years' average for all regions/groups.

Table 2-1: Summary of and period average PM₁₀ concentrations by region/group and year (µg/m³)

Region / Group	Year													Average All Years
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
Central Tablelands	15.1	14.6	13.4	13.3	14.1	18.8	27.4	17.0	11.4	8.7	12.5	12.6	~*	14.9
Illawarra	16.9	17.1	16.2	17.4	18.0	20.1	22.5	19.1	15.3	13.2	16.9	18.2	17.4	17.6
Lower Hunter & Central Coast	20.2	18.2	21.7	22.0	22.9	25.2	29.1	22.3	19.2	17.6	20.9	20.9	20.7	21.6
North West Slopes	16.6	15.8	14.1	15.3	15.3	20.1	33.7	16.8	12.7	10.6	15.1	13.3	13.6	16.4
South West Slopes	10.0	18.3	17.3	17.9	18.2	23.6	29.4	21.7	16.0	12.4	15.5	19.5	20.6	18.5
Sydney East	17.9	17.3	16.8	17.2	18.3	20.2	23.6	19.2	15.9	13.5	16.1	17.0	16.2	17.6
Sydney North West	17.5	16.6	15.1	17.0	17.0	20.3	24.9	18.7	15.7	11.9	17.8	16.3	16.6	17.3
Sydney South West	16.3	16.0	14.8	15.6	16.1	18.9	23.3	17.2	13.8	11.1	15.2	15.3	15.0	16.0
UHAQMN - BG	17.6	16.8	15.1	15.8	16.8	21.1	29.3	19.0	14.1	12.6	16.8	16.0	16.6	17.5
UHAQMN - DG	23.2	21.1	19.1	20.4	22.2	29.0	34.9	21.7	16.7	14.6	21.9	19.2	20.6	21.9
UHAQMN - LP	21.1	20.1	17.9	18.0	20.0	24.5	31.3	20.3	16.2	14.5	18.8	17.1	18.1	19.8
UHAQMN - SC	21.4	20.1	17.7	18.6	20.7	25.4	33.4	21.2	16.4	14.2	21.3	19.6	20.1	20.8

Note: * insufficient data capture. UHAQMN – upper hunter air quality monitoring network, BG - background, DG – diagnostic, LP – larger populations, SC – smaller communities

0% (Min.)	10%	20%	30%	40%	50% (Median)	60%	70%	80%	90%	100% (Max)
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Colour Coding by Percentile (scheme applied independently to annual data and 'all years')

Table 2-2: Summary of and period average PM_{2.5} concentrations by region/group and year (µg/m³)

Region / Group	Year													Average All Years
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
Illawarra	7.7	7.0	7.0	7.3	6.9	7.1	11.1	7.2	5.3	4.3	5.3	5.7	5.2	6.7
Lower Hunter & Central Coast	7.5	7.0	7.5	7.8	7.7	8.2	17.3	7.6	6.3	5.5	6.8	6.5	6.4	7.9
South West Slopes	7.9	7.5	7.6	7.4	8.1	8.4	11.3	10.9	6.3	5.3	6.6	7.4	7.7	7.9
Sydney East	8.2	8.4	8.3	8.1	8.4	8.2	16.5	8.0	6.9	5.2	7.1	6.6	6.5	8.2
Sydney North West	8.3	6.7	8.0	8.3	7.4	8.3	20.5	8.2	6.9	5.1	7.1	6.9	6.5	8.3
Sydney South West	8.0	7.5	7.4	7.6	7.8	8.7	18.9	7.9	7.0	5.0	6.8	6.1	6.0	8.0
UHAQMN - LP	8.7	8.8	8.2	8.2	8.8	8.8	18.0	8.9	6.8	5.7	7.1	7.3	6.7	8.6
UHAQMN - SC	8.2	7.8	7.2	7.5	7.4	8.4	17.3	7.5	5.7	4.8	6.1	5.9	5.5	7.6

Note: UHAQMN – upper hunter air quality monitoring network, LP – larger populations, SC – smaller communities

0% (Min.)	10%	20%	30%	40%	50% (Median)	60%	70%	80%	90%	100% (Max)
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Colour Coding by Percentile (scheme applied independently to annual data and 'all years')

3 ANALYSIS

3.1 Overview

Provided below are revisions of some of the key data tables and figures from the AQ Data Analysis Project, updated to include data from CY2025. Additional commentary is provided as it relates to the inclusion of the CY2025 data.

3.2 Comparison of UHAQMN and remainder of NSW

This section presents a comparison of annual average PM₁₀ and PM_{2.5} concentrations measured across the UHAQMN versus the remainder of NSW. The aim of the comparison is to identify if trends experienced across the UHAQMN are also being experienced across the rest of NSW.

Figure 3-1 presents a graphical representation of the comparison of average PM₁₀ concentrations measured across NSW, with the UHAQMN and the remainder of NSW shown separately.

An inventory of this annual data and the percentage of the respective 2013-2025 average have been presented in Table A-1 found in the appendix of this report.

As noted within the AQ Data Analysis Project and reinforced with the inclusion of CY2021 - CY2025 data, the consistency of temporal trends in the UHAQMN and 'Remainder of NSW' monitoring subsets show that the changes in PM₁₀ concentrations within the Upper Hunter are generally consistent with changes experienced across the rest of NSW.

It is noted that the 'Remainder of NSW' PM₁₀ concentrations have increased by 1% from CY2024 to CY2025 (17.6 µg/m³ to 17.7 µg/m³). The UHAQMN PM₁₀ concentrations have increased by 4% from CY2024 to CY2025 (18.7 µg/m³ to 19.4 µg/m³). Both, the 'Remainder of NSW' values and the UHAQMN remain below their respective 'all years' average.

This indicates that the changes in annual average PM₁₀ concentrations are consistent with regional particulate sources and that the contribution of mining operations on the UHAQMN to these trends is not discernible.

Figure 3-2 presents a graphical representation of the comparison of average PM_{2.5} concentrations measured across NSW, with the UHAQMN and the remainder of NSW shown separately. It should be noted that PM_{2.5} has a lesser association with mechanically generated particulate emissions such as those from mining.

For PM_{2.5}, 'Remainder of NSW' annual average concentrations have reduced from CY2024 to CY2025 but only by 0.2 µg/m³, whereas concentrations from the UHAQMN have reduced by 0.5 µg/m³. Both 'Remainder of NSW' and the UHAQMN annual average concentrations for CY2025 are 6.3 µg/m³.

Notably, the CY2025 PM₁₀ data for the UHAQMN is below the 'all years' average. The recorded concentrations are higher than values recorded in the particularly high rainfall years of CY2021 and CY2022. The recorded concentrations are lower than values recorded in CY2018, CY2020, CY2023 and substantially lower than the anomalously high CY2019 value associated with the 'Black Summer' bushfire event. A similar pattern is also observed in PM_{2.5}, indicating that changes in PM_{2.5} (less likely to be attributed to mining operations) are generally consistent with those observed elsewhere in NSW. As with the PM₁₀ data set, the values for CY2025 emphasise that the annual average for CY2019 was anomalously high.

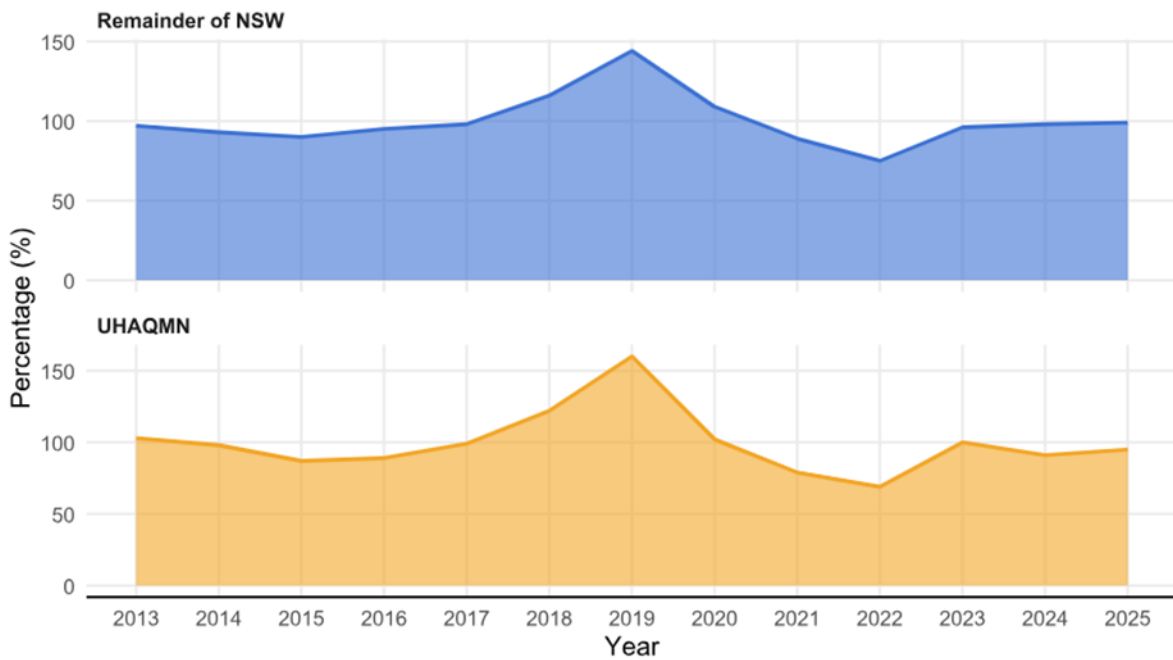


Figure 3-1: Comparison of PM₁₀ variability – UHAQMN vs remainder of NSW regions

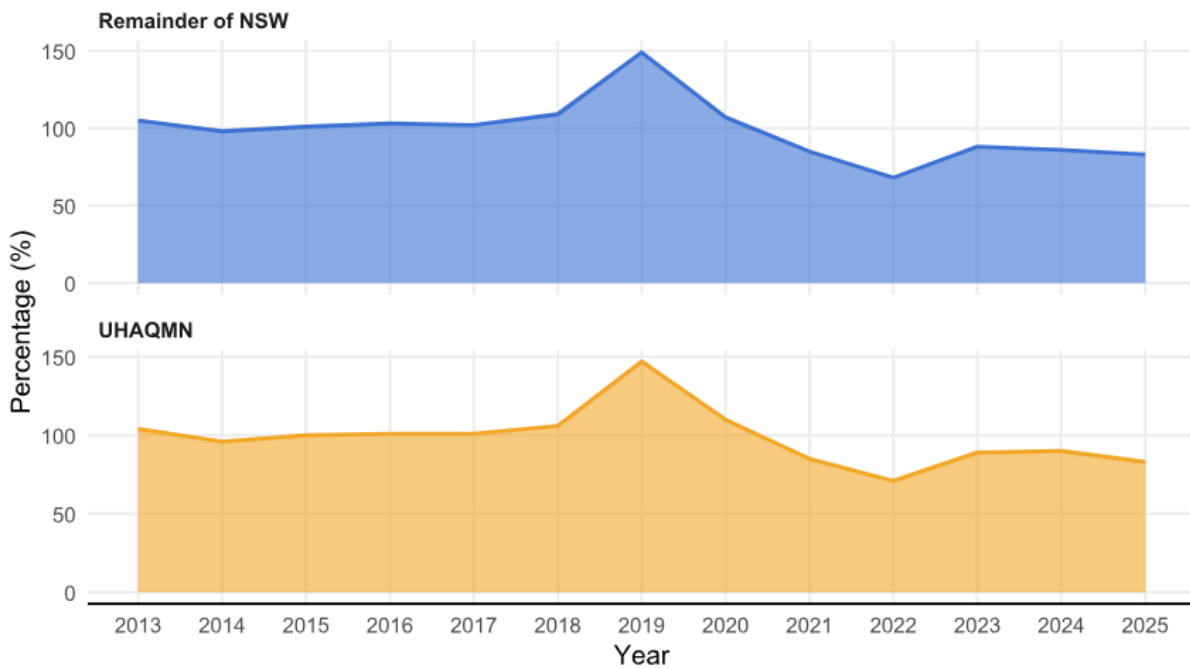


Figure 3-2: Comparison of PM_{2.5} variability – UHAQMN vs remainder of NSW regions

3.3 Comparison across sub-divisions of the UHAQMN

This section reviews the data for the four-station group sub-divisions to understand if trends are similar across the groups. For this review, the annual variance (i.e., the current year annual average minus the ‘all years’ annual average) has been provided for each station group. Figure 3-3 presents the annual PM₁₀ variance against the CY2013 – CY2025 average PM₁₀ concentration for that station group. This is instructive in showing changes in the difference between station groups across the study period, into CY2025.

An inventory of the annual PM₁₀ variance against the CY2013 – CY2025 average PM₁₀ concentration can be found in the Appendix of this report (Table A-2).

Figure 3-3 shows that the differences between PM₁₀ concentrations at Background stations and Diagnostic stations are near identical across CY2013-CY2025 (up to 1 µg/m³ variability), while the range in annual average PM₁₀ concentrations across this period is 22 µg/m³. This reinforces that changes in Upper Hunter PM₁₀ concentrations are associated with regional conditions and are indicative of a minimal change in the contribution from local emission sources inclusive of mining.

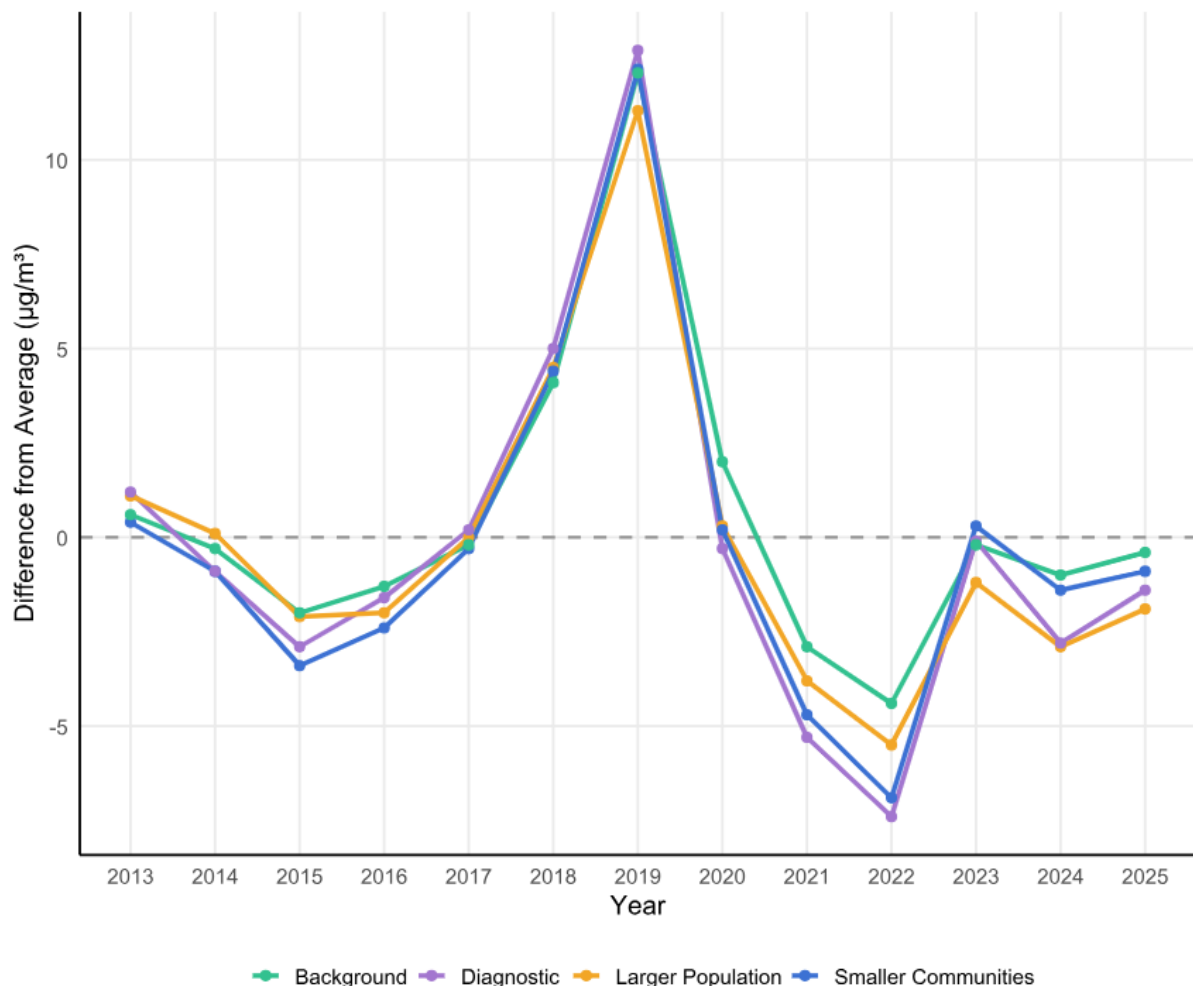


Figure 3-3: Comparison of trends between each UHAQMN station group

3.4 Comparison of UHAQMN and Bulga, Mount Thorley, Warkworth stations

A comparison of the UHAQMN against the Bulga, Mount Thorley and Warkworth stations has been included following a request from members of the Working Group to understand how the air quality compares across these specific locations.

As identified earlier, Bulga and Warkworth are within the smaller community station grouping and Mount Thorley is within the diagnostic grouping. The annual average PM₁₀ concentrations measured across the Bulga, Mount Thorley and Warkworth monitoring stations have been compared against the UHAQMN for CY2018 to CY2025. These three stations and the UHAQMN show concentrations increasing from CY2018 to CY2019 associated with the ‘Black Summer’ bushfire events. All three sites show a reduction in concentrations year on year from CY2019 through to CY2022, due to higher-than-average rainfall volumes particularly in CY2021-CY2022, and then an increase in concentrations from 2022 to 2023. For CY2025, the concentrations have increased when compared with CY2024. The UHAQMN follows the same trend.

Figure 3-4 presents a comparison of trends between the combined average of Bulga, Mount Thorley, Warkworth compared to the UH average.

Figure 3-5 presents a comparison of trends between each of the individual stations of Bulga, Mount Thorley, Warkworth, and the UH average.

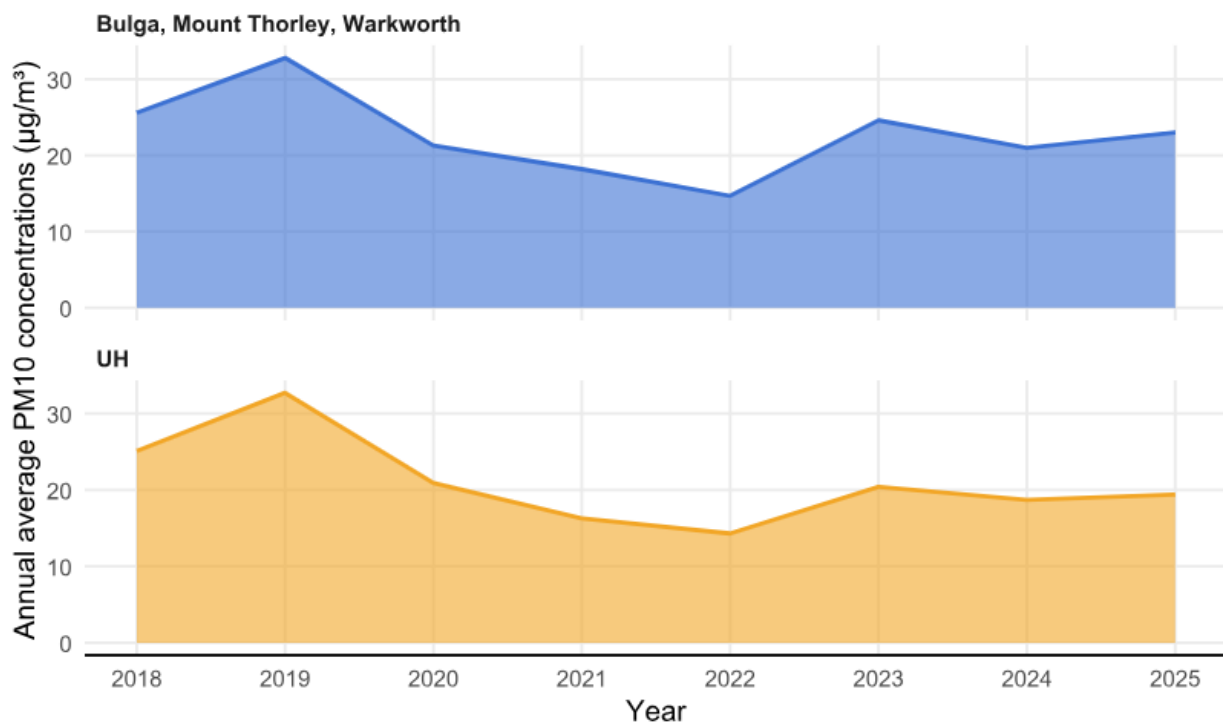


Figure 3-4: Comparison of trends between Bulga, Mount Thorley, and Warkworth combined average and UH average

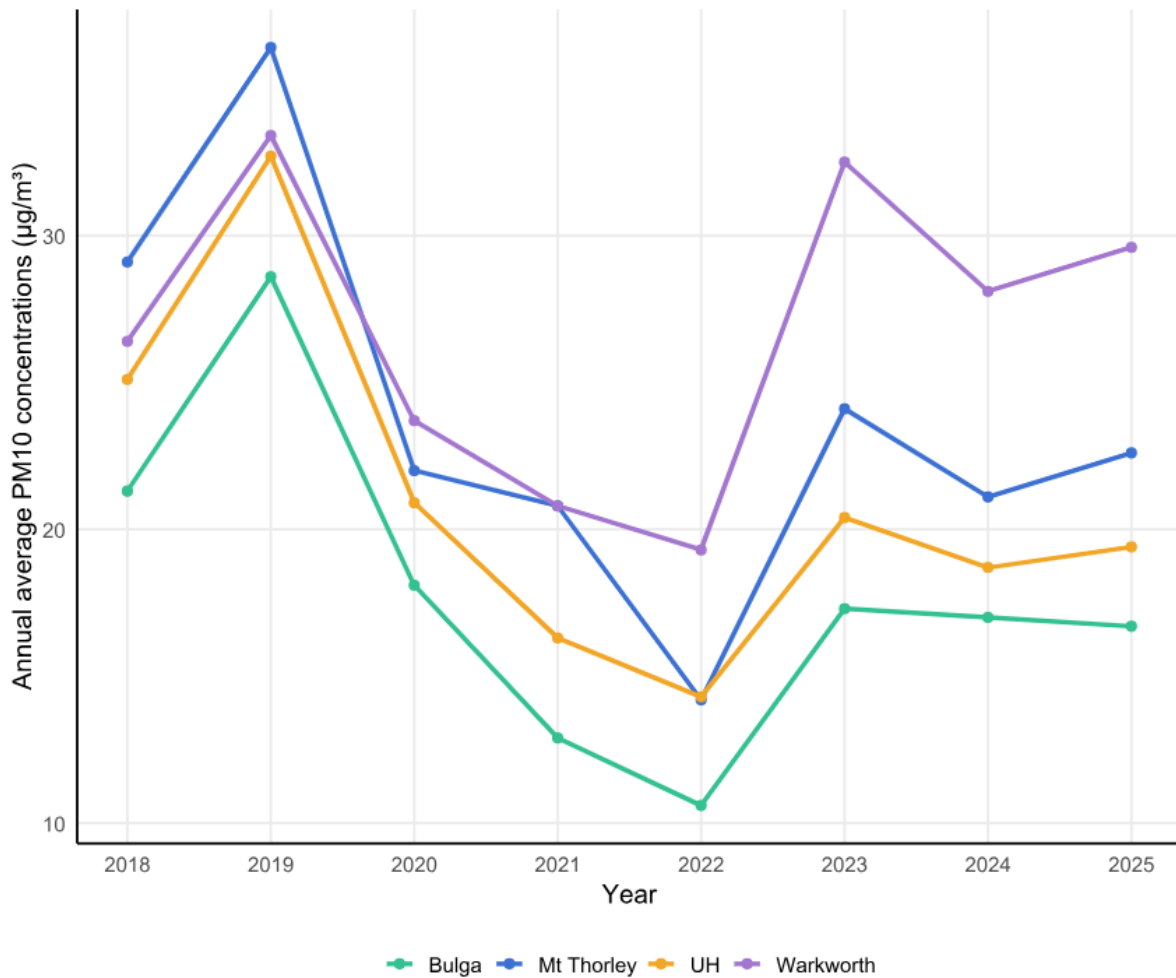


Figure 3-5: Comparison of trends between Bulga, Mount Thorley, Warkworth and UH average

3.5 Comparison of exceedances of 24-hour average PM₁₀ criterion

This section provides a comparison of the number of exceedances of the 24-hour average PM₁₀ criterion for each region / group for the last 13 years of monitoring. In contrast to a review of annual data, the review of 24-hour average exceedances provides an understanding of the short-term peaks in PM₁₀, where these are located and the frequency that measurements are above NSW EPA criterion.

Data for exceedances of 24-hour average PM₁₀ criterion has been gathered for the most recent complete calendar year of CY2025 and all previous years. Table 3-1 presents a summary of the number of exceedances of the 24-hour average PM₁₀ criterion that have been averaged into regions/groups. Results have been shaded using a green to red colour relative gradient scheme with lowest values shown in green, and highest values shown in red, with the median value shown in yellow. This gradient scheme has been applied to the annual data and 'all years' groups separately.

Table 3-1: Number of exceedances of 24-hour average PM₁₀ criterion by region / group (µg/m³)

Region / Group	Year													Average All Years
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
Central Tablelands	3	0	2	0	0	8	40	14	0	0	2	0	1	5
Illawarra	4	0	0	2	2	6	17	13	0	0	3	1	3	4
Lower Hunter & Central Coast	3	1	12	9	11	20	39	14	4	5	8	7	8	11
North West Slopes	0	1	1	1	2	9	52	8	0	0	0	0	1	6
South West Slopes	9	10	5	9	5	21	44	22	4	0	1	5	9	11
Sydney East	3	0	1	1	1	5	19	8	0	0	1	0	1	3
Sydney North West	4	0	1	3	1	8	26	10	1	0	0	0	1	4
Sydney South West	3	0	1	3	2	6	25	9	2	0	2	0	1	4
UHAQMN - BG	3	2	2	0	1	8	46	12	1	0	1	1	3	6
UHAQMN - DG	18	3	4	3	11	22	63	14	2	0	9	4	8	13
UHAQMN - LP	5	1	2	0	3	10	50	11	0	0	1	0	2	7
UHAQMN - SC	15	6	4	2	8	19	60	15	2	0	10	7	9	12

Note: UHAQMN – upper hunter air quality monitoring network, BG - background, DG – diagnostic, LP – larger populations, SC – smaller communities

0% (Min.)	10%	20%	30%	40%	50% (Median)	60%	70%	80%	90%	100% (Max)
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Colour Coding by Percentile (scheme applied independently to annual data and 'all years')

For the average across all years, the highest number of exceedance days have been recorded at UHAQMN Diagnostic stations, with the next highest observed at UHAQMN Smaller communities, followed by South West Slopes and Lower Hunter.

For CY2025, all locations recorded exceedance days below the 'all years' average. Of the 12 station groupings all show exceedance days, yet five of these have only one exceedance day for the entirety of CY2025. When compared against CY2024, all locations in CY2025 showed higher exceedance days than CY2024.

Figure 3-6 presents a comparison of the number of exceedance days of the 24-hour average PM₁₀ criterion at the grouped UHAQMN stations for CY2013 to CY2025. The figure shows that these grouped locations show generally the same trend. Figure 3-7 presents a comparison of the average number of exceedance days of the 24-hour average PM₁₀ criterion for the 'Remainder of NSW' and 'UHAQMN'. Again, the figure shows that these grouped locations show generally the same trend, regardless of the location.

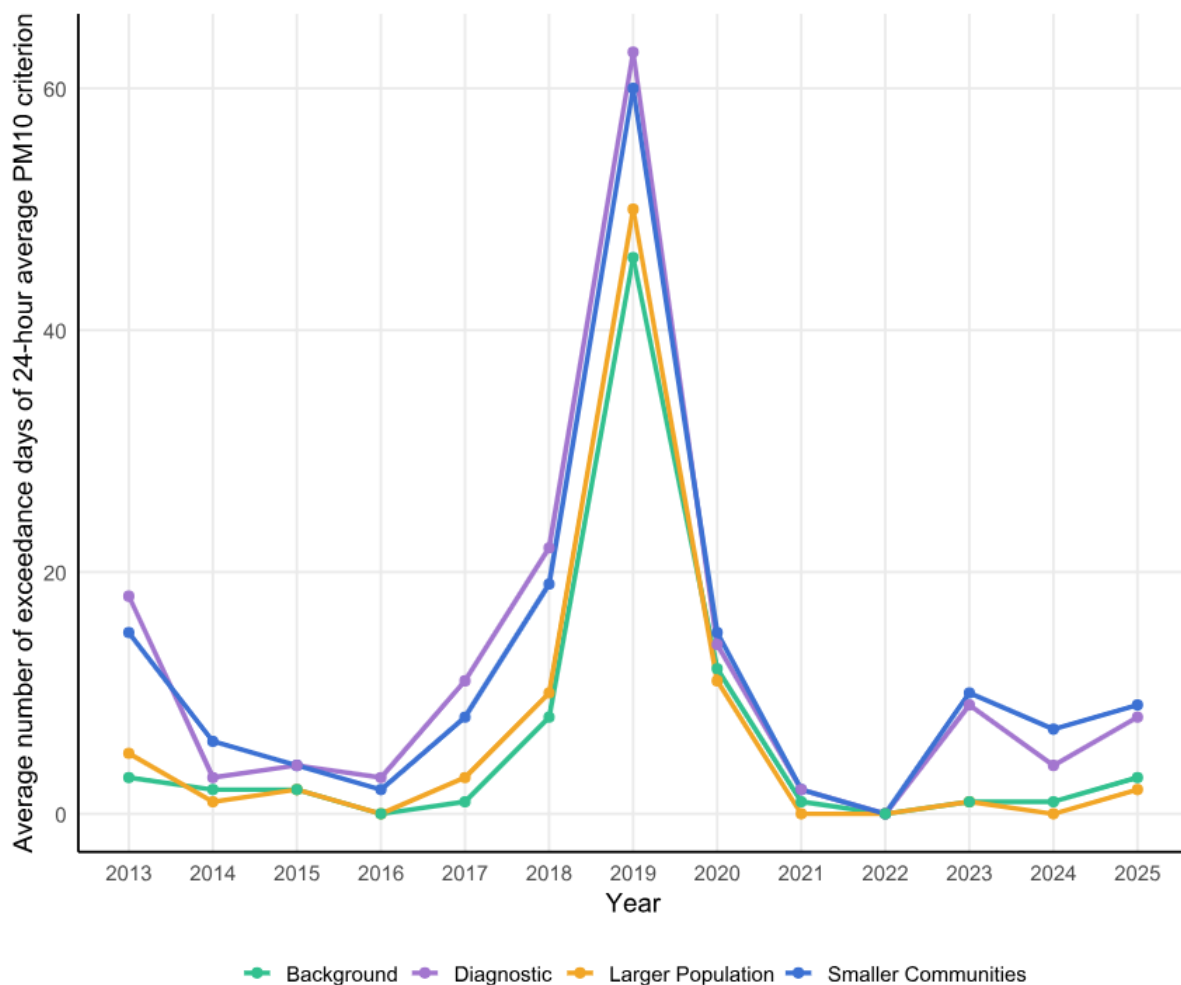


Figure 3-6: Comparison of the number of exceedance days of the 24-hour average PM₁₀ criterion at the grouped UHAQMN stations for 2013 to 2025

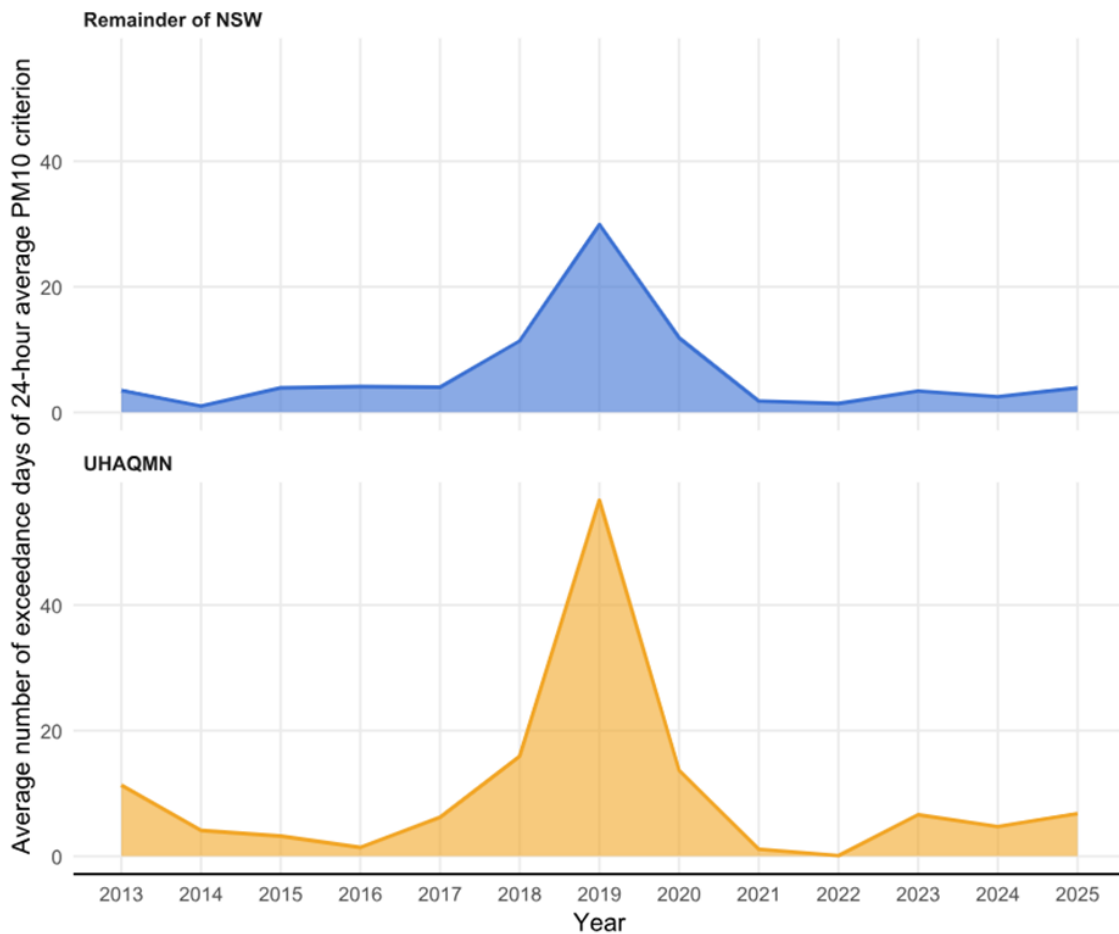


Figure 3-7: Comparison of the average number of exceedance days of the 24-hour average PM₁₀ criterion for the 'Remainder of NSW' and 'UHAQMN'

3.6 Comparison of UHAQMN annual average PM₁₀ and NSW/ACT rainfall

Rainfall (or the lack of) is a key component when discussing particulate matter concentrations. This section compares annual average PM₁₀ concentrations and annual rainfall totals with the aim of understanding the strength of the relationship between the two.

In Appendix A1.4 of the AQ Data Analysis Project, the conclusion is that there is a statistically significant relationship between NSW mean annual rainfall and annual average PM₁₀. Figure 3-8 presents NSW/ACT annual rainfall and UHAQMN annual average PM₁₀ over the period CY2013-CY2025. An inventory of this data can also be found in Table A-3 of the Appendix of this report.

Figure 3-8 clearly shows that there is a negative correlation between rainfall and particulate matter concentrations across the UHAQMN. Given the consistency between PM₁₀ trends across NSW and the UHAQMN (refer Figure 3-1), this relationship also holds for NSW PM₁₀ concentrations more broadly. In Figure 3-8, the annual average PM₁₀ concentration is represented in yellow / orange and the NSW rainfall is represented with the blue line.

CY2025 data reinforces this negative correlation. PM₁₀ shows a moderate decrease in line with a moderate increase in rainfall, compared to very high rainfall conditions and corresponding low PM₁₀ during CY2021-CY2022 (La Niña climatic conditions). A very strong negative correlation was observed between annual rainfall and PM₁₀ concentrations ($r = -0.85$). The ' r ' value has been chosen, as opposed to ' R^2 ', as this is the most informative when trying to understand the nature of a

relationship between two variables. A perfect positive correlation is +1 and a perfect negative correlation is -1.

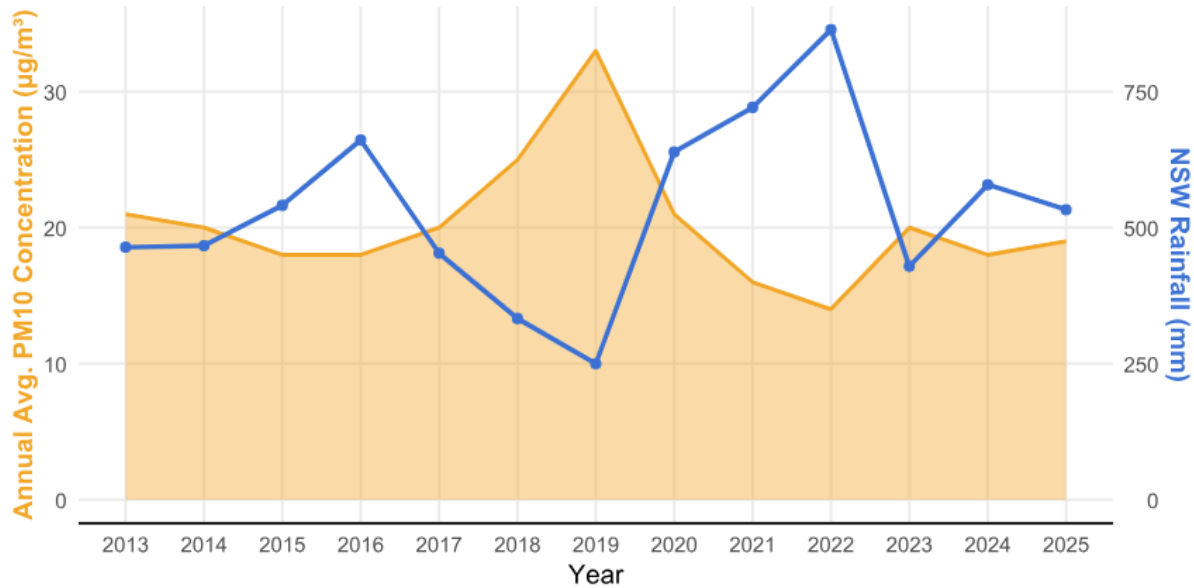


Figure 3-8: NSW / ACT annual rainfall and UHAQMN annual average PM₁₀

3.7 Comparison of UHAQMN annual average PM₁₀ and Hunter Valley Coal Production

This section compares annual average PM₁₀ concentrations and annual raw coal production across the Hunter Valley with the aim of understanding the strength of the relationship between the two.

Appendix A1.1 of the AQ Data Analysis Project demonstrated that, over the period CY2013-CY2019, the relationship between annual coal production and annual average PM₁₀ is not statistically significant. Similarly, Appendix A1.2 of the AQ Data Analysis Project showed that the relationship between annual National Pollutant Inventory (NPI) reported PM₁₀ emissions and annual average PM₁₀ concentrations is not statistically significant. This update now presents a comparison of Hunter Valley coal production data and PM₁₀ concentrations measured by the UHAQMN including data for CY2025. Table 3-2 presents the Hunter Valley raw coal production between CY2013 and CY2025.

Table 3-2: Hunter Valley raw coal production (2013-2025)

Year	Hunter Valley Raw Coal Production (Mt)	Percentage of 2013 Raw Coal Production (%)
2013	158	100
2014	160	102
2015	146	92
2016	145	92
2017	146	92
2018	151	96
2019	155	99
2020	146	92
2021	142	90
2022	126	80
2023	136	86
2024	141	89
2025	143	91

CY2013 has been nominated as a reference year to show the relative scale of coal production since the beginning of the monitoring study period. As shown in Table 3-2, the annual Hunter Valley raw coal production rates have been generally consistent over the period CY2013-CY2021, ranging between 90% and 102% of the 2013 value. However, production levels have been decreasing year on year from CY2019 through to CY2022, before increasing again in CY2023 and CY2025. Annual coal production rates for CY2025 are higher than CY2021, CY2022, CY2023, CY2024 but lower than all other previous years.

Figure 3-9 presents the comparison of Hunter Valley coal production data and UHAQMN annual average PM₁₀ concentrations. The annual average PM₁₀ concentration is represented in green / purple / orange / blue and the annual coal production is represented as the dotted line.



Figure 3-9: Comparison of Hunter Valley coal production data and UHAQMN annual average PM₁₀ concentrations

As shown in these data, there is no visually apparent correlation between raw coal production and ambient PM₁₀ concentrations measured by the UHAQMN between CY2013 and CY2019. Figure 3-9 shows inconsistency in the scale of variability in each metric across CY2013-CY2019, with minor proportional variability in coal production relative to significant proportional variability in annual average PM₁₀.

From CY2019 to CY2022, both coal production and annual average PM₁₀ concentrations have reduced year on year. In CY2023, coal production was higher than in CY2022, while PM₁₀ concentration increased across the UHAQMN. In CY2024, coal production has increased from CY2023, whilst PM₁₀ concentrations have reduced. For CY2025 coal production has increased from CY2024 and so has PM₁₀ concentrations. There is more of a visually apparent correlation between raw coal production and ambient PM₁₀ concentrations measured by the UHAQMN between CY2020 and CY2025. This correlation however cannot be inferred as direct causation as many factors play into both raw coal production and ambient PM₁₀ concentrations. As noted above, rainfall has a strong relationship with PM₁₀, and causes business interruption to mining activity, hence a year with lower rainfall may show an increase in both raw coal production and PM₁₀ concentrations.

Across the entire period (CY2013 to CY2025) there is a moderate to strong positive correlation observed ranging from $r = 0.55$ (at background stations) to $r = 0.65$ (at large populations). Whilst the correlation coefficients have increased over time, the fluctuations in annual average PM₁₀ concentrations are anticipated to be related to ambient temperatures and the amount of rainfall during each of these years, rather than changes in coal production. This can be seen in rainfall levels providing a stronger statistical explanation when comparing with annual average PM₁₀ data ($r = -0.85$) compared to coal production (ranging from $r = 0.55$ to 0.65).

It is recommended that relationships between PM₁₀ concentrations, coal production and rainfall continue to be reevaluated annually.

3.8 Comparison of UHAQMN annual average PM₁₀ and Hunter Valley overburden removal

This section compares annual average PM₁₀ concentrations and overburden removed across the Hunter Valley with the aim of understanding the strength of the relationship between the two.

This update now presents a comparison of Hunter Valley overburden removal data and PM₁₀ concentrations measured by the UHAQMN including data for CY2025. Table 3-3 presents the Hunter Valley overburden removal between CY2016 and CY2025.

Table 3-3: Hunter Valley overburden removed (2016-2025)

Year	Hunter Valley Overburden Removed ('000m ³)	Percentage of 2016 Overburden Removed (%)
2016	649,187	100
2017	653,447	101
2018	685,683	106
2019	735,480	113
2020	694,933	107
2021	663,081	102
2022	610,881	94
2023	695,520	107
2024	685,635	106
2025	696,480	107

CY2016 has been nominated as a reference year to show the relative scale of overburden removed from when data is available (CY2016). As shown in Table 3-3, the annual Hunter Valley overburden removal rates have been generally consistent over the period CY2016-CY2025, ranging between 94% and 113% of the 2016 value. However, removal levels have been increasing year on year from CY2016 through to CY2019, before decreasing again in CY2020 to CY2022. This stabilises out in CY2023 to CY2025 around 106-107%. Overburden removal rates for CY2025 is higher than all previous years except for CY2019.

Figure 3-10 presents the comparison of Hunter Valley overburden removal data and UHAQMN annual average PM₁₀ concentrations. The annual average PM₁₀ concentration is represented in yellow / orange, and the annual overburden removal is represented as the dark purple dots and line.

Figure 3-11 presents a further comparison of Hunter Valley overburden removal data against NSW annual rainfall. The NSW annual rainfall is represented in blue, and the annual overburden removal is represented as the dark purple dots and line.

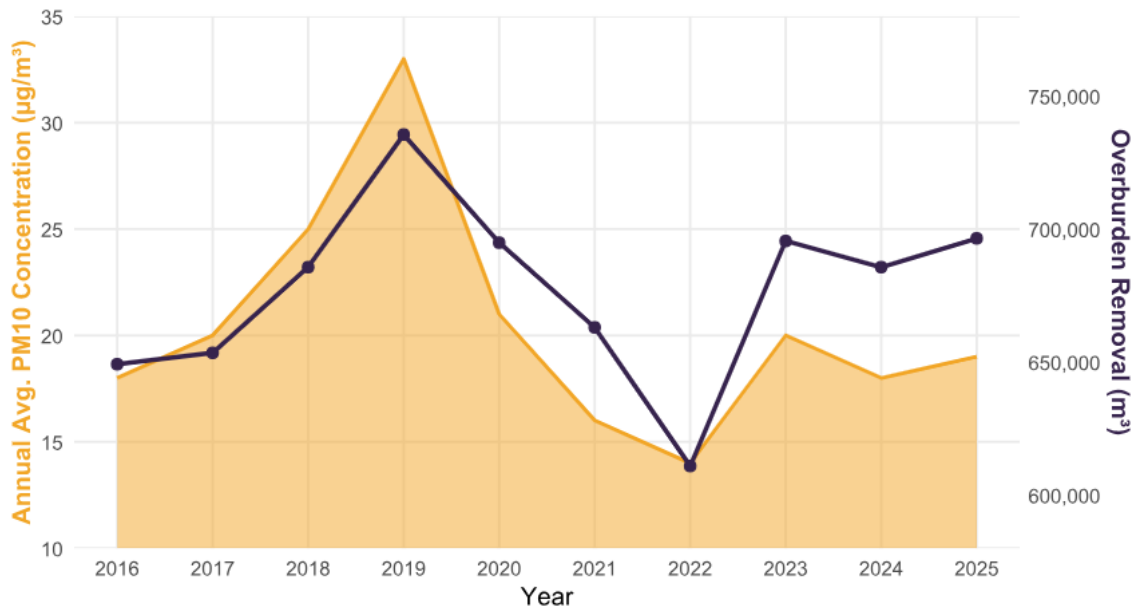


Figure 3-10: Comparison of Hunter Valley overburden removed data and UHAQMN annual average PM₁₀ concentrations

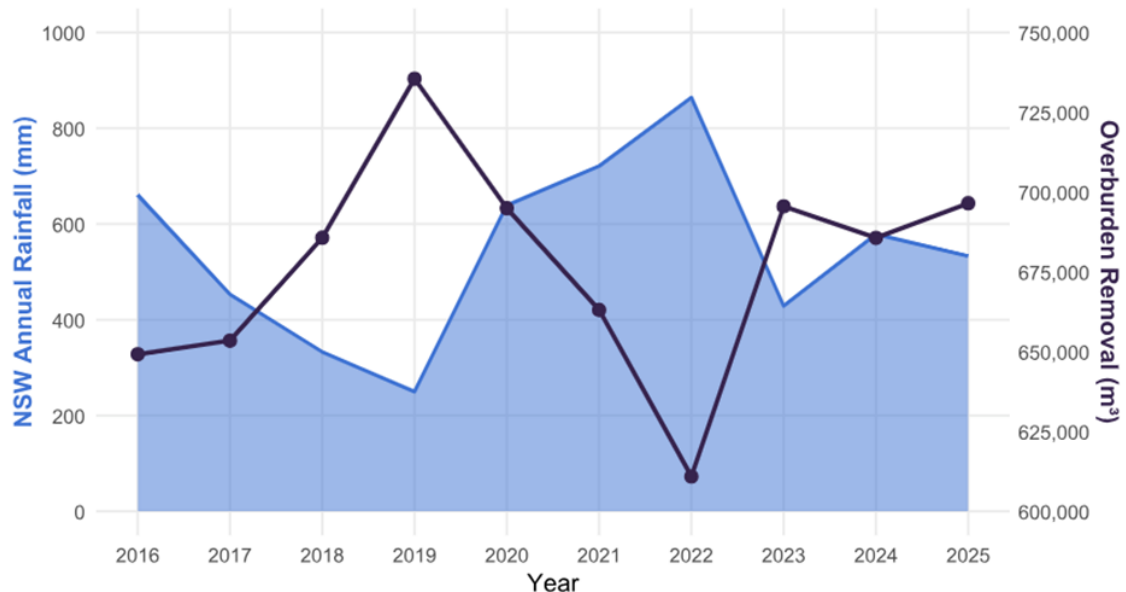


Figure 3-11: Comparison of Hunter Valley overburden removed data and rainfall data

As shown in these data, there is a visually apparent correlation between overburden and ambient PM₁₀ concentrations measured by the UHAQMN between CY2016 and CY2025. There is a strong positive correlation between overburden removal and PM₁₀ levels ($r = 0.79$). Yet, overburden and rainfall had a

strong negative correlation ($r = -0.77$), hence overburden and PM₁₀ may both be affected by rainfall not necessarily each other.

Figure 3-10 shows inconsistency in the scale of variability in each metric across CY2016 – CY2025, with minor proportional variability in PM₁₀ relative to significant proportional variability in overburden removal. From CY2016 to CY2019, both overburden and annual average PM₁₀ concentrations have increased year on year. Both variables also decrease from CY2019 to CY2022. Whilst a similar trend can be seen between the two variables, correlation does not warrant causation. The fluctuations in annual average PM₁₀ concentrations are anticipated to be related to ambient temperatures and the amount of rainfall during each of these years, rather than changes in overburden removed. This can be seen in rainfall levels providing a stronger statistical explanation when comparing with annual average PM₁₀ data ($r = -0.85$) compared to overburden removal ($r = -0.77$).

When comparing overburden removal with annual rainfall in Figure 3-11, a negative correlation can be seen with CY2019 having the highest overburden production and the lowest rainfall and CY2022 having the lowest overburden production compared to the highest rainfall. When comparing rainfall against annual average PM₁₀ data and overburden removed, there is a stronger correlation between rainfall and PM₁₀ ($r = -0.85$), than rainfall and overburden ($r = -0.77$). The strong correlation between rainfall and overburden may be explained by cohesion and water content of soils making them harder to excavate when saturated. Rainfall can also limit or cease production operations all together, creating an extra linkage between rainfall and overburden removal. Hence, rainfall is anticipated to be the driving factor of fluctuations in both annual average PM₁₀ concentrations and overburden removal.

It is recommended that relationships between PM₁₀ concentrations, overburden removal and rainfall continue be reevaluated annually to uncover any long-term trends that may be seen in the data.

4 CONCLUSION

Overall, as noted within the previous annual reviews and reinforced with the inclusion of CY2025 data, the temporal trends in the UHAQMN and 'Remainder of NSW' monitoring subsets show that the changes in PM₁₀ concentrations within the Upper Hunter are generally consistent with changes experienced across the rest of NSW.

A summary of the findings is:

- Both the 'Remainder of NSW' and UHAQMN annual average PM₁₀ concentrations have increased from CY2024 to CY2025 indicating that the changes in PM₁₀ concentrations are consistent with regional particulate sources and that the contribution of mining operations on the UHAQMN to these trends is not discernible.
- The differences between PM₁₀ concentrations at Background stations and Diagnostic stations are near identical across CY2013-CY2025. This reinforces that changes in Upper Hunter PM₁₀ concentrations are associated with regional conditions and are indicative of a minimal change in the contribution from local emission sources inclusive of mining.
- The 'Remainder of NSW' and UHAQMN grouped locations show generally the same trend when comparing the average number of exceedance days of the 24-hour average PM₁₀ criterion.
- When considering rainfall and particulate matter concentrations, it continues to be seen that there is a negative correlation between the two across the UHAQMN. This is supported by a correlation coefficient (r value) of -0.85 .
- There is no visually apparent correlation between raw coal production and ambient PM₁₀ concentrations measured by the UHAQMN between CY2013 and CY2019. There is more of a visually apparent correlation between raw coal production and ambient PM₁₀ concentrations measured between CY2020 and CY2025. The correlation coefficient (r value) for the station groupings for the entire period ranged between 0.55 and 0.65 (moderate to strong).

- Comparison of annual average PM₁₀ concentrations recorded across the UHAQMN versus overburden removal saw a positive correlation r value of 0.79. While there is a trend present, statistical analysis indicates that regional air quality remains more sensitive to meteorological conditions than to industrial activity. The strong correlation between rainfall and PM₁₀ suggests that annual dust exceedances are largely dictated by rainfall effects and ambient temperature.
- To ensure ongoing accuracy in impact attribution, the relationships between coal production, overburden removal, rainfall, and PM₁₀ levels should be re-analysed on an annual basis.

5 REFERENCES

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APPENDIX A: Additional data tables

Table A.1: Comparison of PM₁₀ and PM_{2.5} variability – UHAQMN vs remainder of NSW regions

Year	PM ₁₀				PM _{2.5}			
	UHAQMN*		Remainder of NSW		UHAQMN*		Remainder of NSW	
	Conc. (ug/m ³)	% of average (all years)	Conc. (ug/m ³)	% of average (all years)	Conc. (ug/m ³)	% of average (all years)	Conc. (ug/m ³)	% of average (all years)
2013	21.2	103%	17.4	97%	7.9	104%	7.9	105%
2014	20.1	98%	16.7	93%	7.3	96%	7.4	98%
2015	17.8	87%	16.2	90%	7.6	100%	7.6	101%
2016	18.3	89%	17	95%	7.7	101%	7.8	103%
2017	20.4	99%	17.5	98%	7.7	101%	7.7	102%
2018	25	122%	20.9	116%	8.1	106%	8.2	109%
2019	32.7	160%	25.9	144%	11.2	147%	11.2	149%
2020	20.9	102%	19.5	109%	8.4	110%	8.1	107%
2021	16.3	79%	15.9	89%	6.4	85%	6.4	85%
2022	14.3	69%	13.5	75%	5.4	71%	5.1	68%
2023	20.4	100%	17.2	96%	6.8	89%	6.6	88%
2024	18.7	91%	17.6	98%	6.8	90%	6.5	86%
2025	19.4	95%	17.7	99%	6.3	83%	6.3	83%
All years	20.4	-	17.9	-	7.5	-	7.4	-

Note: UHAQMN – upper hunter air quality monitoring network, * - Larger Populations and Smaller Communities station groups

Table A.2: Annual variance against CY2013 – CY2025 station group average (µg/m³)

Station Group	Year												
	13	14	15	16	17	18	19	20	21	22	23	24	25
Larger Population	1	0	-2	-2	0	5	11	0	-4	-6	-1	-3	-2
Smaller Communities	0	-1	-3	-2	0	4	12	0	-5	-7	0	-1	-1
Diagnostic	1	-1	-3	-2	0	5	13	0	-5	-7	0	-3	-1
Background	1	0	-2	-1	0	4	12	2	-3	-4	0	-1	0

Table A.3: NSW/ACT annual rainfall and UHAQMN annual average PM₁₀

Parameter	Year												
	13	14	15	16	17	18	19	20	21	22	23	24	25
PM ₁₀ (µg/m ³)	21	20	18	18	20	25	33	21	16	14	20	18	19
Rainfall (mm)	464	467	541	661	453	333	250	639	721	864	429	579	533