

Air quality in the Upper Hunter: Autumn 2021

Air quality in the Upper Hunter was good during autumn 2021. Daily particle levels were within national benchmarks 100% of the time at Muswellbrook and Singleton. Hourly particle levels were in the good to fair air quality categories 100% of the time at both Singleton and Muswellbrook. Regional air quality was improved compared to the last few years, with the region experiencing a wetter and cooler than average autumn.

- Levels of fine particle matter PM_{2.5} (particles less than or equal to 2.5 microns in diameter), nitrogen dioxide (NO₂) and sulfur dioxide (SO₂) were good, remaining below national benchmarks.
- Daily average levels of PM₁₀ (particles less than or equal to 10 microns in diameter) were above the 50 µg/m³ benchmark on one day (15 April 2021) at Singleton South. The regional maximum daily PM₁₀ level on this day was 53.7 µg/m³.

Annual air quality trends in the Upper Hunter

A comparison of annual average PM₁₀ and PM_{2.5} levels shows the long-term trends. The national annual average benchmarks are 25 µg/m³ for PM₁₀ and 8 µg/m³ for PM_{2.5}, based on a calendar year. Figure 1 shows the PM₁₀ and PM_{2.5} **rolling** annual averages¹, based on the 12-month periods to the end of autumn, for 2013 to 2021.

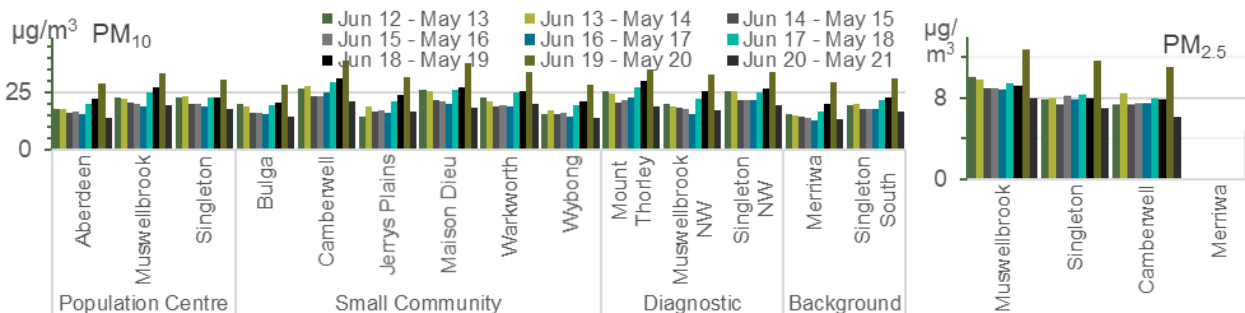


Figure 1 PM₁₀ and PM_{2.5} rolling annual averages: to the end of autumn 2013 to 2021

Note: The Merriwa background air quality monitoring station was upgraded in July 2020 to monitor particles as PM_{2.5}, visibility, ozone, nitrogen oxides, carbon monoxide and sulfur dioxide.

The comparison in Figure 1 shows significant improvement in particle levels throughout the region during the 12 months to the end of autumn 2021 compared to earlier years. Particle levels are especially low compared to the previous 12-month period, that included intense drought and extensive bushfires. Most stations recorded their lowest rolling annual average PM₁₀ and PM_{2.5} particle levels to the end of autumn 2021 since the network began operation.

The greatly improved particle levels resulted from comparatively cooler and wetter conditions in early 2021, reducing dust storm and bushfire activity. At the end of autumn 2021, 16% of New South Wales was affected by drought (Figure 2), compared to 90.8% of the state drought declared by the end of autumn 2020².

¹ Rolling averages are not intended to be compared to benchmarks. The rolling annual averages provide a guide to long-term trends, using the most up to date monitoring data.

² Sourced from Department of Primary Industries [NSW State seasonal update – May 2020](#) (accessed August 2021).

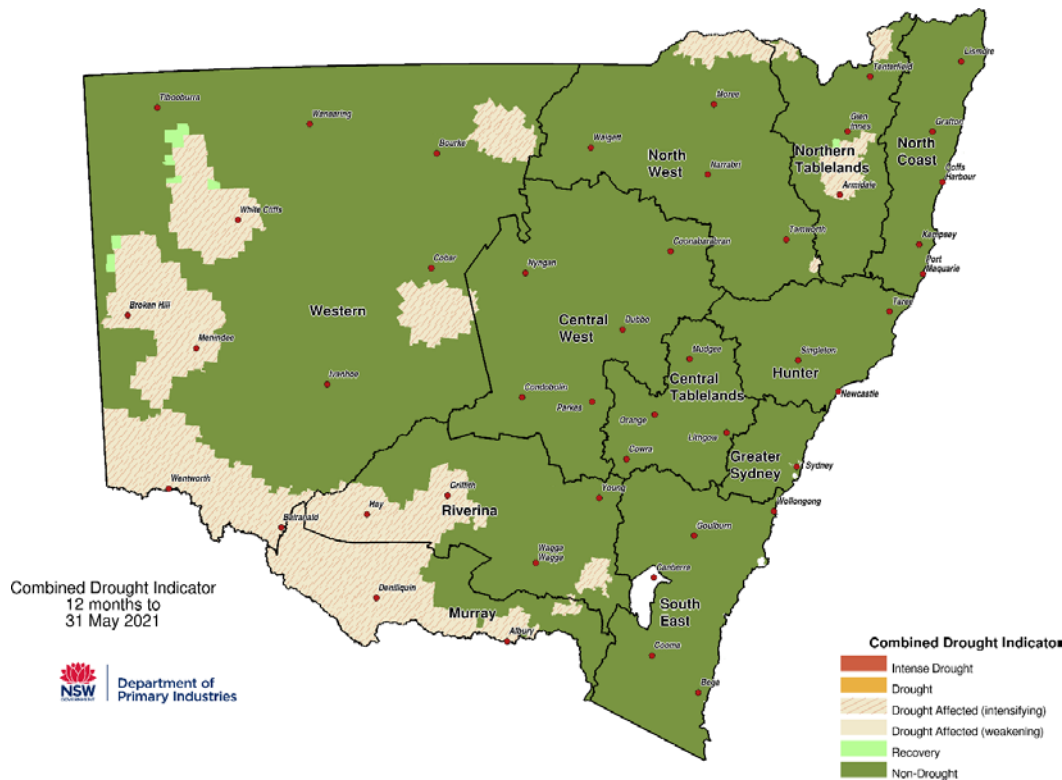


Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 31 May 2021³

Days above benchmark concentrations

There was one day over the PM10 daily benchmark in autumn 2021 at Singleton South on 15 April 2021. PM2.5 levels remained below the daily benchmark throughout the season.

Table 1 Number of days above the relevant national benchmarks – autumn 2021

Station type*	Station	PM10 daily [50 µg/m ³ benchmark]	PM2.5 daily [25 µg/m ³ benchmark]	SO ₂ hourly ⁴ [20 pphm benchmark]	SO ₂ daily ⁴ [8 pphm benchmark]	NO ₂ hourly ⁴ [12 pphm benchmark]
Population centre	Aberdeen	0	-	-	-	-
Population centre	Muswellbrook	0	0	0	0	0
Population centre	Singleton	0	0	0	0	0
Smaller community	Bulga	0	-	-	-	-
Smaller community	Camberwell	0	0	-	-	-
Smaller community	Jerrys Plains	0	-	-	-	-
Smaller community	Maison Dieu	0	-	-	-	-
Smaller community	Warkworth	0	-	-	-	-
Smaller community	Wybong	0	-	-	-	-
Diagnostic	Mount Thorley	0	-	-	-	-
Diagnostic	Muswellbrook NW	0	-	-	-	-
Diagnostic	Singleton NW	0	-	-	-	-
Background	Merriwa	0	0	0	0	0
Background	Singleton South	1	-	-	-	-

µg/m³ = micrograms per cubic metre

pphm = parts per hundred million by volume (i.e. parts of pollutant per hundred million parts of air)

- = not monitored

* For explanation, refer to the end of the report **Definitions: Upper Hunter monitoring station types**

³ Sourced from Department of Primary Industries [NSW State seasonal update – May 2021](#) (accessed August 2021).

⁴ Note: The [National Environment Protection \(Ambient Air Quality\) Measure \(Air NEPM\)](#) was updated on 18 May 2021. New national benchmarks were introduced for hourly SO₂ (now 10 pphm), daily SO₂ (now 2 pphm) and hourly NO₂ (now 8 pphm).

Pollution roses from hourly particle data

The seasonal pollution rose maps⁵ (Figure 3 and Figure 4) show that hourly PM10 and PM2.5 levels⁶ were predominantly low during the season.

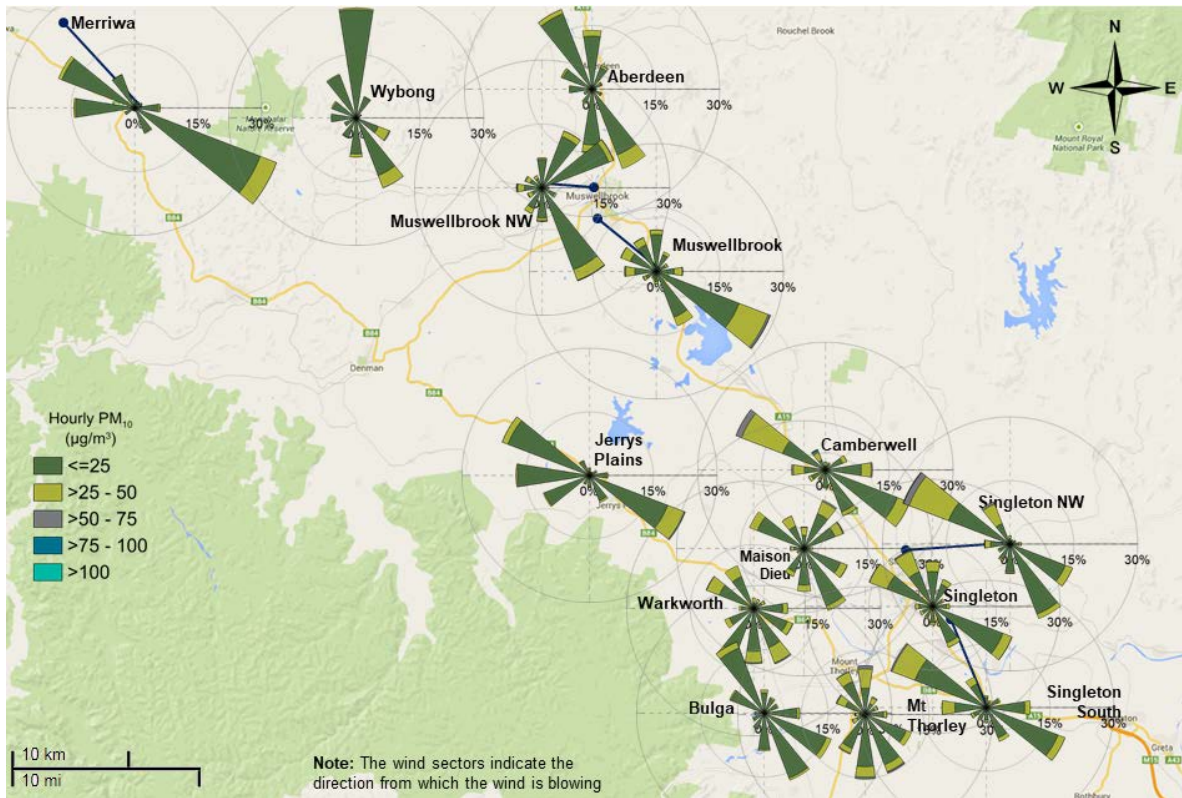


Figure 3 Hourly PM10 pollution rose map for the Upper Hunter region for autumn 2021

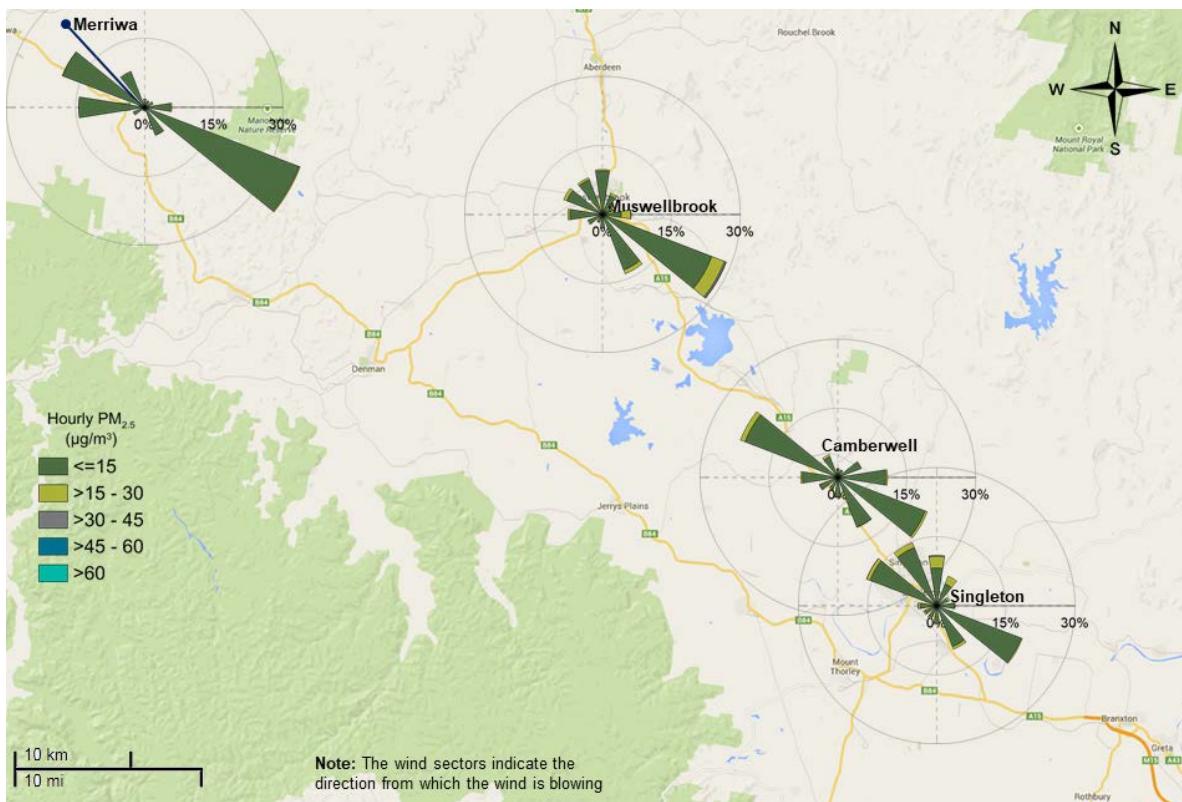


Figure 4 Hourly PM2.5 pollution rose map for the Upper Hunter region for autumn 2021

⁵ Pollution roses show wind direction and particle levels at a location. The length of each bar around the circle shows the percentage of time the wind blows from a particular direction. The colours along the bars indicate categories of particle levels.

⁶ There are no standards for hourly PM10 or PM2.5 in the National Environment Protection (Ambient Air Quality) Measure.

Daily time series plots

Daily average time series plots for PM10 and PM2.5 and daily one-hour maximum plots for NO₂ and SO₂ show the concentrations throughout autumn (Figure 5 to Figure 11). PM2.5, NO₂ and SO₂ remained below the benchmarks. PM10 levels remained below the benchmark at all stations, except for 15 April 2021 at Singleton South. On this day, Singleton South recorded an hourly PM10 peak in the early afternoon, under light to moderate north-west winds from an undetermined source. Other stations recorded increased daily PM10 levels on this day, however, elevated hourly levels were at varying times.

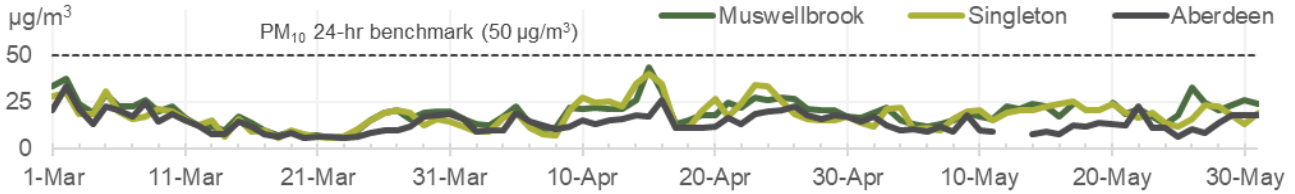


Figure 5 Population centre stations: daily average PM10 – autumn 2021

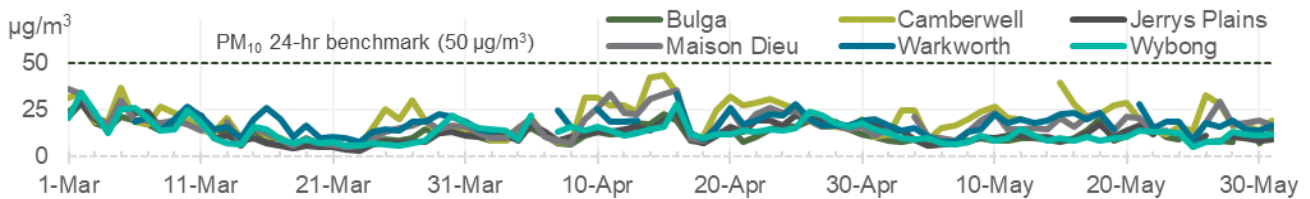


Figure 6 Smaller community stations: daily average PM10 – autumn 2021

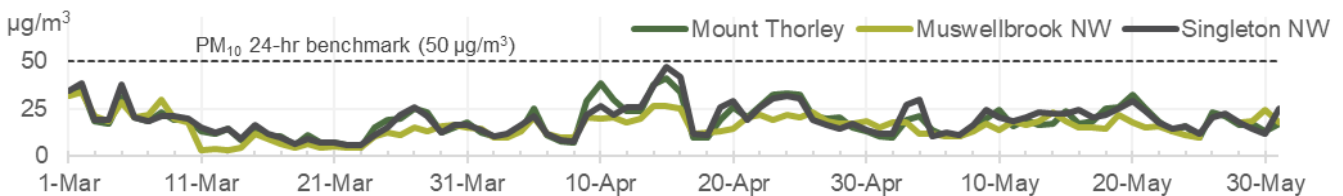


Figure 7 Diagnostic stations: daily average PM10 – autumn 2021

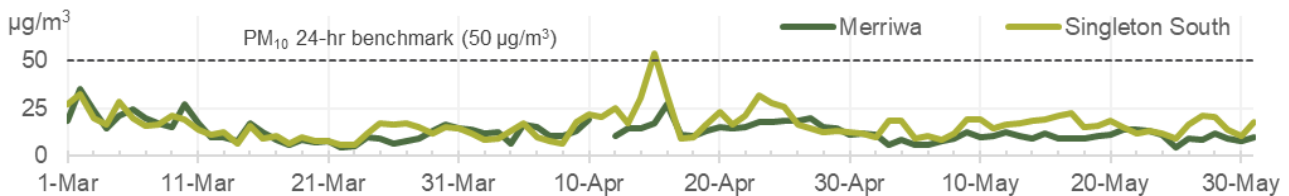


Figure 8 Background stations: daily average PM10 – autumn 2021

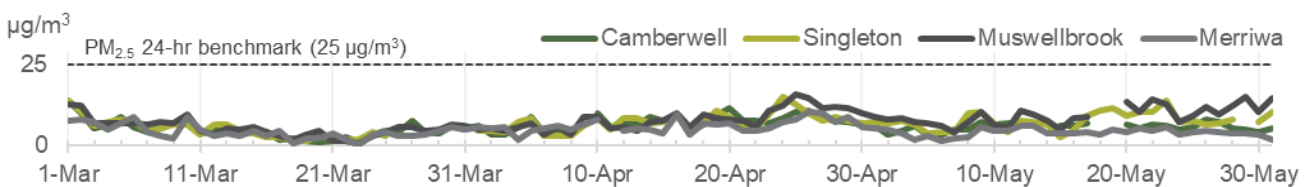


Figure 9 Daily average PM2.5 – autumn 2021

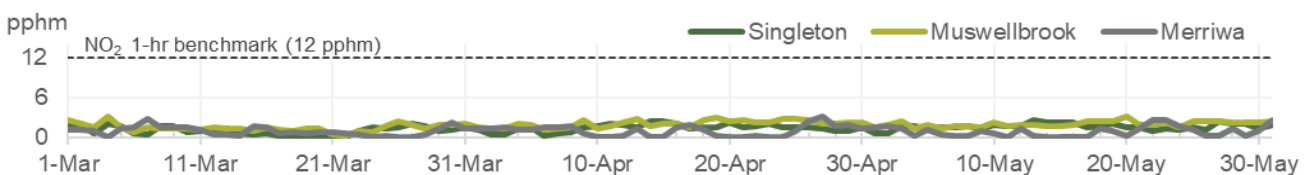


Figure 10 Daily 1-hr maximum NO₂ – autumn 2021

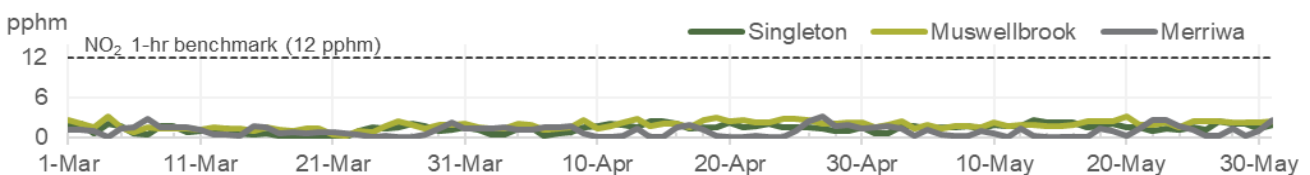


Figure 11 Daily 1-hr maximum SO₂ – autumn 2021

Seasonal comparisons

This section compares air quality in autumn 2021 with previous autumn seasons (Figure 12).

All autumn days were below national benchmark concentrations for NO₂ and SO₂ over the past 10 years.

One day was recorded over the daily PM10 benchmark during autumn 2021, compared to 5 days during autumn 2020 (Figure 12). From autumn 2012 to 2019, there were between one (autumn 2017) and 17 days (autumn 2018) recorded over the PM10 benchmark.

All days in autumn 2021 were below the daily average PM2.5 benchmark at all stations, a result also observed in 2018 and 2019, as well as from 2012 to 2015. Two days over the PM2.5 benchmark were recorded at Singleton in autumn 2016. One day over the PM2.5 benchmark was recorded at Singleton and Muswellbrook in autumn 2017.

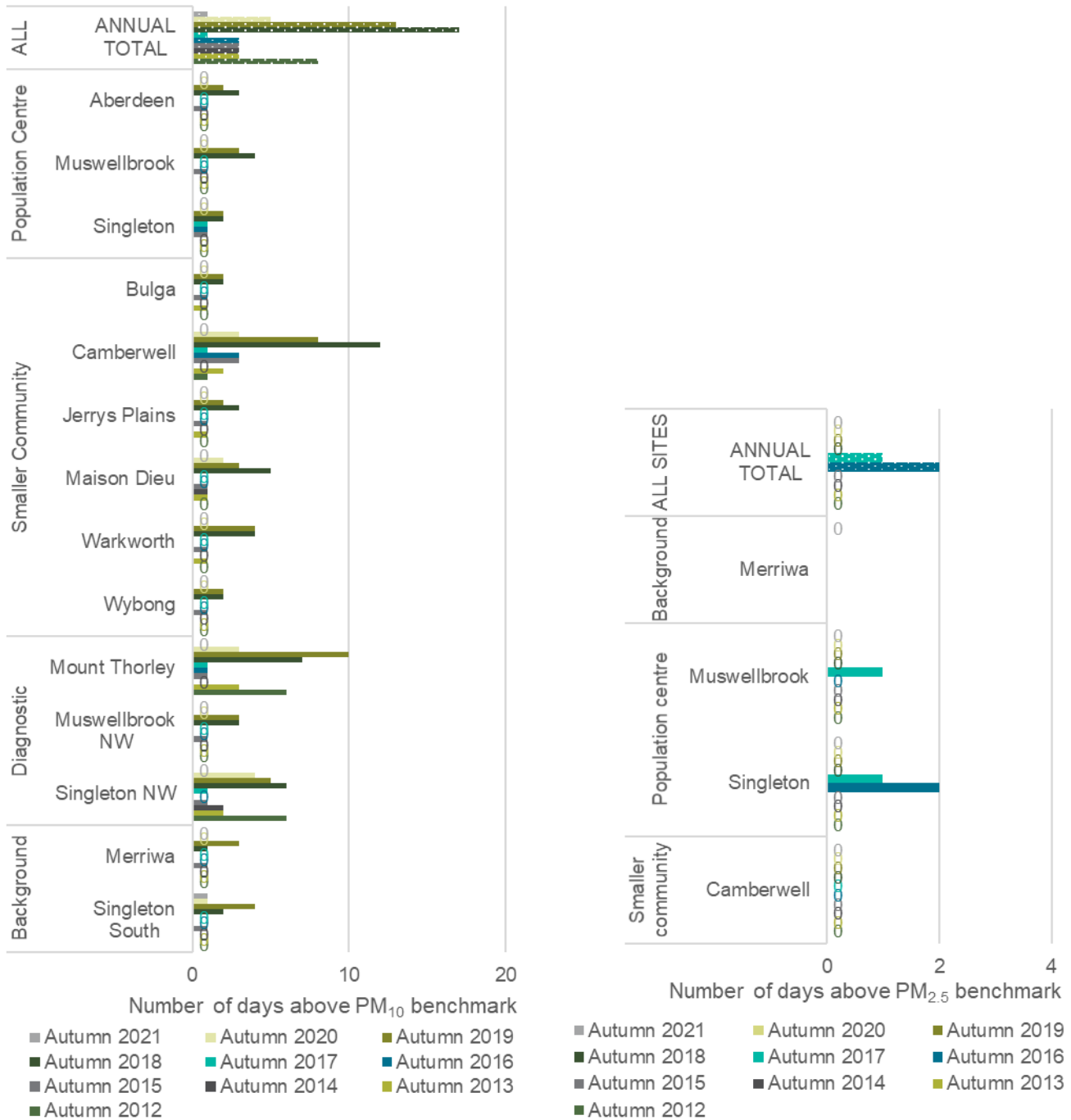


Figure 12 Number of days above the PM10 and PM2.5 daily benchmarks: autumn 2013 to 2021

Note: The Merriwa background air quality monitoring station was upgraded in July 2020 to monitor particles as PM2.5, visibility, ozone, nitrogen oxides, carbon monoxide and sulfur dioxide.

Particle air quality trends in the Upper Hunter

Figure 13 and Figure 14 show daily average PM10 levels during autumn 2021, compared to the daily maximum and minimum levels (i.e. shaded range) for autumn seasons from 2011 to 2020, at Singleton and Muswellbrook. Daily PM10 levels were within or below the historical range throughout the season. Regional rainfall levels were very much above average in March, with below average rainfall recorded at Singleton in April and May 2021 (Figure 15).

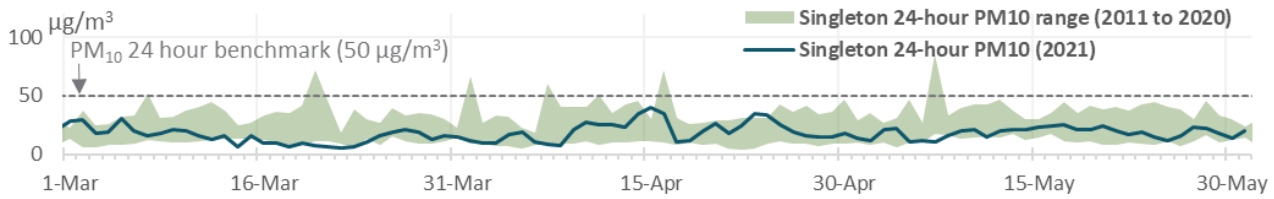


Figure 13 Singleton daily average PM10 during autumn 2021 plotted against the daily maximum and minimum PM10 levels from 2011 to 2020

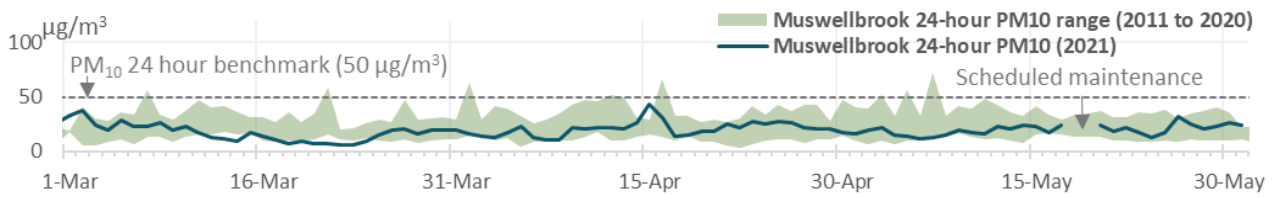


Figure 14 Muswellbrook daily average PM10 during autumn 2021 plotted against the daily maximum and minimum PM10 levels from 2011 to 2020

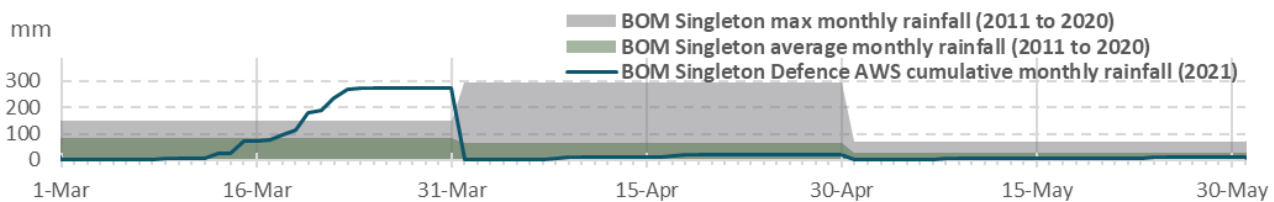


Figure 15 Bureau of Meteorology Singleton Defence AWS⁷ cumulative monthly rainfall in autumn 2021 against maximum and average monthly rainfall from 2011 to 2020⁸

Figure 16 and Figure 17 show daily average PM2.5 levels during autumn 2021, compared to the daily maximum and minimum levels (shaded range) for autumn periods from 2012 to 2020, at Singleton and Muswellbrook. Daily PM2.5 levels were generally within or below the historical range throughout the season.

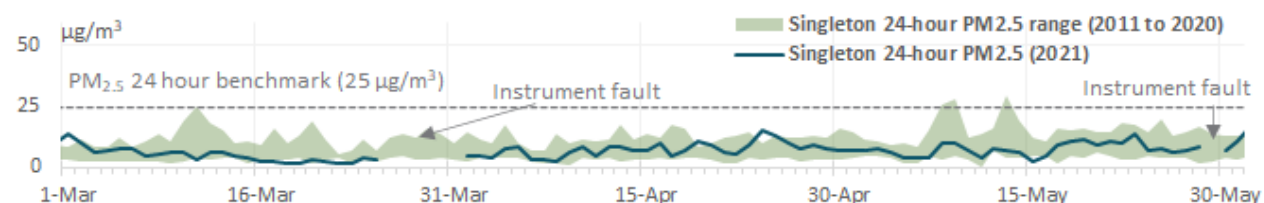


Figure 16 Singleton daily average PM2.5 during autumn 2021 plotted against the daily maximum and minimum PM2.5 levels from 2011 to 2020

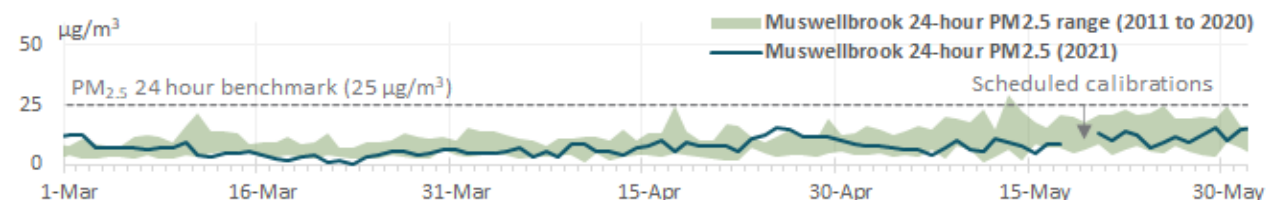


Figure 17 Muswellbrook daily average PM2.5 during autumn 2021 plotted against the daily maximum and minimum PM2.5 levels from 2012 to 2020

⁷ Data obtained from the Bureau of Meteorology [Singleton Defence AWS monthly rainfall data](#) (accessed August 2021).

⁸ The Bureau of Meteorology STP station was decommissioned in January 2019. Therefore, statistics have been calculated from a combination of the [Singleton STP monthly rainfall data](#) (accessed August 2021) from January 2011 to March 2017 and [Singleton Defence AWS monthly rainfall data](#) from April 2017.

Meteorological summary

Rainfall and temperature⁹

The Upper Hunter experienced above average rainfall during autumn 2021 (Figure 18). Autumn 2021 was wetter than the past 3 autumns. There was up to 200 millimetres more rain in autumn 2021 than autumns 2020 and 2019 for parts of the Upper Hunter region and between 100 and 200 millimetres more than autumn 2018.

Maximum temperatures were below average (Figure 19), and minimum temperatures were average during autumn 2021.

New South Wales rainfall deciles 1 March to 31 May 2021
Australian Gridded Climate Data

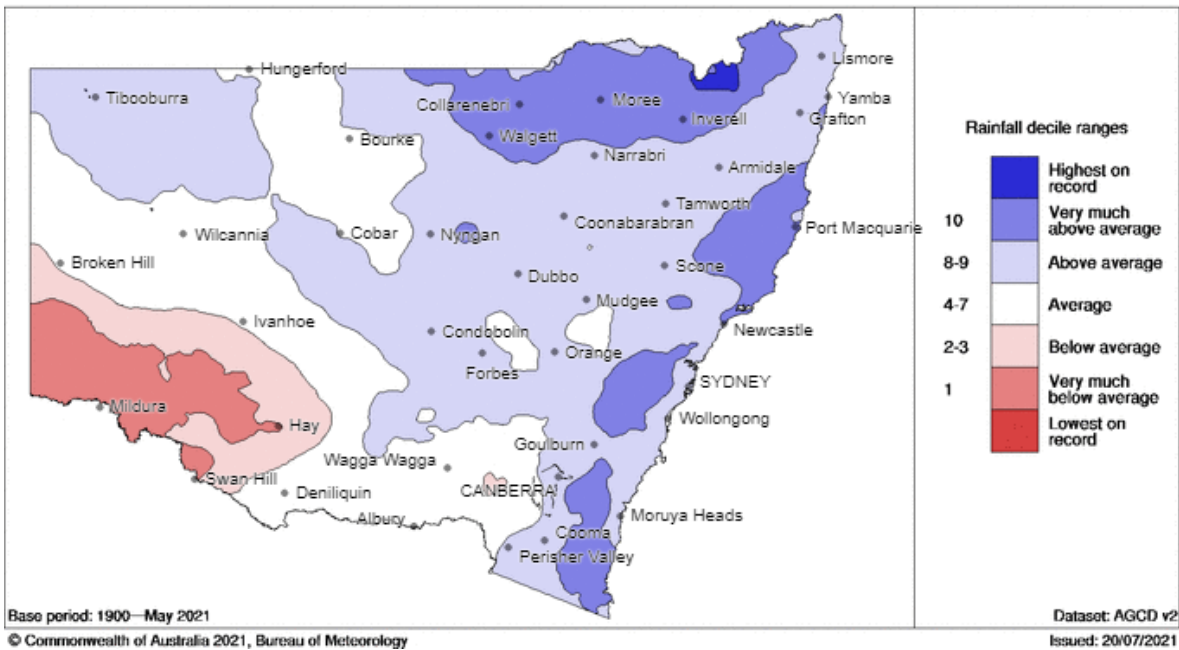


Figure 18 NSW rainfall deciles – autumn 2021

Maximum Temperature Deciles 1 March to 31 May 2021
Distribution Based on Gridded Data
Australian Bureau of Meteorology



Figure 19 NSW maximum temperature deciles – autumn 2021

⁹ Rainfall and temperature information is from the Bureau of Meteorology [New South Wales autumn 2021 climate statement](#) (access August 2021) and [climate maps](#) (accessed August 2021).

Wind

Wind directions were variable during autumn 2021 (Figure 20). This is typical for this time of year. Winds tend to shift from a south-easterly direction during the warmer months towards a more north-westerly flow as temperatures cool. Regional wind speeds in autumn 2021 were lower compared to autumn 2020.

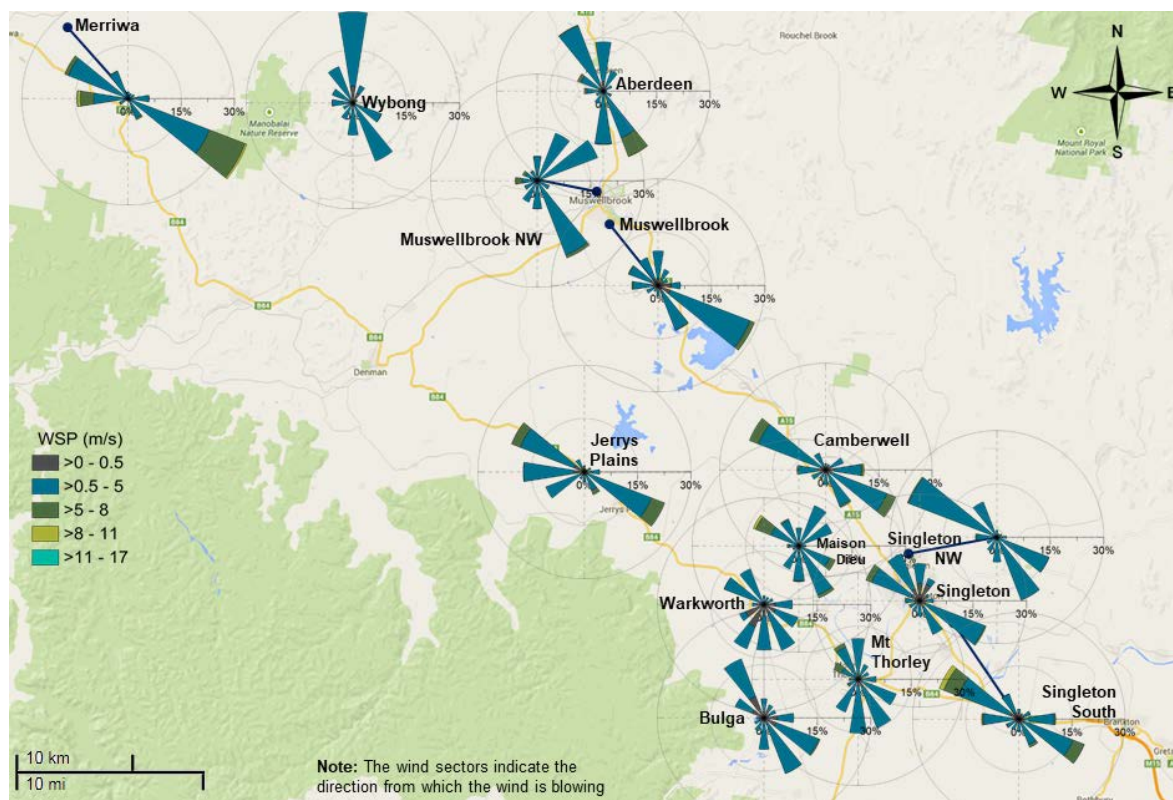


Figure 20 Wind rose map¹⁰ for the Upper Hunter region for autumn 2021

¹⁰ Wind roses show the wind direction and speed at a location. The length of each bar around the circle show the percentage of time that the wind blows from a particular direction. The colours along the bars indicate the wind speed categories.

Network performance

The target network performance is at least 95% available data for all parameters. The maximum online time that can be attained for NO₂ and SO₂ is 96%, due to daily calibrations.

Table 2 Online performance (%) during autumn 2021

Station	Particles PM10 daily	Particles PM2.5 daily	Gases SO ₂ hourly	Gases NO ₂ hourly	Meteorology Wind hourly
Aberdeen	98	-	-	-	100
Bulga	98	-	-	-	98
Camberwell	98	93	-	-	99
Jerrys Plains	97	-	-	-	97
Maison Dieu	97	-	-	-	97
Merriwa	99	99	94	94	94
Mount Thorley	100	-	-	-	99
Muswellbrook	98	98	95	96	100
Muswellbrook NW	98	-	-	-	99
Singleton	100	92	95	91	100
Singleton NW	100	-	-	-	99
Singleton South	100	-	-	-	98
Warkworth	88	-	-	-	91
Wybong	99	-	-	-	99

- = not monitored

The overall reduced online times were mainly due to:

- Camberwell PM2.5 – scheduled calibrations (4 days) and maintenance (2 days)
- Singleton PM2.5 – instrument fault (8 days)
- Warkworth PM10 – power outage (4 days) and datalogger fault (7 days)
- Warkworth wind – power outage (2 days), datalogger fault (4 days) and storm damage (2 days)
- Merriwa wind – scheduled maintenance (1 day), instrument fault (2 days) and rodent damage to instrument cable (4 days)

Definitions: Upper Hunter monitoring station types

The 14 monitoring stations in the Upper Hunter serve different purposes:

Larger population: stations near the larger population centres monitor the air quality in these centres.

Smaller communities: stations near smaller communities monitor the air quality at those locations.

Diagnostic: provide data that can help 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.

Background: the stations near Merriwa and Singleton South are at both ends of the valley and provide background data, measuring the quality of air entering and leaving the Upper Hunter Valley under predominant winds (south-easterlies and north-westerlies).

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