Air quality in the Upper Hunter: Spring 2021

Air quality in the Upper Hunter was good during spring 2021. Daily particle levels were within national benchmarks 98.9% of the time at Singleton and 100% of the time at Muswellbrook. Hourly particle levels were in the good to fair air quality categories 99.7% and 99.9% at Muswellbrook and Singleton, respectively. Regional air quality continued to improve compared to recent years, with the region experiencing wetter conditions and average maximum temperatures in spring 2021.

- Levels of fine particle matter PM2.5 (particles less than or equal to 2.5 microns in diameter), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) were good, remaining below national benchmarks.
- Daily levels of PM10 (particles less than or equal to 10 microns in diameter) were above the 50 µg/m^3 benchmark on 5 days at Mount Thorley (12 and 24 September and 7, 10 and 29 October 2021), 4 days at both Camberwell and Warkworth (12 September and 7, 10 and 29 October 2021 at both stations) and one day each at Singleton, Maison Dieu, Singleton NW and Singleton South (29 October 2021 at each station). Regional maximum daily PM10 levels on these days ranged from 58 to 82 µg/m^3. Warkworth recorded the regional daily maximum for 43% (40 days) of spring 2021.

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[1], based on the 12-month periods to the end of spring, for 2013 to 2021.

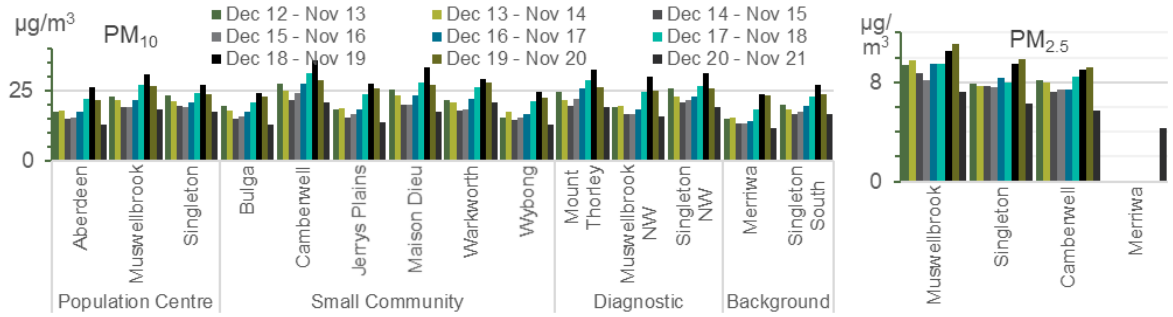

Figure 1 PM10 and PM2.5 rolling annual averages: to the end of spring 2013 to 2021

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.

The comparison in Figure 1 shows significant improvement in particle levels throughout the region during the 12 months to the end of spring 2021 compared to earlier years. All stations recorded their lowest rolling annual average PM10 and PM2.5 particle levels to the end of spring 2021 since the network began. By contrast, in the 12 months to the end of spring 2020, all stations recorded their second or third highest rolling annual average for PM10 and the highest rolling annual average for PM2.5 particle levels since the network began as a result of intense drought and extensive bushfires.

The improved particle levels resulted from comparatively cooler and wetter conditions throughout 2021, reducing dust storm and bushfire activity. At the end of spring 2021, 5% of New South Wales was affected by drought (Figure 2), compared to 10% of the state drought declared by the end of spring 2020[2].

[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 – November 2020 (accessed January 2022).

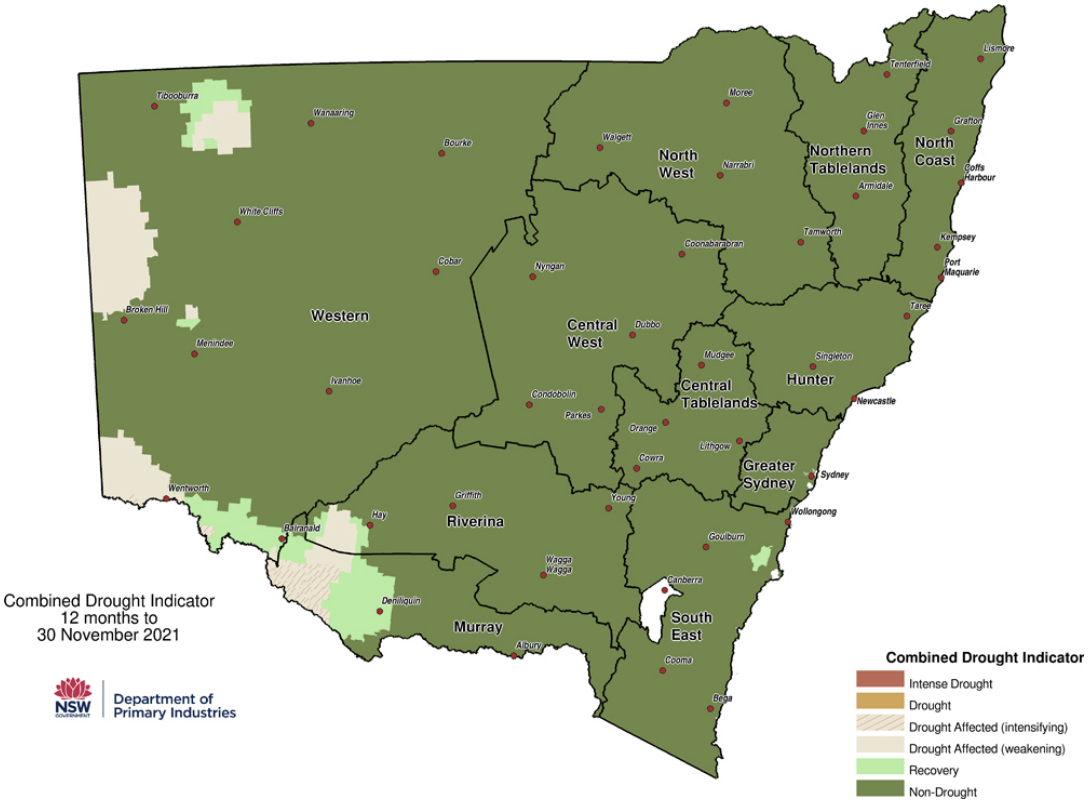

Figure 2 **Department of Primary Industries NSW Combined Drought Indicator to 31 November 2021**[3]

Days above benchmark concentrations

PM10 and PM2.5 levels remained below their respective daily benchmarks throughout the season.

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

Station type*	Station	PM10 daily [50 µg/m³ benchmark]	PM2.5 daily [25 µg/m³ benchmark]	SO_2 hourly[4] [10 pphm benchmark]	SO_2 daily[4] [2 pphm benchmark]	NO_2 hourly[4] [8 pphm benchmark]
Population centre	**Aberdeen**	0	-	-	-	-
Population centre	**Muswellbrook**	0	0	0	0	0
Population centre	**Singleton**	1	0	0	0	0
Smaller community	**Bulga**	0	-	-	-	-
Smaller community	**Camberwell**	4	0	-	-	-
Smaller community	**Jerrys Plains**	0	-	-	-	-
Smaller community	**Maison Dieu**	1	-	-	-	-
Smaller community	**Warkworth**	4	-	-	-	-
Smaller community	**Wybong**	0	-	-	-	-
Diagnostic	**Mount Thorley**	5	-	-	-	-
Diagnostic	**Muswellbrook NW**	0	-	-	-	-
Diagnostic	**Singleton NW**	1	-	-	-	-
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 – November 2021 (accessed January 2022).

[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 SO_2 (now 10 pphm), daily SO2 (now 2 pphm) and hourly NO_2 (now 8 pphm).

Pollution roses from hourly particle data

The seasonal pollution rose maps[5] (Figure 3 and Figure 4) show that higher hourly PM10 levels[6] generally associated with north-westerly winds at Camberwell and Warkworth. Higher hourly PM2.5 levels also were associated with north-westerly winds at Camberwell.

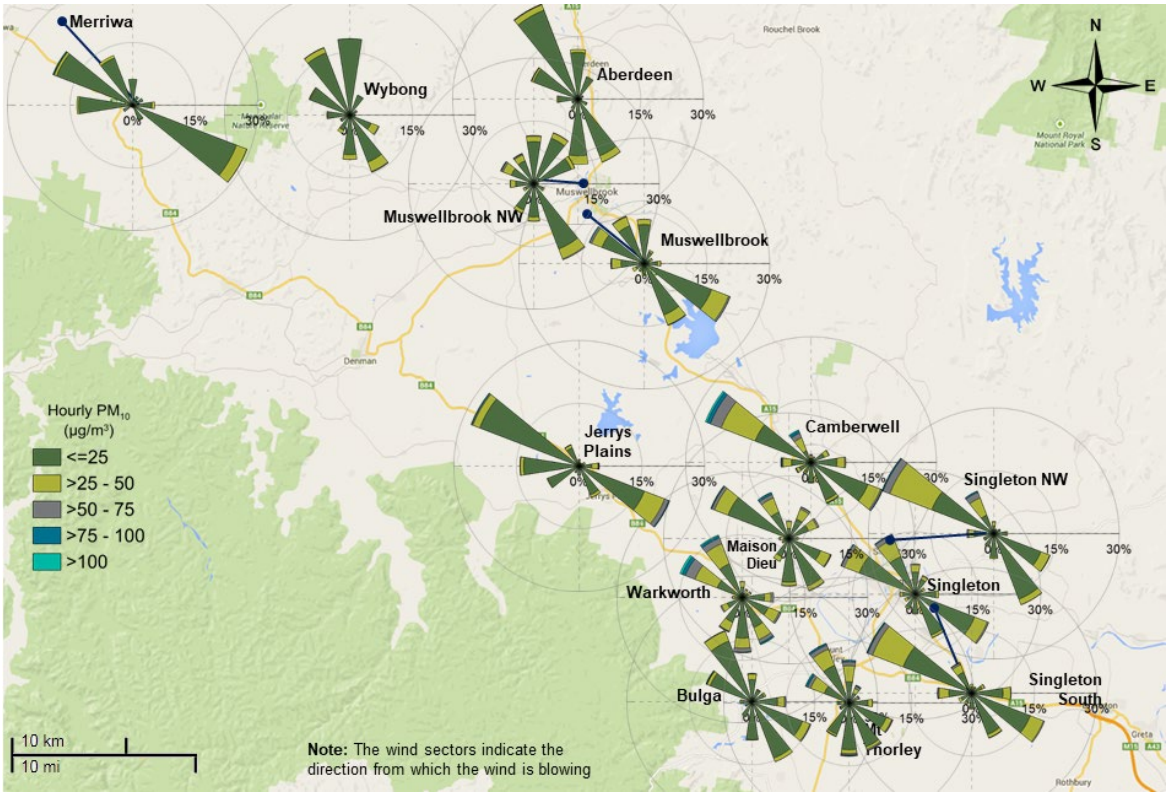

Figure 3 **Hourly PM10 pollution rose map for the Upper Hunter region for spring 2021**

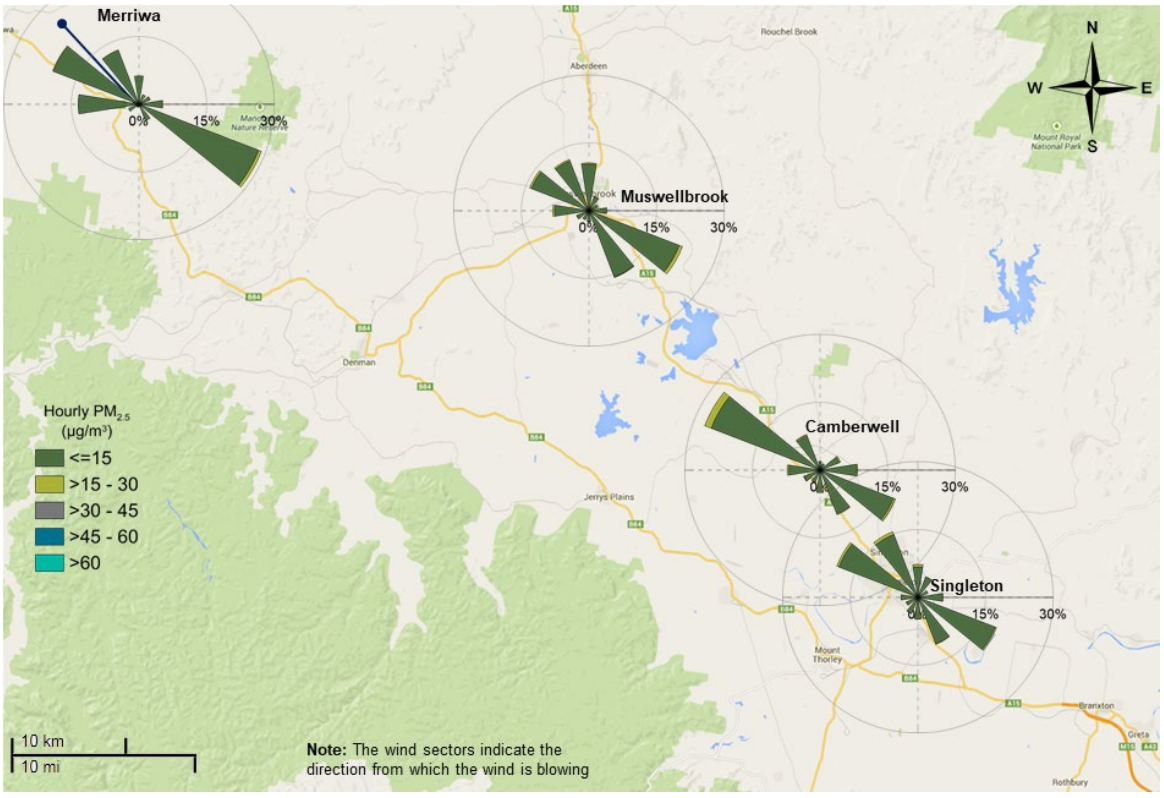

Figure 4 **Hourly PM2.5 pollution rose map for the Upper Hunter region for spring 2021**

[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 NO_2 and SO_2 show the concentrations throughout spring (Figure 5 to Figure 11). PM2.5, NO_2 and SO_2 remained below the benchmarks, while PM10 exceeded the 50 µg/m^3 at seven stations during spring 2021.

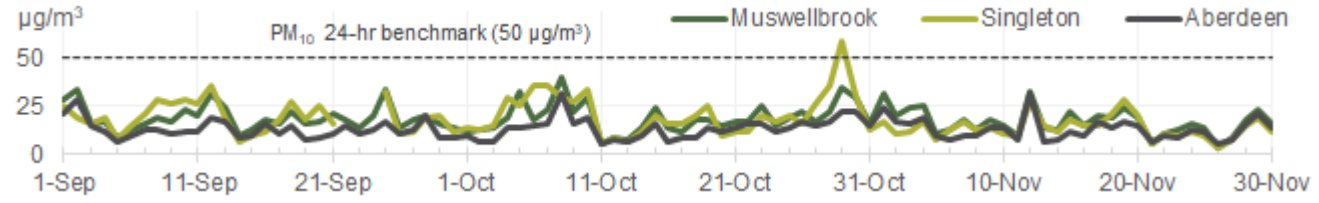

Figure 5 **Population centre stations: daily average PM10 – spring 2021**

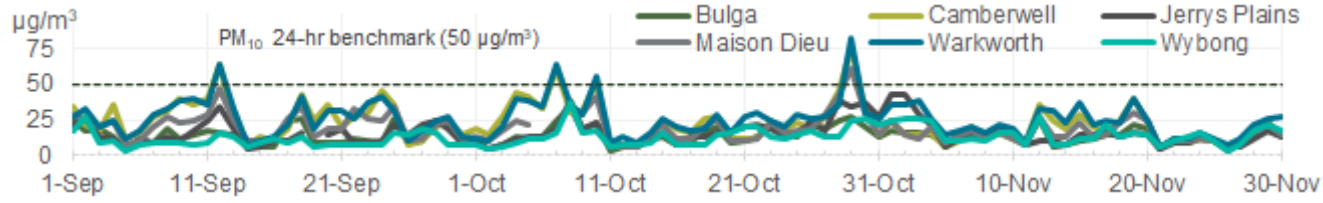

Figure 6 **Smaller community stations: daily average PM10 – spring 2021**

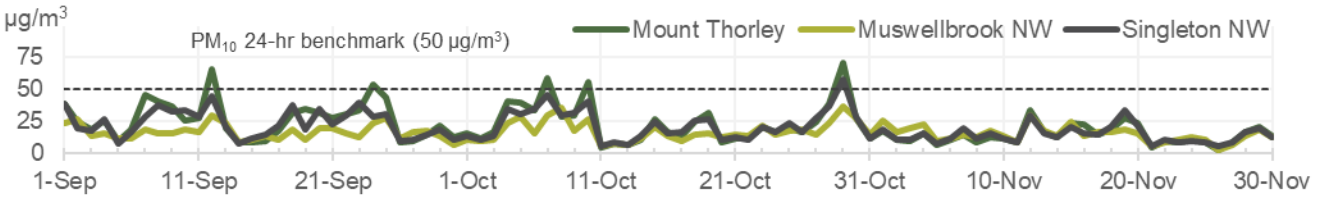

Figure 7 **Diagnostic stations: daily average PM10 – spring 2021**

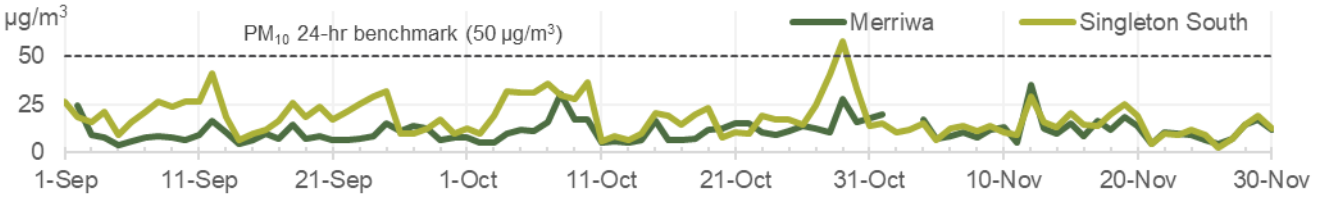

Figure 8 **Background stations: daily average PM10 – spring 2021**

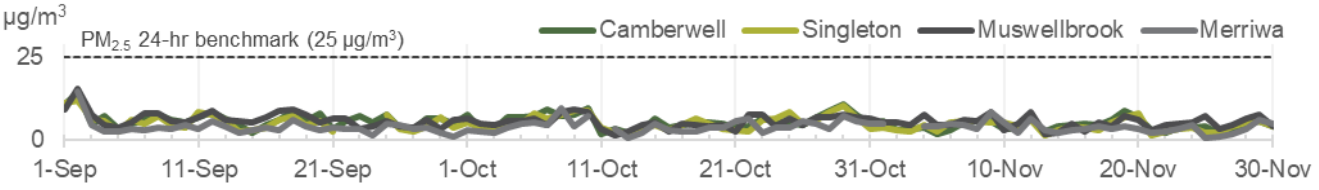

Figure 9 **Daily average PM2.5 – spring 2021**

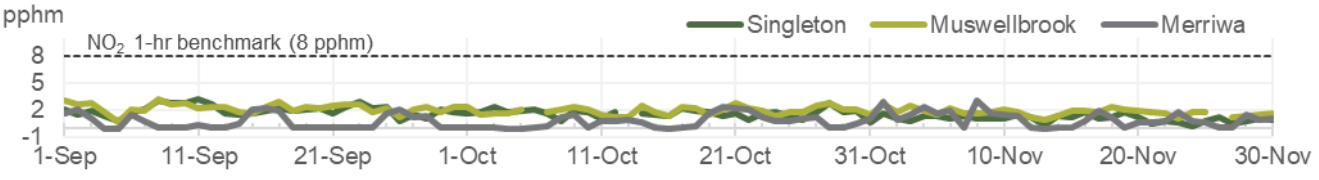

Figure 10 **Daily 1-hr maximum NO_2 – spring 2021**

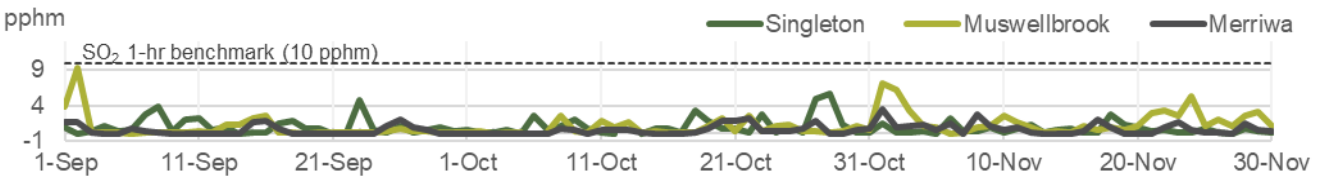

Figure 11 **Daily 1-hr maximum SO_2 – spring 2021**

Seasonal comparisons

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

All spring days were below national benchmark concentrations for NO_2 and SO_2 over the past 10 years.

There were 5 days above the daily average PM10 benchmark in the Upper Hunter during spring 2021, one more than the 4 exceedance days in spring 2020. This was the second fewest number of exceedance days during spring since the network began operation. Exceedance days in the remaining spring seasons ranged from 45 days in spring 2019 to 6 days in spring 2016, both seasons associated with dust and bushfire smoke.

For the second spring in a row, all days in spring 2021 were below the daily average PM2.5 benchmark at all stations. In comparison, 14 days above the benchmark were recorded in spring 2019. No days above the PM2.5 daily benchmark were recorded in from spring 2015 to spring 2018. Days above the PM2.5 daily benchmark ranged from one in spring 2012 and 2014 to 2 days in spring 2013.

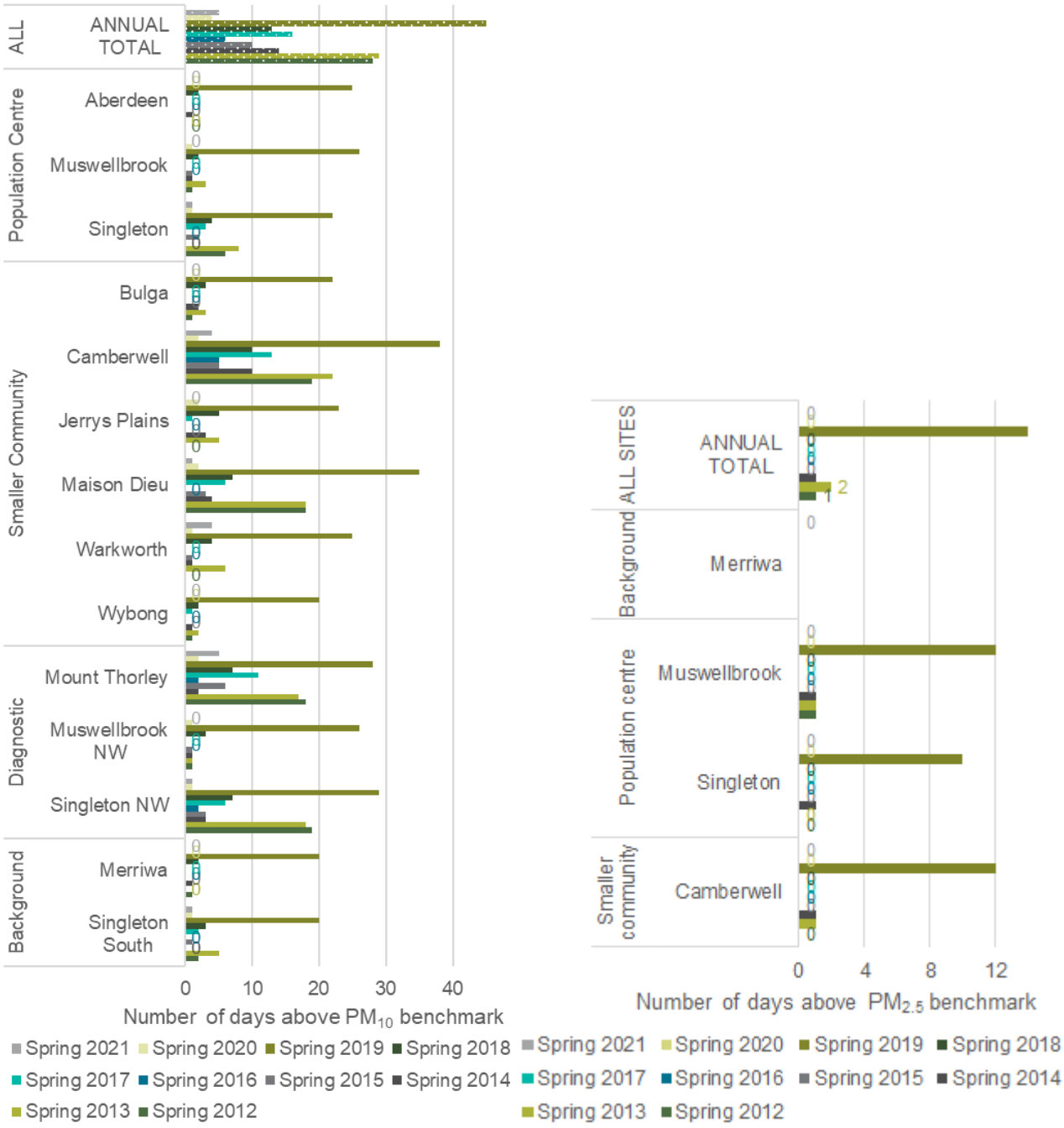

Figure 12 Number of days above the PM10 and PM2.5 daily benchmarks: spring 2012 to 2021

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 spring 2021, compared to the daily maximum and minimum levels (i.e. shaded range) for spring seasons from 2011 to 2020, at Singleton and Muswellbrook. Daily PM10 levels were within or below the historical range throughout the season at both stations. Regional rainfall levels were above average during spring 2021, with good falls at Singleton in mid to late November 2021 (Figure 15).

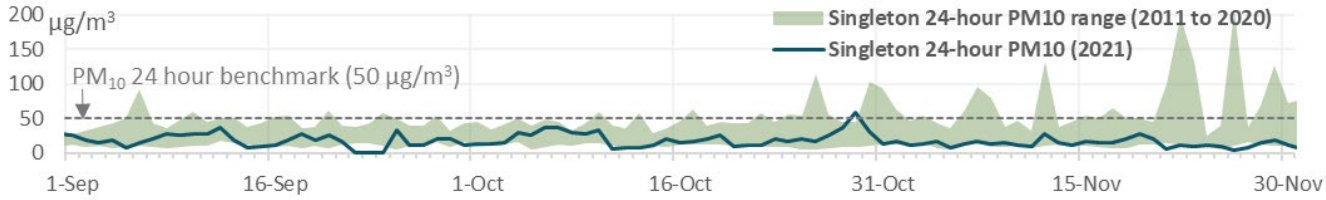

Figure 13 **Singleton daily average PM10 during spring 2021 plotted against the daily maximum and minimum PM10 levels from 2011 to 2020**

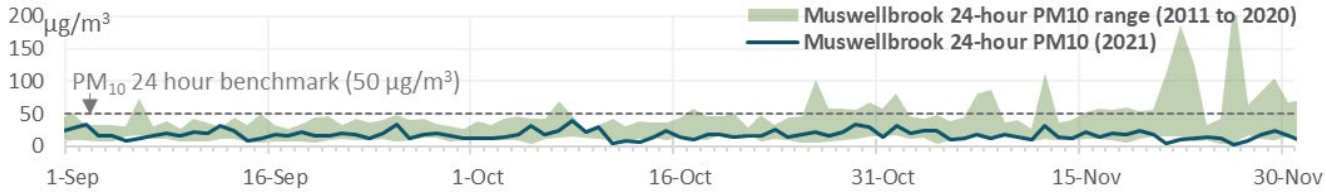

Figure 14 **Muswellbrook daily average PM10 during spring 2021 plotted against the daily maximum and minimum PM10 levels from 2011 to 2020**

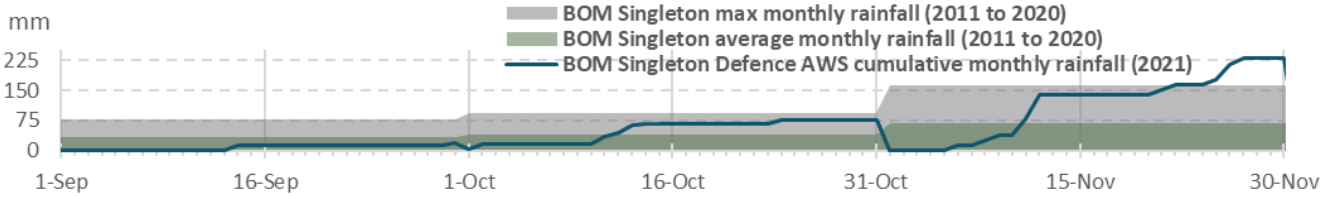

Figure 15 **Bureau of Meteorology Singleton Defence AWS[7] cumulative monthly rainfall in spring 2021 against maximum and average monthly rainfall from 2011 to 2020[8]**

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

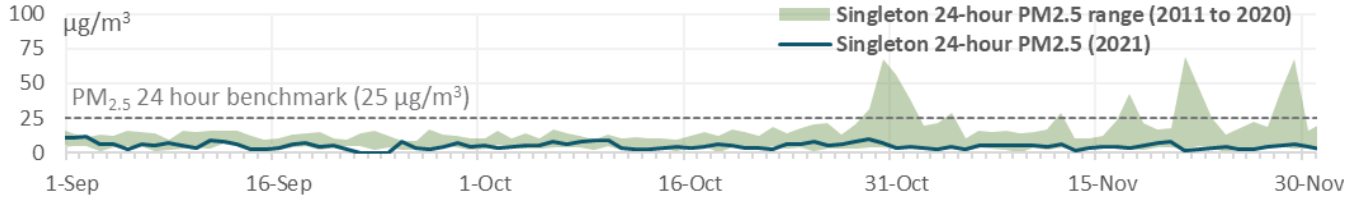

Figure 16 **Singleton daily average PM2.5 during spring 2021 plotted against the daily maximum and minimum PM2.5 levels from 2011 to 2020**

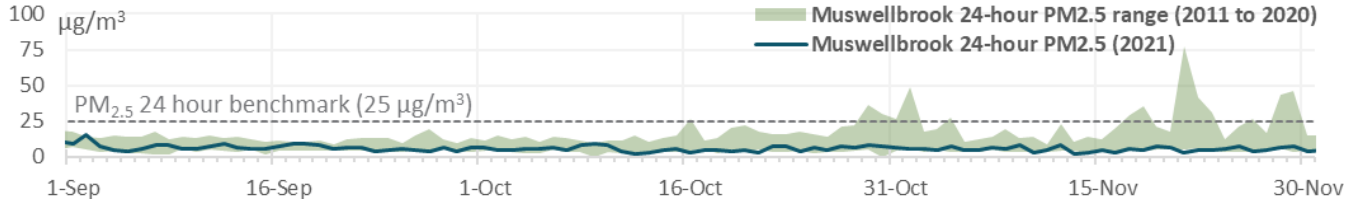

Figure 17 **Muswellbrook daily average PM2.5 during spring 2021 plotted against the daily maximum and minimum PM2.5 levels from 2012 to 2020**

[7] Data obtained from the Bureau of Meteorology Singleton Defence AWS monthly rainfall data (accessed October 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 October 2021) from January 2011 to March 2017 and Singleton Defence AWS monthly rainfall data from April 2017.

Meteorological summary

Rainfall and temperature[9]

The Upper Hunter recorded rainfall at levels very much above average to the highest on record during spring 2021 (Figure 18). The region received 200 to 400 millimetres more rainfall in spring 2021 than either spring 2020 or spring 2019. Spring 2021 was wetter than spring 2018 by 100 to 400 millimetres of rain.

Maximum temperatures (day time) were average, while minimum temperatures (night time) were above average (Figure 19) during spring 2021.

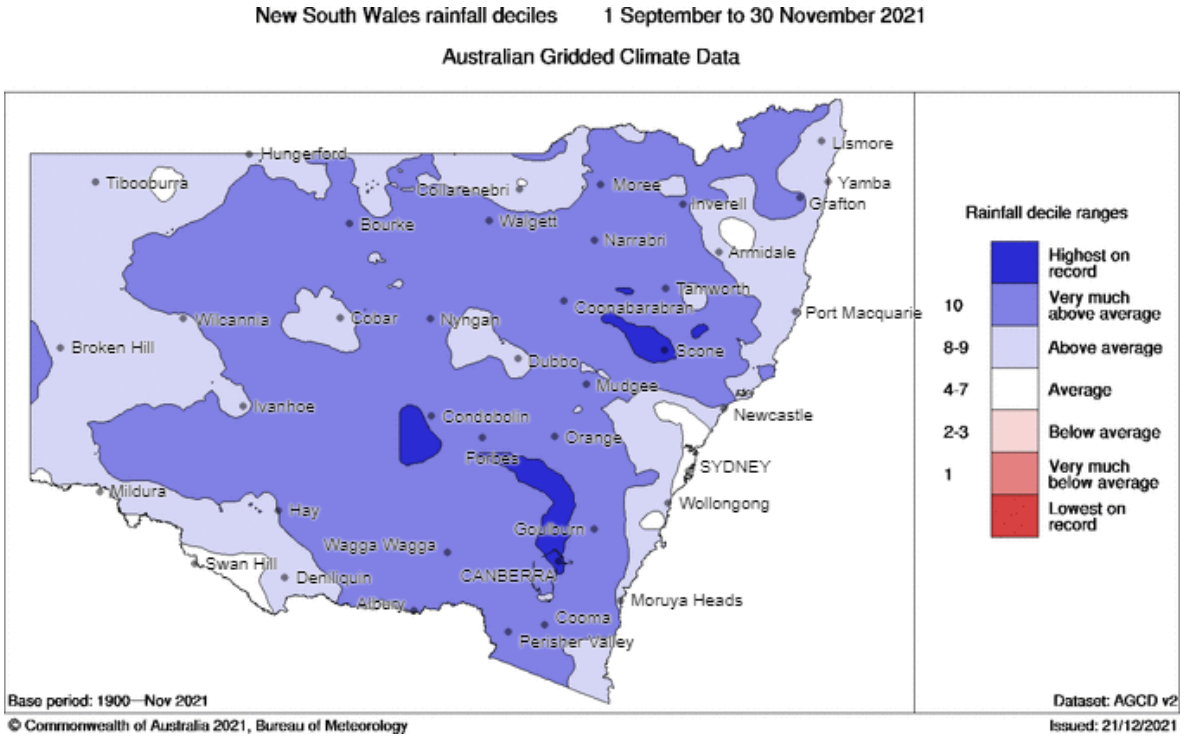

Figure 18 NSW rainfall deciles – spring 2021

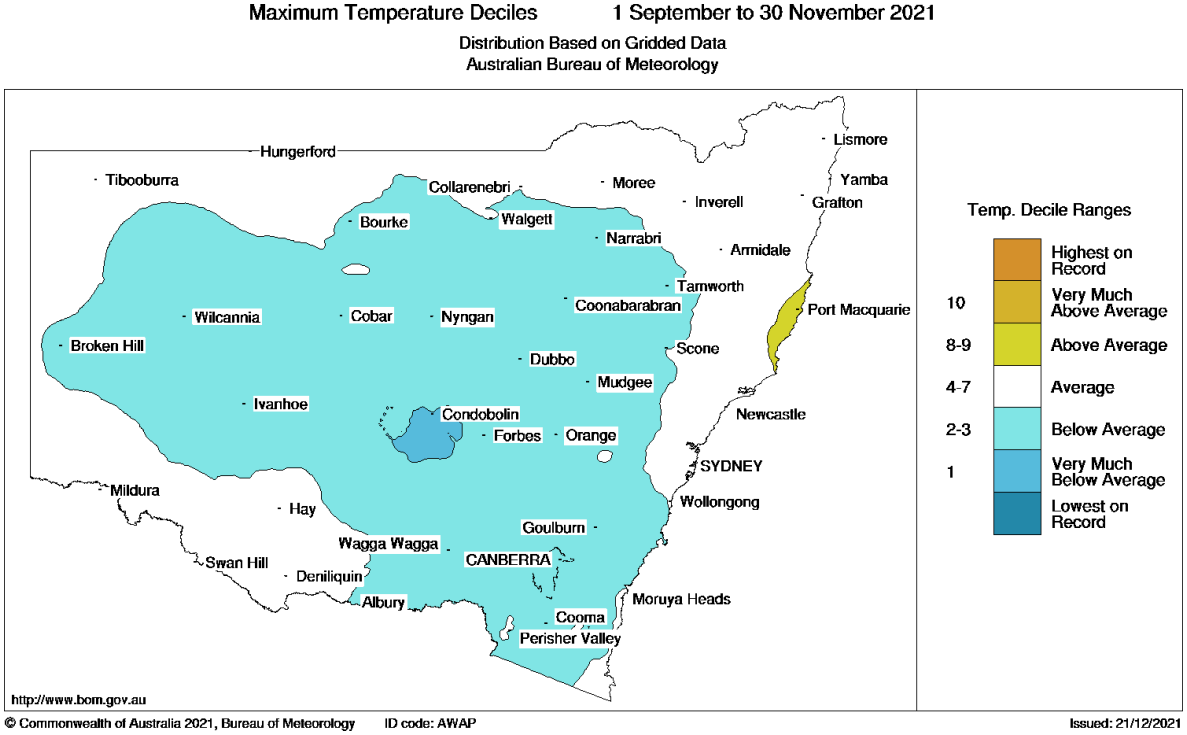

Figure 19 NSW maximum temperature deciles – spring 2021

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

Wind

Winds were predominantly from the north-west in early spring, later turning to south-east (Figure 20), which was typical for this time of year. Regional wind speeds in spring 2021 were higher compared to spring 2020.

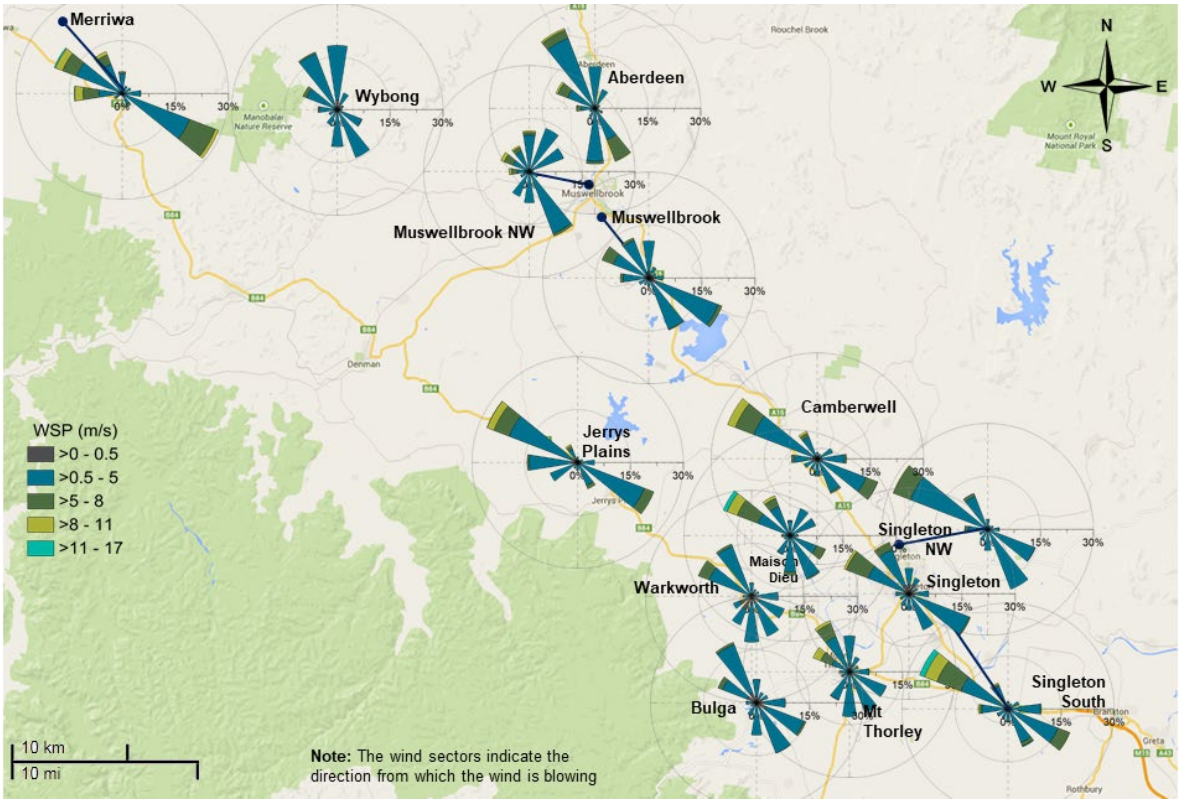

Figure 20 Wind rose map[10] for the Upper Hunter region for spring 2021

[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 for 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.

Parameters generally met at least 95% available data targets in spring 2021. Reduced online times mainly were due to scheduled maintenance and replacement parts for gaseous instruments at Muswellbrook and Singleton and wind sensors at Singleton.

Table 2 Online performance (%) during spring 2021

Station	Particles PM10 daily	Particles PM2.5 daily	Gases SO_2 hourly	Gases NO_2 hourly	Meteorology Wind hourly
Aberdeen	100	-	-	-	100
Bulga	100	-	-	-	100
Camberwell	100	100	-	-	100
Jerrys Plains	97	-	-	-	100
Maison Dieu	98	-	-	-	100
Merriwa	97	96	95	95	99
Mount Thorley	100	-	-	-	100
Muswellbrook	100	100	94	93	100
Muswellbrook NW	100	-	-	-	100
Singleton	97	97	94	93	94
Singleton NW	100	-	-	-	100
Singleton South	100	-	-	-	99
Warkworth	100	-	-	-	100
Wybong	100	-	-	-	100

- = not monitored

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 at Merriwa and Singleton South are at the north-west and south-east extents of the Upper Hunter region and measure the quality of air entering and leaving the region under predominant winds (generally north-westerlies in cooler months and south-easterlies in warmer months).

This document was prepared by Sean Watt and reviewed by David Salter and Dr Leanne Graham.

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