Air quality in the Upper Hunter: Spring 2022

Air quality in the Upper Hunter was good during spring 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 (NO_2) and sulfur dioxide (SO_2) levels were good to fair, remaining within hourly and daily national benchmarks.
- Daily average levels of PM2.5[1] remained within national benchmarks at all stations.
- Daily average levels of PM10[1] remained within national benchmarks at all stations, except one day at Warkworth (20 November). On 20 November, the regional maximum daily PM10 was 50.2 µg/m^2.
- The region experienced very much above average rainfall and very much below average maximum temperatures during spring.

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/m^3 for PM10 and 8 µg/m^3 for PM2.5, based on a calendar year.

Figure 1 shows the PM10 and PM2.5 **rolling** annual averages[2], based on the 12-month periods from spring 2013 to spring 2022.

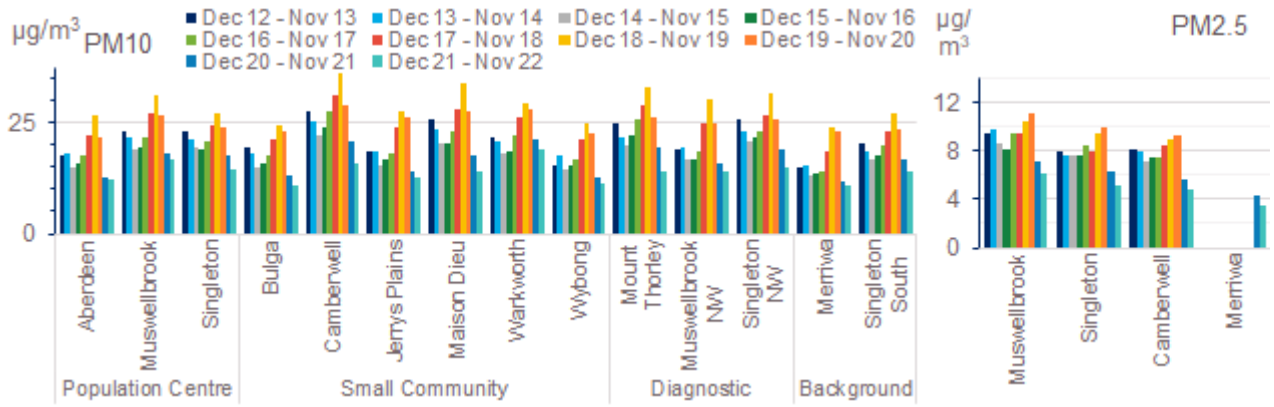

Figure 1 PM10 and PM2.5 rolling annual averages: to the end of spring 2013 to 2022

Note: The Merriwa background air quality monitoring station was upgraded in July 2020 to also monitor PM2.5.

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

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 spring 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 and cooler daytime temperatures over the 12 months. At the end of spring 2022, there were no areas in New South Wales that were drought affected (Figure 2), compared to 5% at the end of spring 2021[3] and 10% at the end of spring 2020[4].

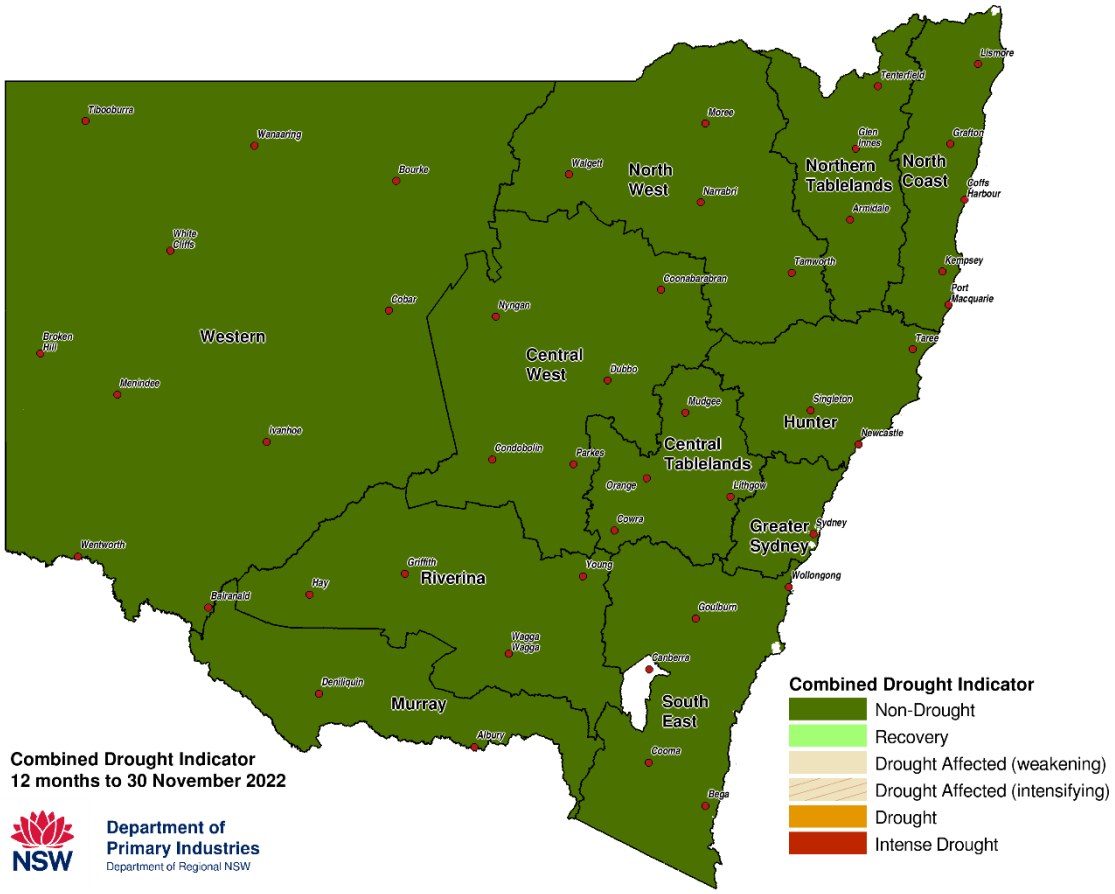

Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 30 November 2022[5]

[3] Sourced from Department of Primary Industries NSW State seasonal update – November 2021 (accessed February 2023).

[4] Sourced from Department of Primary Industries NSW State seasonal update – November 2020 (accessed February 2023).

[5] Sourced from Department of Primary Industries NSW State seasonal update – November 2022 (accessed February 2023).

Days above benchmark concentrations

All parameters remained within the national benchmarks throughout the season, except for Warkworth PM10 on one day.

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

Station type*	Station	PM10 daily [50 µg/m^3 benchmark]	PM2.5 daily [25 µg/m^3 benchmark]	SO_2 hourly [10 pphm benchmark]	SO_2 daily [2 pphm benchmark]	NO_2 hourly [8 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**	1	-	-	-	-
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/m^3 = 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 maps[6] (Figure 3 and Figure 4) show that hourly PM10 and PM2.5 levels[7] were predominantly low during the season.

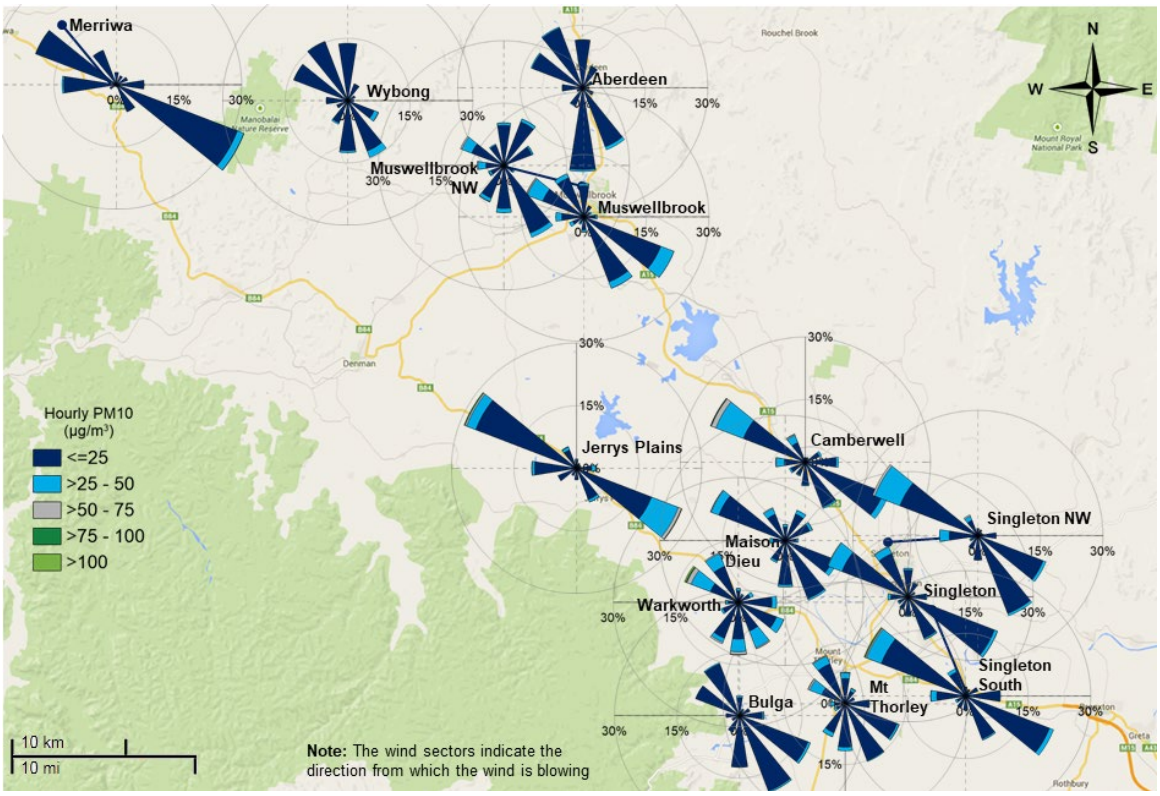

Figure 3 Hourly PM10 pollution rose map for the Upper Hunter region for spring 2022

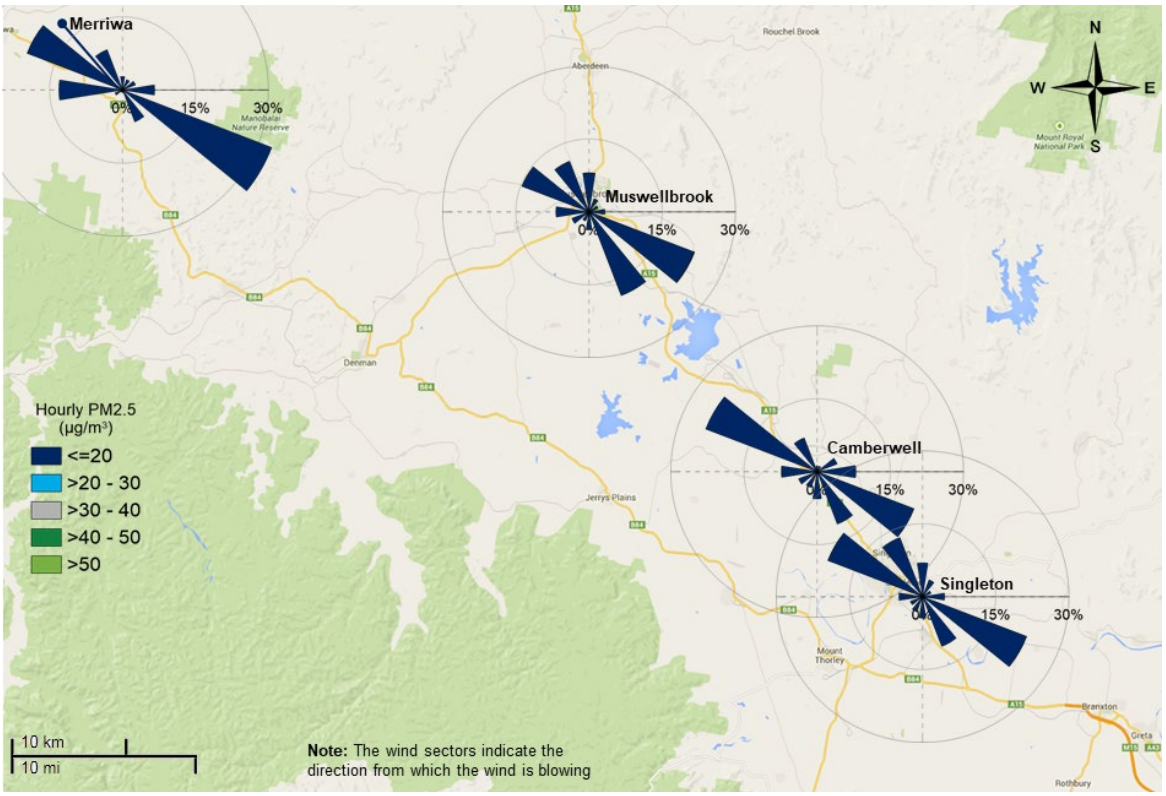

Figure 4 Hourly PM2.5 pollution rose map for the Upper Hunter region for spring 2022

[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

Figure 5 to Figure 12 show daily average time series plots for PM10, PM2.5 and SO_2 and daily 1-hour maximum plots for NO_2 and SO_2. All parameters were within the benchmarks, except PM10 on 20 November at Warkworth. Elevated levels on this day occurred under moderate north-west winds.

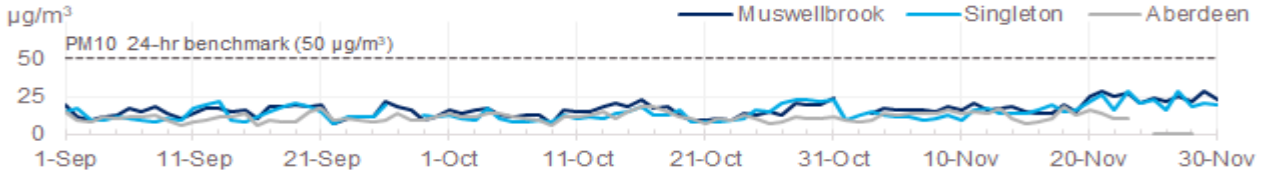

Figure 5 Population centre stations: daily average PM10 – spring 2022

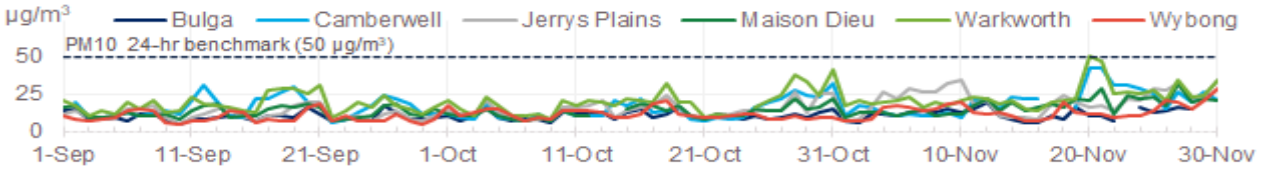

Figure 6 Smaller community stations: daily average PM10 – spring 2022

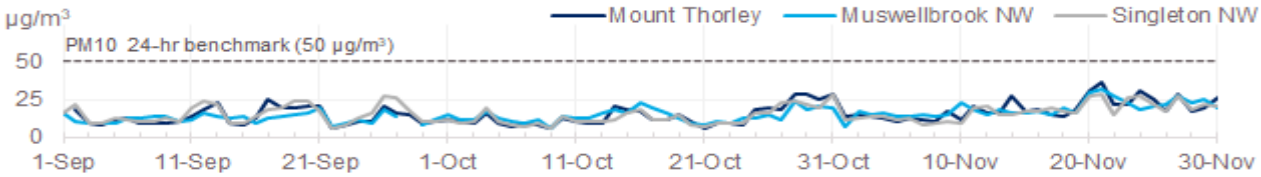

Figure 7 Diagnostic stations: daily average PM10 – spring 2022

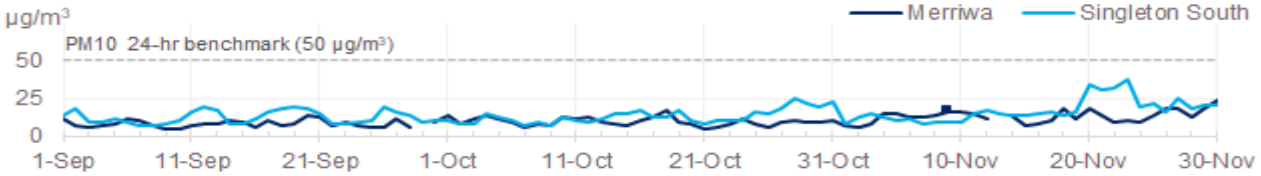

Figure 8 Background stations: daily average PM10 – spring 2022

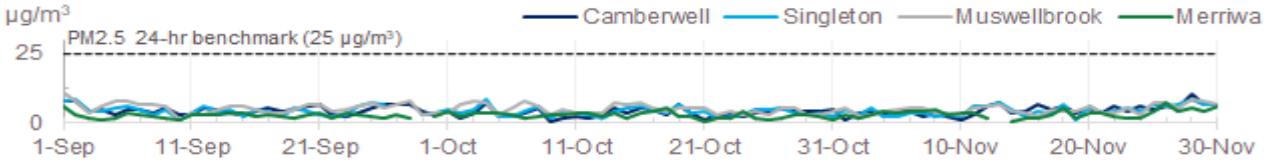

Figure 9 Daily average PM2.5 – spring 2022

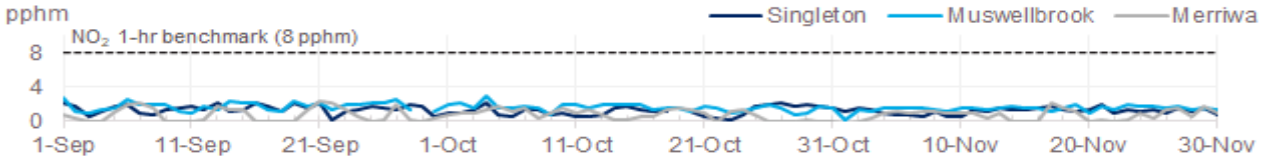

Figure 10 Daily 1-hr maximum NO_2 – spring 2022

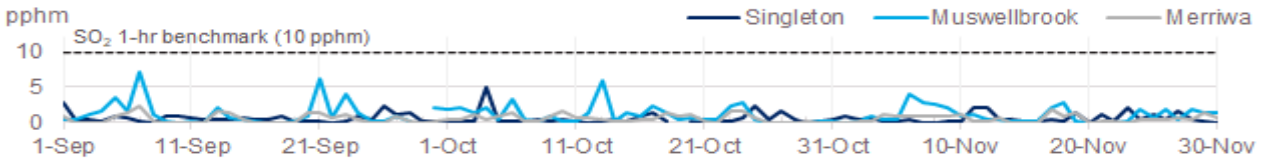

Figure 11 Daily 1-hr maximum SO_2 – spring 2022

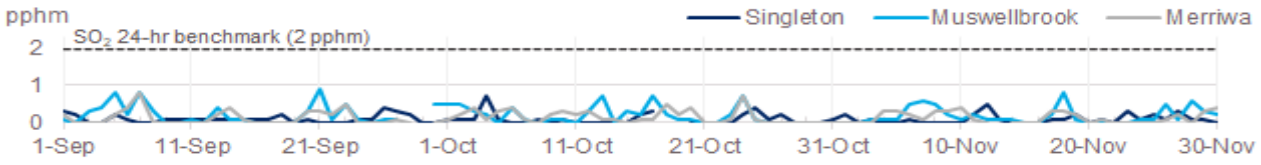

Figure 12 Daily average SO_2 – spring 2022

Seasonal comparisons

This section compares air quality in spring 2022 with previous spring seasons (Figure 13).

There were no days over the national benchmarks for NO_2 and SO_2 in spring 2022. From 2012 to 2021 in spring, under the more stringent benchmarks (applied from May 2021 onwards), Muswellbrook would have recorded 5 hours above the current hourly SO_2 benchmark of 10 parts per hundred million (pphm). This includes one hour in 2011, 2016 and 2018 and 2 hours in 2019. There would also have been 2 days above the current daily SO_2 benchmark at Muswellbrook, one each in 2013 and 2017. There would not have been any days above the current hourly NO_2 benchmark.

There was one day over the PM10 daily benchmark during spring 2022. This is the lowest number of PM10 exceedance days during spring since the network began operations. From 2012 to 2021, the region recorded between 4 days (spring 2020) and 45 days (spring 2019) over the PM10 benchmark.

There were no days over the PM2.5 daily benchmark during spring 2022. From 2012 to 2021, the region recorded between zero days (springs 2015–2018 and 2020–2021) and 14 days (spring 2019) over the PM2.5 benchmark.

Higher particle levels occurred in spring 2019 due to severe drought conditions and extreme bushfires.

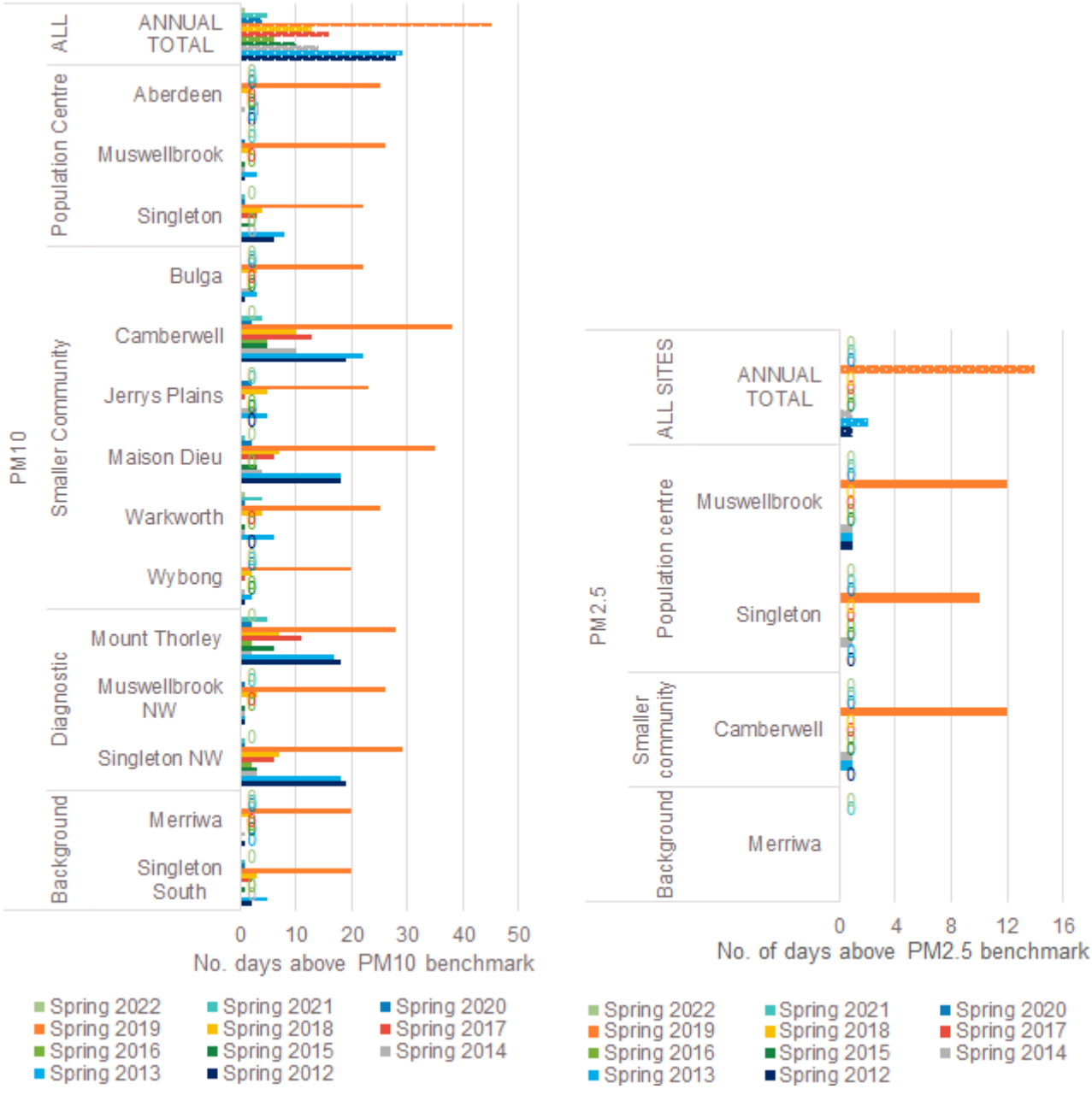

Figure 13 Number of days above the PM10 and PM2.5 daily benchmarks: spring 2012 to 2022

Note: The Merriwa background air quality monitoring station was upgraded in July 2020 to also monitor PM2.5

Particle air quality trends in the Upper Hunter

Figure 14 and Figure 15 show daily average PM10 levels during spring 2022, compared to the daily maximum and minimum levels (i.e. shaded range) for spring 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 for the season (Figure 16).

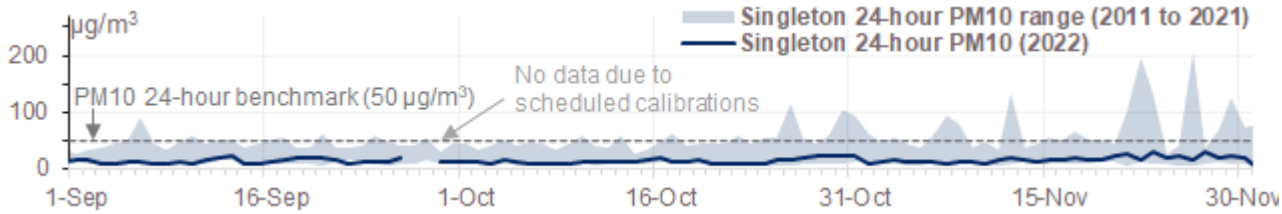

Figure 14 **Singleton daily average PM10 during spring 2022 plotted against the daily maximum and minimum PM10 levels from 2011 to 2021**

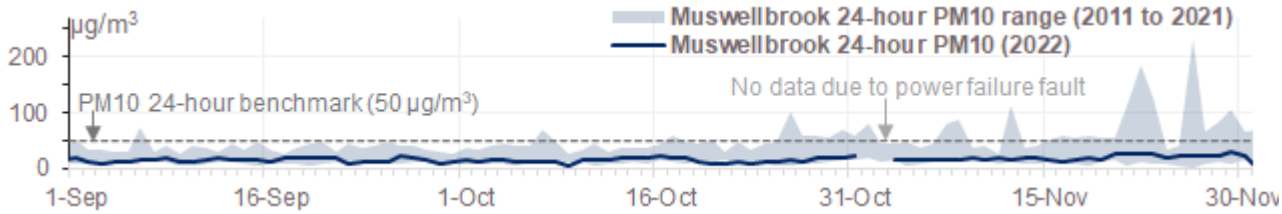

Figure 15 **Muswellbrook daily average PM10 during spring 2022 plotted against the daily maximum and minimum PM10 levels from 2011 to 2021**

Figure 16 **Bureau of Meteorology Singleton Defence AWS[8] cumulative monthly rainfall in spring 2022 against maximum and average monthly rainfall from 2011 to 2021[9]**

Figure 17 and Figure 18 show daily average PM2.5 levels during spring 2022, compared to the daily maximum and minimum levels (shaded range) for spring periods from 2011 to 2021, at Singleton and Muswellbrook. Daily PM2.5 levels were within or below the historical range in the season.

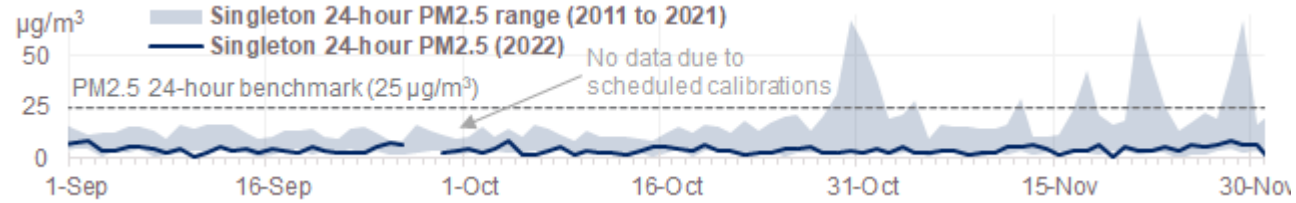

Figure 17 **Singleton daily average PM2.5 during spring 2022 plotted against the daily maximum and minimum PM2.5 levels from 2011 to 2021**

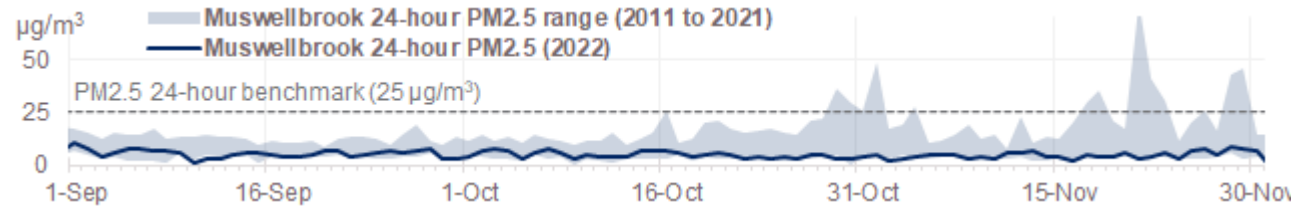

Figure 18 **Muswellbrook daily average PM2.5 during spring 2022 plotted against the daily maximum and minimum PM2.5 levels from 2011 to 2021**

[8] Data obtained from the Bureau of Meteorology Singleton Defence AWS monthly rainfall data (accessed January 2023).

[9] 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 March 2020) from January 2011 to March 2017 and Singleton Defence AWS monthly rainfall data from April 2017.

Meteorological summary

Rainfall and temperature[10]

The Upper Hunter experienced very much above average rainfall during spring 2022 (Figure 19). Spring 2022 was drier than spring 2021, with 25 to 100 millimetres less rain. The season was wetter than spring 2020, with 100 to 200 millimetres more rain and wetter than spring 2019 with 200 to 400 millimetres more rain.

Maximum temperatures were very much below average (Figure 20), and minimum temperatures were average during the season.

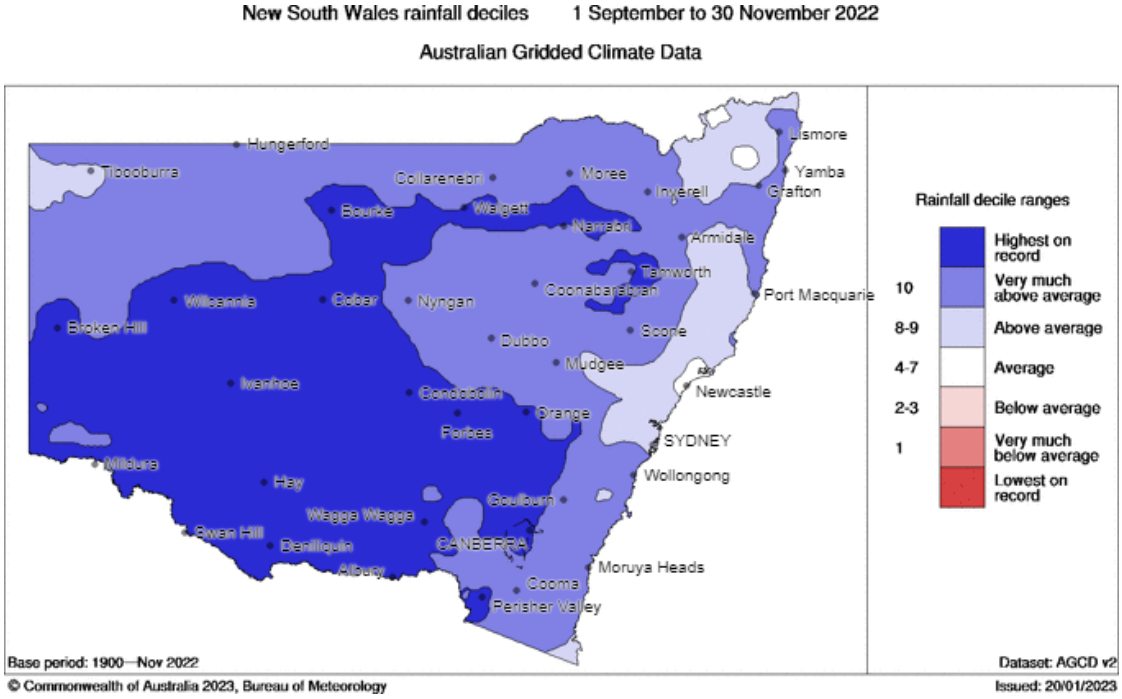

Figure 19 NSW rainfall deciles – spring 2022

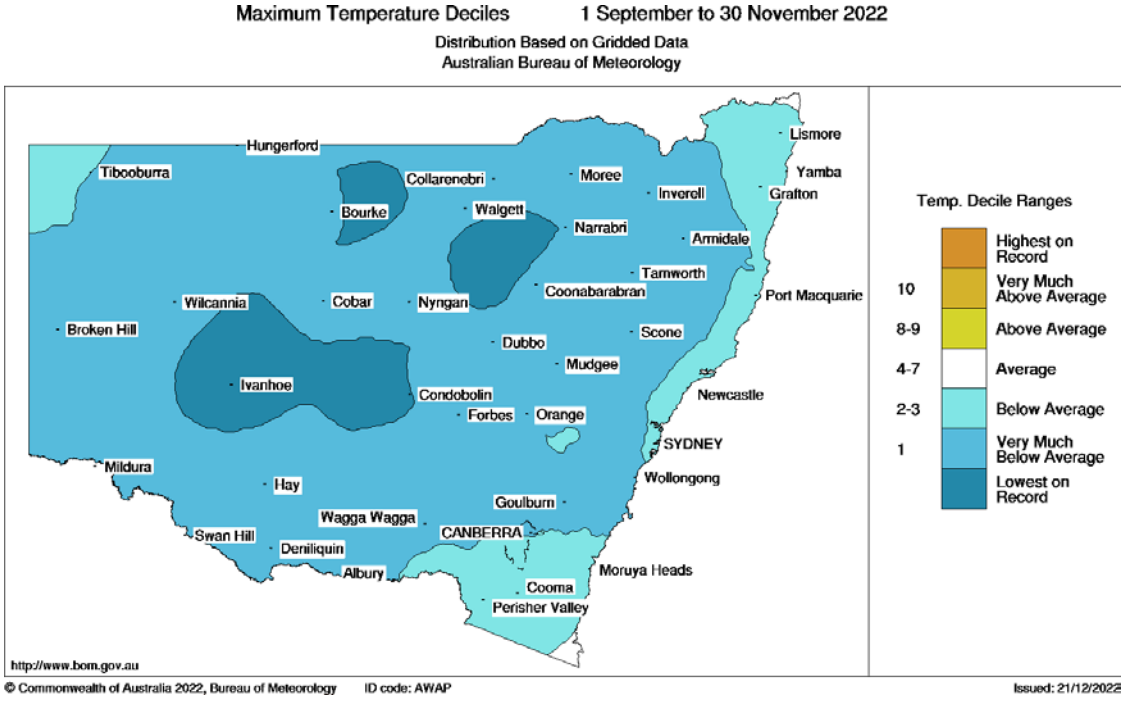

Figure 20 NSW maximum temperature deciles – spring 2022

[10] Rainfall and temperature information is from the Bureau of Meteorology New South Wales spring 2022 climate statement (accessed February 2023) and climate maps (accessed February 2023).

Wind

The winds were variable in the region during spring 2022 (Figure 21), which was typical for this transitional season. Winds typically change from north-westerly in winter to south-easterly in summer.

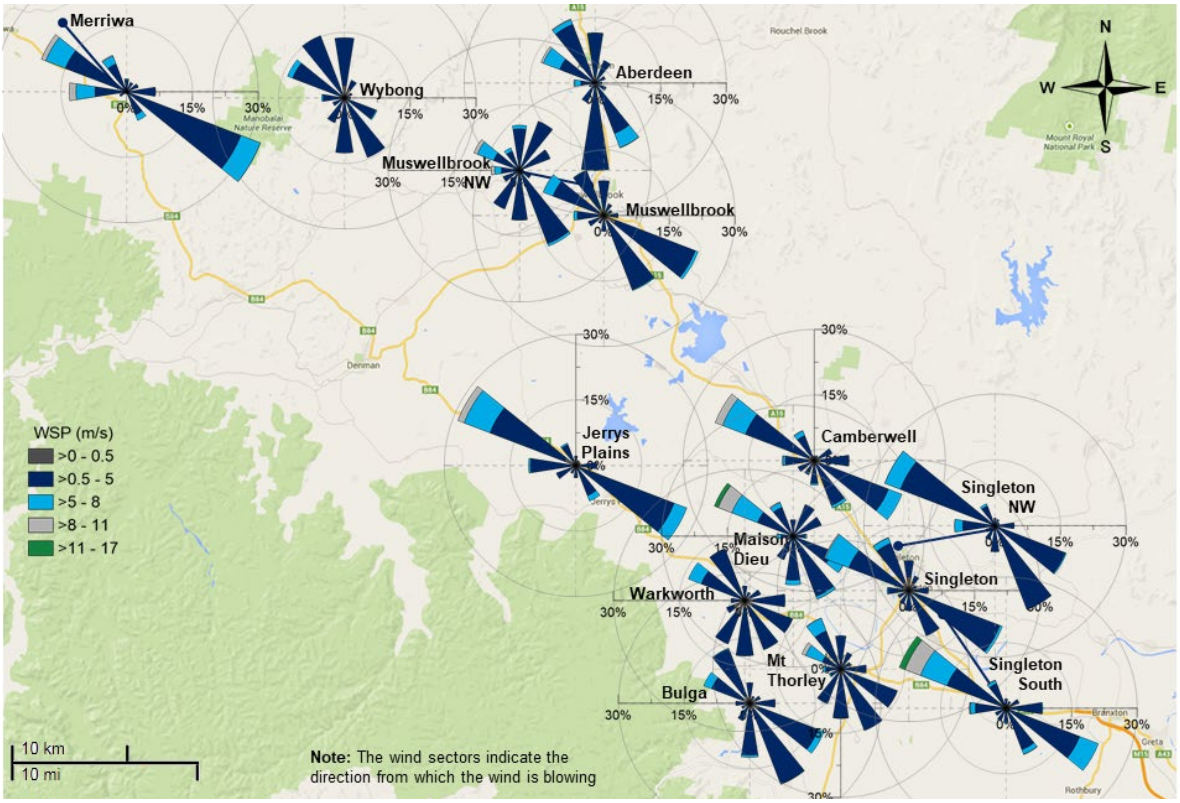

Figure 21 Wind rose map[11] for the Upper Hunter region for spring 2022

[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 NO_2 and SO_2 is 96%, due to daily calibrations.

Table 2 Online performance (%) during spring 2022

Station	Particles PM10 daily	Particles PM2.5 daily	Gases SO_2 hourly	Gases NO_2 hourly	Meteorology Wind hourly
Aberdeen	93	-	-	-	94
Bulga	98	-	-	-	99
Camberwell	97	100	-	-	100
Jerrys Plains	100	-	-	-	100
Maison Dieu	98	-	-	-	100
Merriwa	98	98	95	94	99
Mount Thorley	99	-	-	-	100
Muswellbrook	98	100	94	94	99
Muswellbrook NW	99	-	-	-	100
Singleton	98	98	94	90	100
Singleton NW	100	-	-	-	100
Singleton South	100	-	-	-	100
Warkworth	99	-	-	-	99
Wybong	100	-	-	-	100

- = not monitored

The overall reduced online times were mainly due to:

- Aberdeen PM10 and wind– datalogger fault (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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Published by: Department of Planning and Environment, Locked Bag 5022, Parramatta NSW 2124. Ph: 131 555 (environment information and publications requests). TTY: (02) 9211 4723. Email: info@environment.nsw.gov.au;
Web: www.environment.nsw.gov.au.

ISSN 2206-0391; EHG 2023/00105; February 2023