

Air quality in the Upper Hunter: Winter 2022

Air quality in the Upper Hunter was good during winter 2022. 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 Singleton and Muswellbrook.

- Nitrogen dioxide (NO₂) and sulfur dioxide (SO₂) levels were good, remaining within hourly and daily national benchmarks.
- Daily average levels of PM10 and PM2.5¹ remained within national benchmarks at all stations.
- The region experienced very much above average rainfall and average maximum temperatures during winter.

Annual air quality trends in the Upper Hunter

A comparison of annual average PM10 and PM2.5 levels shows the long-term trends. The national annual average benchmarks are 25 µg/m³ for PM10 and 8 µg/m³ for PM2.5, based on a calendar year. Figure 1 shows the PM10 and PM2.5 **rolling** annual averages², based on the 12-month periods from winter 2013 to winter 2022.

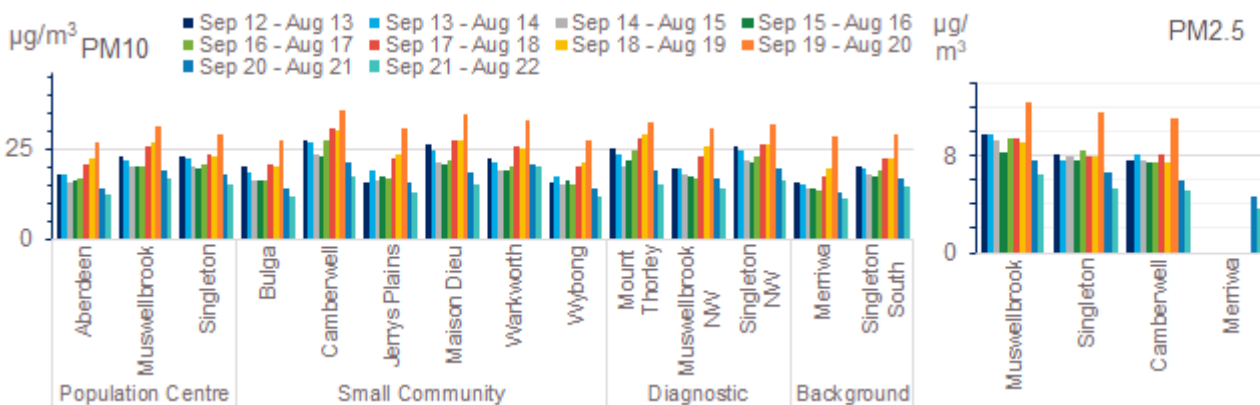


Figure 1 PM10 and PM2.5 rolling annual averages: to the end of winter 2013 to 2022

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

The comparison in Figure 1 shows that particle levels continued to decrease during the 12 months to the end of winter 2022 at all stations, compared to the same 12-month period in previous years (especially compared to the end of winter 2020).

All stations recorded rolling annual average PM10 and PM2.5 levels within the annual benchmarks, with most recording the lowest since the network began operation. Although Warkworth PM10 levels decreased to the end of winter 2022, compared to the previous year, levels were not the lowest seen

¹ PM2.5 and PM10 refer to airborne particles, less than or equal to 2.5 and 10 micrometres in diameter, respectively.

² 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.

since operations began. This is likely due to nearby mining operations, with the United Wambo Joint Venture Open Cut mine starting operations in 2020.

Lower particle levels resulted from continuing wetter than average conditions over the 12 months. At the end of winter 2022, there were no areas in New South Wales that were drought affected (Figure 2), compared to 7% at the end of winter 2021³ and 35% at the end of winter 2020⁴.

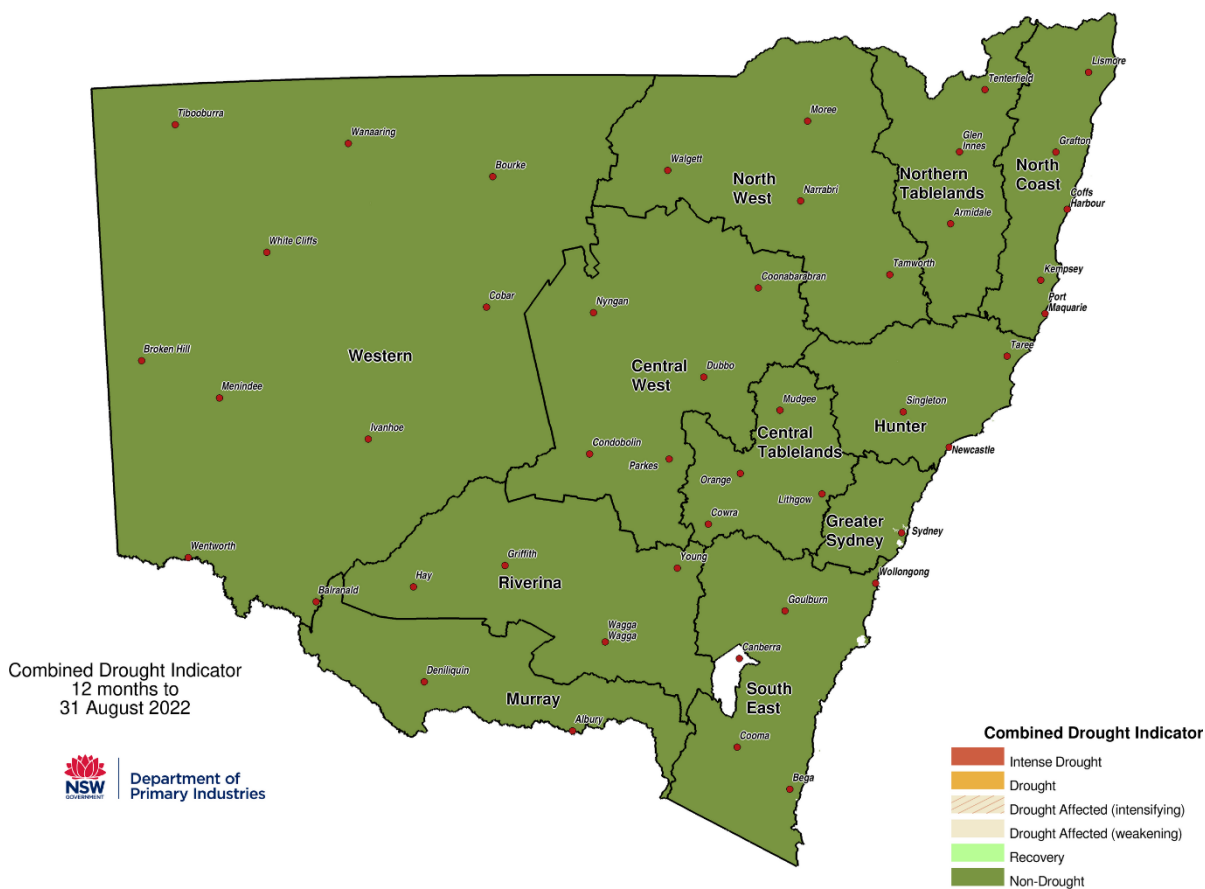


Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 31 August 2022⁵

³ Sourced from Department of Primary Industries NSW State seasonal update – August 2021 (accessed January 2023).

⁴ Sourced from Department of Primary Industries NSW State seasonal update – August 2020 (accessed January 2023).

⁵ Sourced from Department of Primary Industries NSW State seasonal update – August 2022 (accessed October 2022).

Days above benchmark concentrations

All parameters remained within the national benchmarks throughout the season.

Table 1 Number of days above the relevant national benchmarks – winter 2022

Station type*	Station	PM10 daily [50 µg/m ³ benchmark]	PM2.5 daily [25 µg/m ³ benchmark]	SO ₂ hourly [10 ppm benchmark]	SO ₂ daily [2 ppm benchmark]	NO ₂ hourly [8 ppm 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	0	-	-	-	-

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.

Pollution roses from hourly particle data

The seasonal pollution rose maps⁶ (Figure 3 and Figure 4) show that hourly PM10 and PM2.5 levels⁷ were predominantly low during the season.

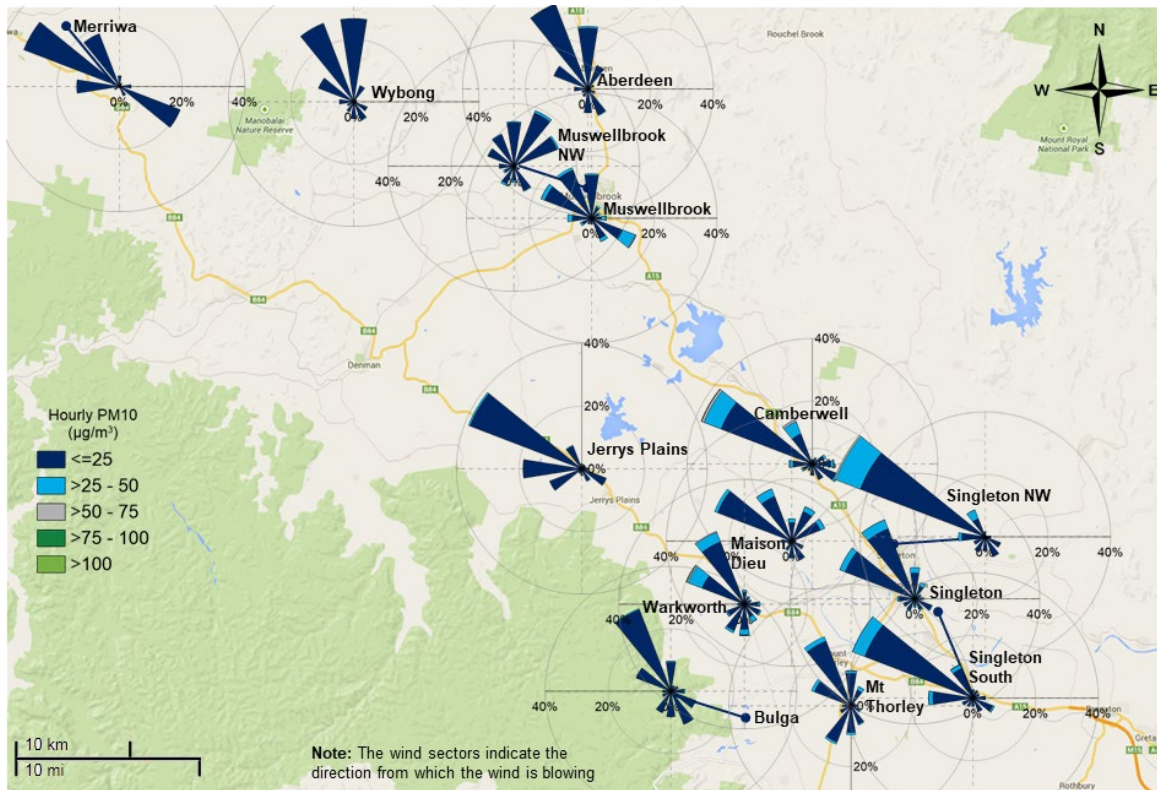


Figure 3 Hourly PM10 pollution rose map for the Upper Hunter region for winter 2022

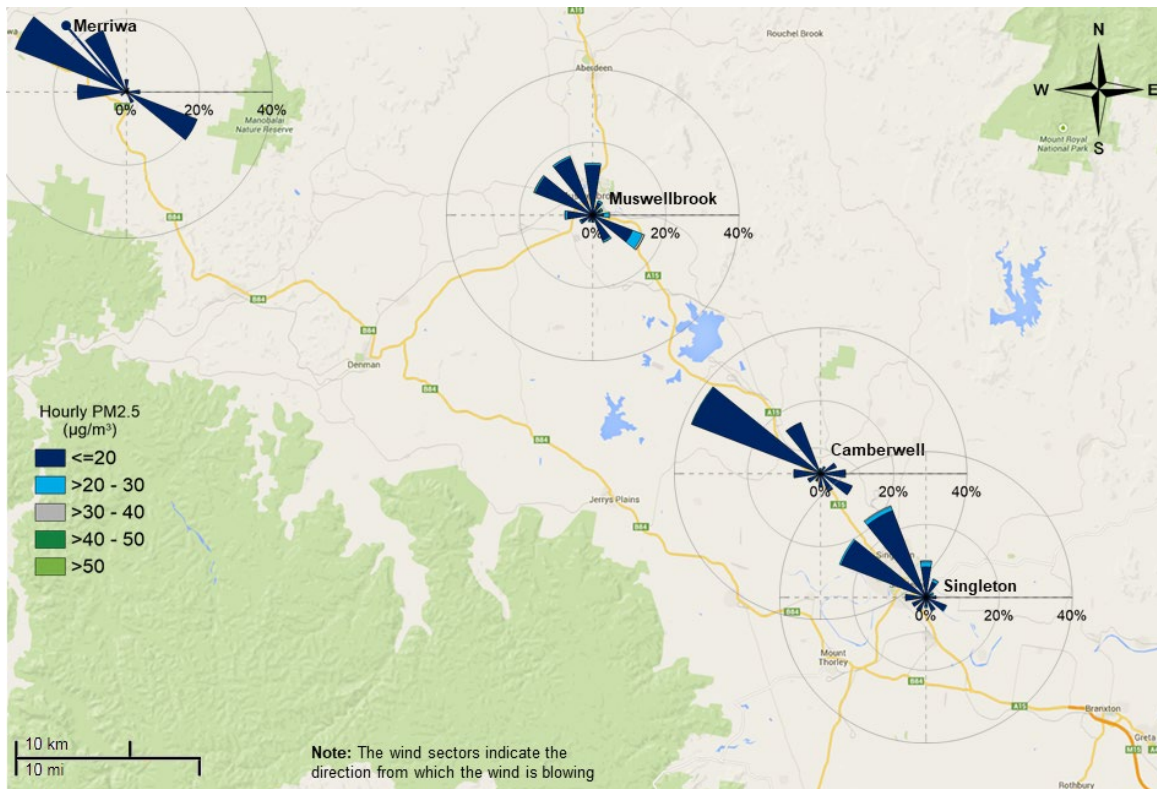


Figure 4 Hourly PM2.5 pollution rose map for the Upper Hunter region for winter 2022

⁶ 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.

⁷ 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 winter (Figure 5 to Figure 11). All parameters remained within the benchmarks.

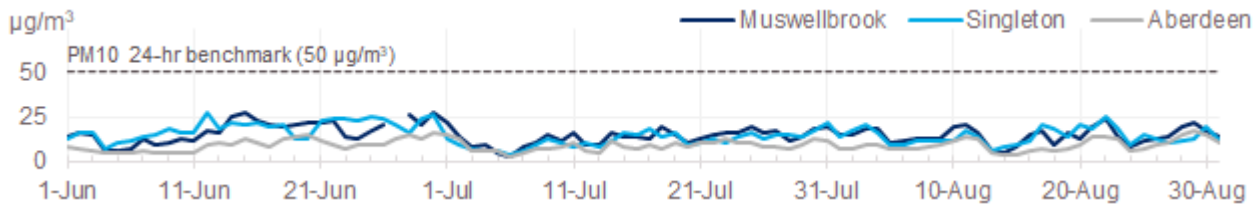


Figure 5 Population centre stations: daily average PM10 – winter 2022

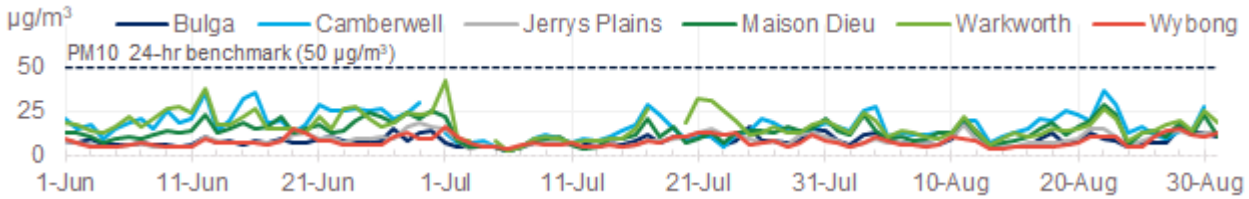


Figure 6 Smaller community stations: daily average PM10 – winter 2022

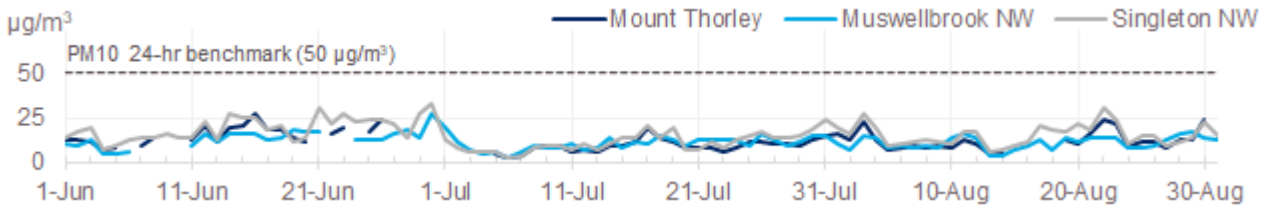


Figure 7 Diagnostic stations: daily average PM10 – winter 2022

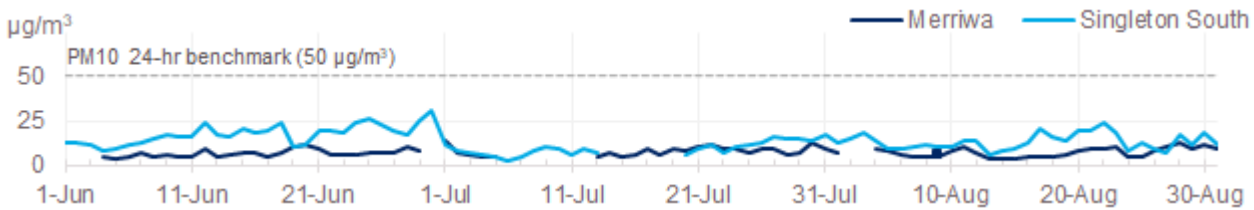


Figure 8 Background stations: daily average PM10 – winter 2022

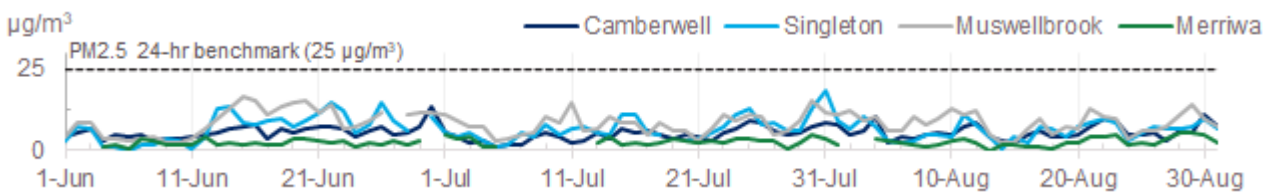


Figure 9 Daily average PM2.5 – winter 2022

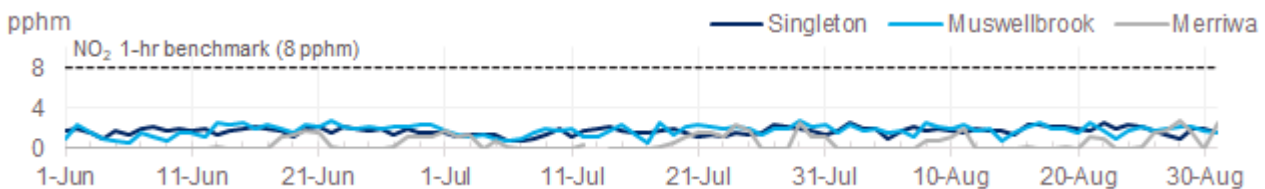


Figure 10 Daily 1-hr maximum NO₂ – winter 2022

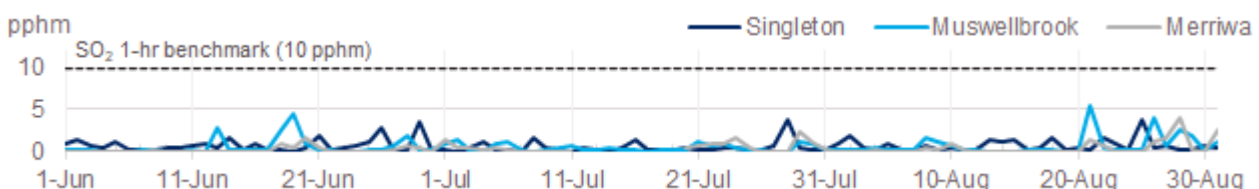


Figure 11 Daily 1-hr maximum SO₂ – winter 2022

Seasonal comparisons

This section compares air quality in winter 2022 with previous winter seasons (Figure 12).

There were no days over the national benchmarks for NO₂ and SO₂ in winter 2022. From 2012 to 2021, in winter, under the more stringent standards (applied from May 2021 onwards), Muswellbrook would have recorded 1 hour above the current hourly SO₂ standard of 10 parts per hundred million (pphm). There would not have been any days above the current hourly NO₂ standard or daily SO₂ standard.

There were no days over the PM10 daily benchmark during winter 2022. From 2012 to 2021, the region recorded between zero days (winters 2016 and 2021) and 29 days (winter 2018) over the PM10 benchmark. Higher particle levels occurred in the winters of 2018 and 2019 due to drought conditions.

There were no days over the PM2.5 daily benchmark during winter 2022. From 2012 to 2021, the region recorded between zero days (winters 2013 and 2021) and 3 days (winters 2015 and 2020) over the PM2.5 benchmark.

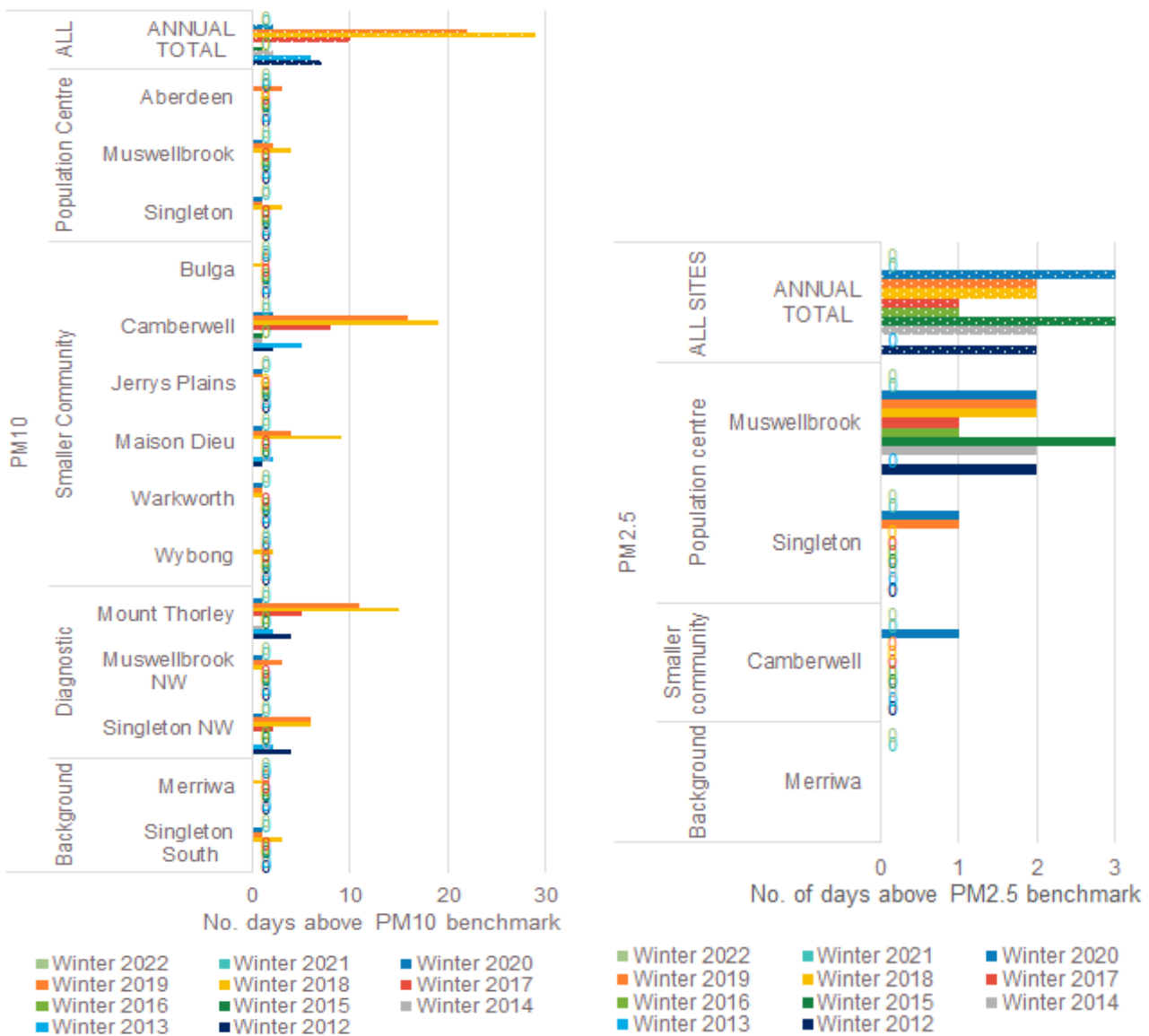


Figure 12 Number of days above the PM10 and PM2.5 daily benchmarks: winter 2012 to 2022

Note: The Merriwa background air quality monitoring station was upgraded in July 2020 to monitor particles such 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 winter 2022, compared to the daily maximum and minimum levels (i.e. shaded range) for winter periods from 2011 to 2021, 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 (Figure 15), with dry conditions in June followed by wet conditions in July and August.

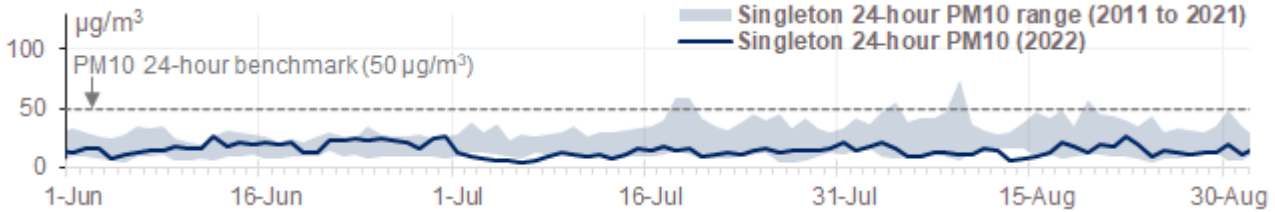


Figure 13 Singleton daily average PM10 during winter 2022 plotted against the daily maximum and minimum PM10 levels from 2011 to 2021

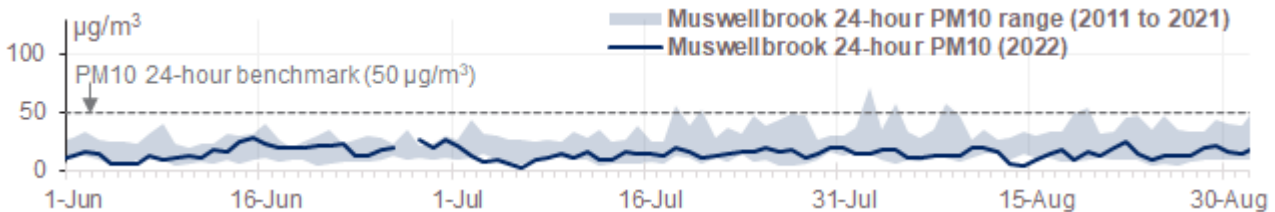


Figure 14 Muswellbrook daily average PM10 during winter 2022 plotted against the daily maximum and minimum PM10 levels from 2011 to 2021

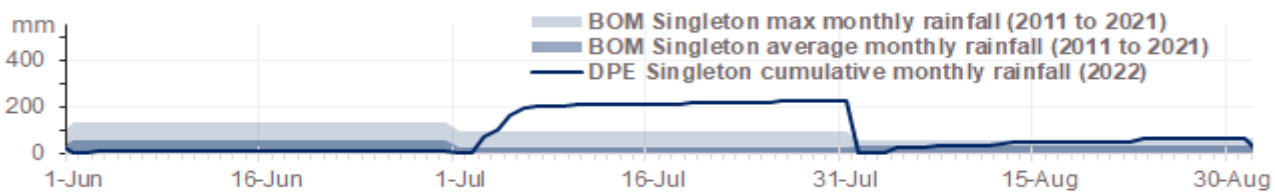


Figure 15 Singleton cumulative monthly rainfall in winter 2022⁸ against maximum and average monthly rainfall from 2011 to 2021⁹

Figure 16 and Figure 17 show daily average PM2.5 levels during winter 2022, compared to the daily maximum and minimum levels (shaded range) for winter periods from 2011 to 2021, at Singleton and Muswellbrook. Daily PM2.5 levels were predominantly within or below the historical range in the season.

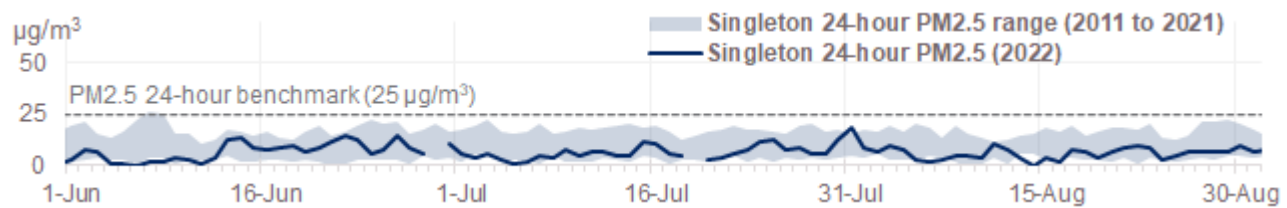


Figure 16 Singleton daily average PM2.5 during winter 2022 plotted against the daily maximum and minimum PM2.5 levels from 2011 to 2021

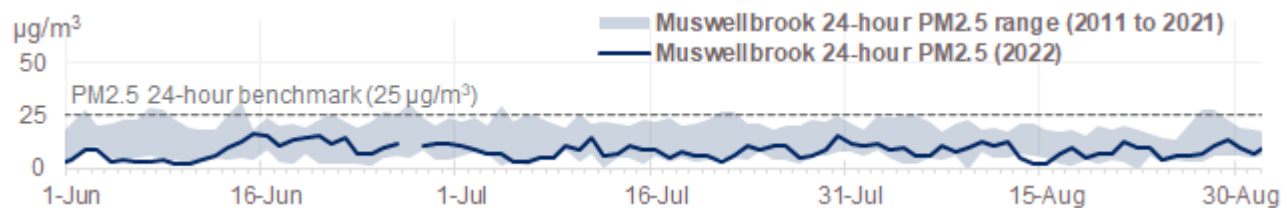


Figure 17 Muswellbrook daily average PM2.5 during winter 2022 plotted against the daily maximum and minimum PM2.5 levels from 2011 to 2021

⁸ No BOM Singleton Defence AWS data from 20 April to 12 July, so DPE Singleton data have been used for this report.

⁹ The BOM STP station was decommissioned in January 2019. Statistics have been calculated from combined [Singleton STP monthly rainfall data](#) from January 2011 to March 2017 and [Singleton Defence AWS monthly rainfall data](#) from April 2017.

Meteorological summary

Rainfall and temperature¹⁰

The Upper Hunter experienced very much above average rainfall during winter 2022 (Figure 18). There was large monthly variability, with a dry June followed by wet conditions in July and August. Winter 2022 was wetter than the 3 previous winters, with around 50 to 200 millimetres more rain than winters 2021 and 2020 and 100 to 400 millimetres more rain than winter 2019.

Maximum temperatures were average (Figure 19), and minimum temperatures were above average during the season.

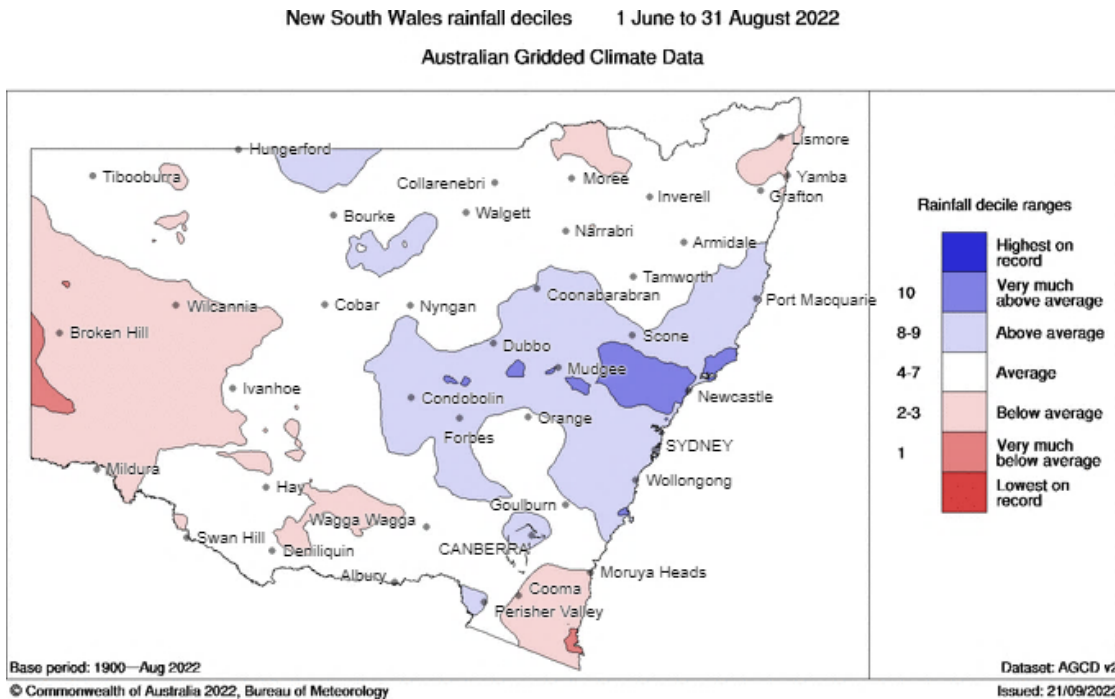


Figure 18 NSW rainfall deciles – winter 2022

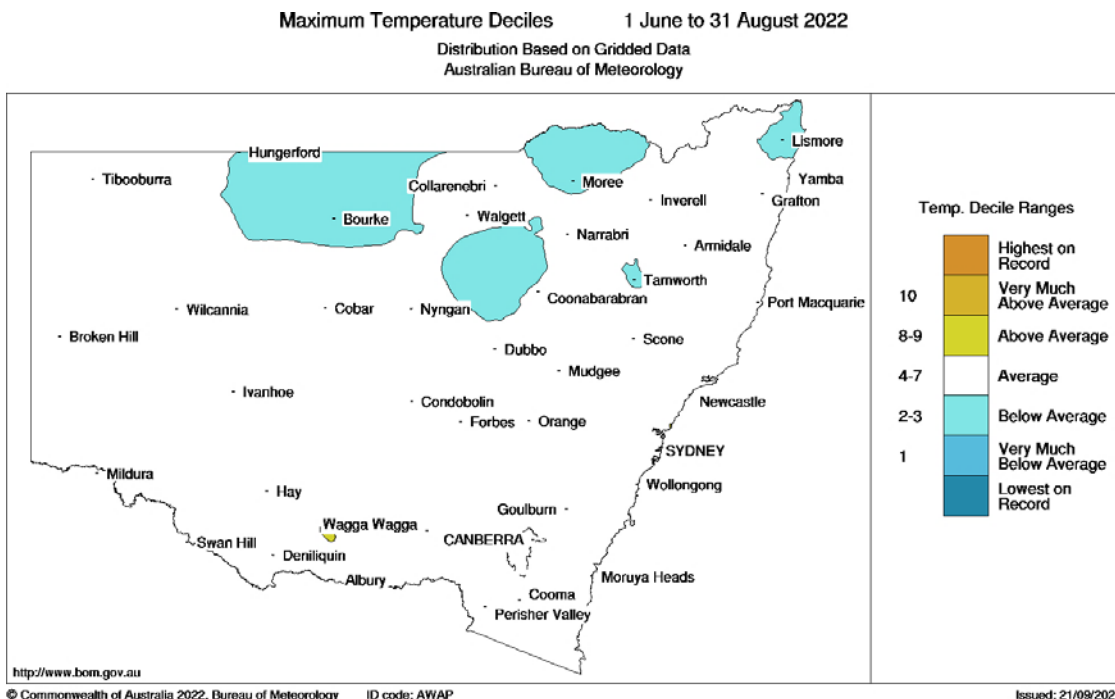


Figure 19 NSW maximum temperature deciles – winter 2022

¹⁰ Rainfall and temperature information is from the Bureau of Meteorology [New South Wales winter 2022 climate statement](#) (accessed October 2022) and [climate maps](#) (accessed October 2022).

Wind

Winds were predominantly from the north-west during winter 2022 (Figure 20), which was typical for this time of year.

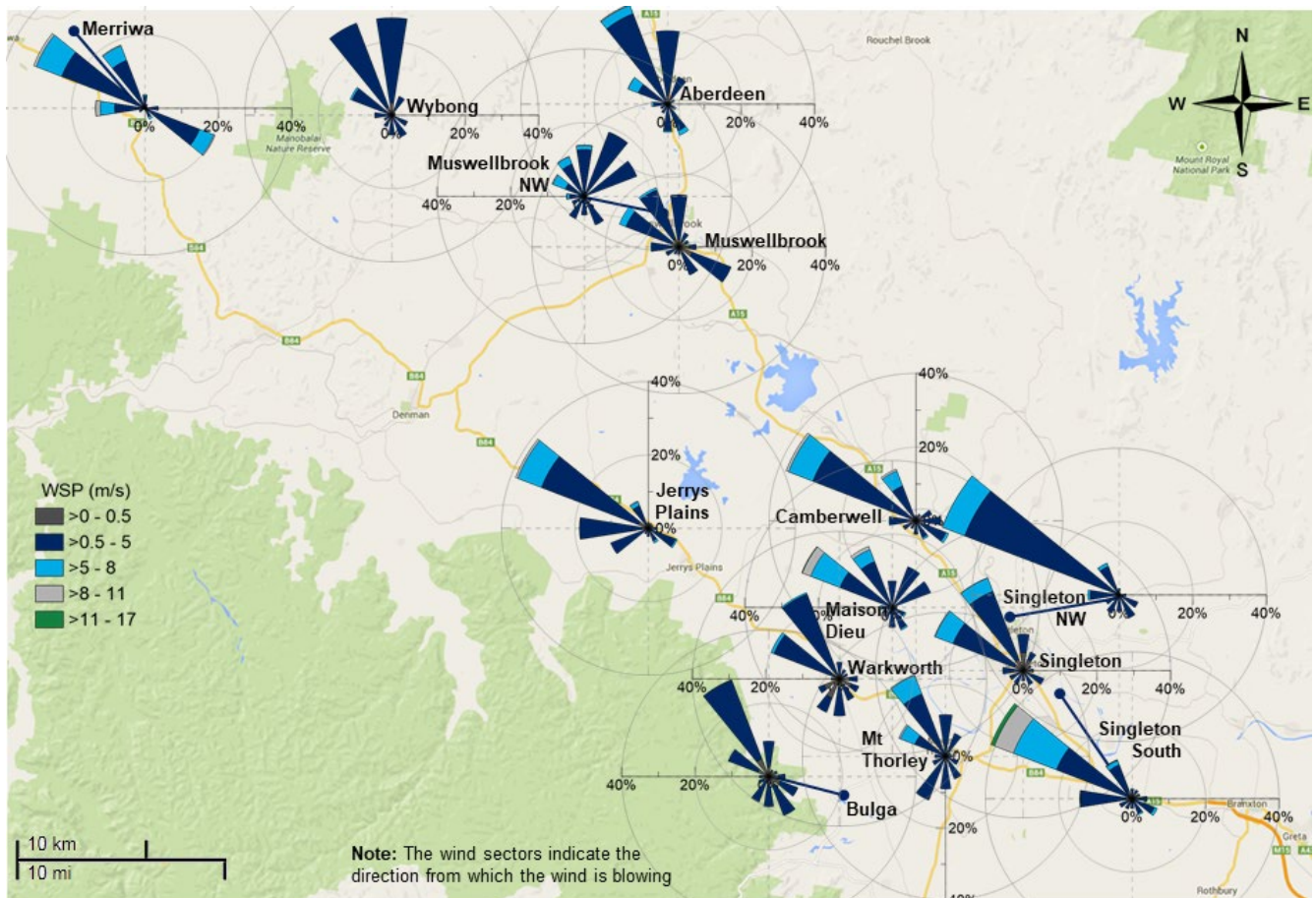


Figure 20 Wind rose map¹¹ for the Upper Hunter region for winter 2022

¹¹ Wind roses show the wind direction and speed at a location. The length of each bar around the circle shows 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 winter 2022

Station	Particles PM10 daily	Particles PM2.5 daily	Gases SO ₂ hourly	Gases NO ₂ hourly	Meteorology Wind hourly
Aberdeen	100	-	-	-	100
Bulga	95	-	-	-	96
Camberwell	98	100	-	-	100
Jerrys Plains	100	-	-	-	100
Maison Dieu	100	-	-	-	100
Merriwa	86	86	79	84	91
Mount Thorley	83	-	-	-	91
Muswellbrook	99	99	95	95	100
Muswellbrook NW	95	-	-	-	99
Singleton	100	98	95	95	99
Singleton NW	100	-	-	-	100
Singleton South	93	-	-	-	94
Warkworth	97	-	-	-	98
Wybong	100	-	-	-	100

- = not monitored

The overall reduced online times were mainly due to:

- Merriwa PM10, PM2.5, SO₂, NO₂ and wind – intermittent datalogger faults (11 days), scheduled calibrations (2 days) and SO₂ instrument fault (5 days)
- Mount Thorley PM10 and wind – intermittent datalogger faults (7 days), power outage (4 days), PM10 instrument fault (4 days) and PM10 scheduled calibration (1 day)
- Singleton South PM10 and wind – offline due to flooding (6 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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