Air quality in the Upper Hunter: Autumn 2019

Upper Hunter air quality for 1 March to 31 May 2019 was generally good to fair. Muswellbrook and Singleton recorded very good to fair air quality indices within national benchmarks 97% and 98% of the time, respectively.

- Levels of fine particulate matter $PM_{2.5}$ (particles less than or equal to 2.5 microns in diameter), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) were below benchmark concentrations.
- Daily average levels of PM_{10} (particles less than or equal to 10 microns in diameter) were above the 50 µg/m^3 benchmark on 13 days (6, 11, 27 and 31 March, 8–9 and 26 April, and 2, 21–23, 27 and 29 May). Regional maximum daily PM_{10} levels on these days ranged from 50.5 to 113.8 µg/m^3.
  - All sites recorded days over the PM_{10} benchmark, ranging from two days at Aberdeen, Bulga, Jerrys Plains, Singleton and Wybong, and up to ten days at Mt Thorley (Table 1).
  - The most extensive events occurred on 6 and 31 March, being exceptional events due to long-range dust. March was the dustiest March for New South Wales since DustWatch records began in 2005[1].
    - On 6 March, PM_{10} levels over the benchmark were recorded at all 21 Upper Hunter, Newcastle and Central Tablelands sites. The region was affected by long-range dust transported from central and western NSW, ahead of a cold front.
    - On 31 March, 19 sites in the Upper Hunter (all sites except Bulga), Newcastle, Northern Tablelands and North West Slopes recorded PM_{10} levels over the benchmark. Elevated particle levels were observed at all sites in the Upper Hunter region from late the previous night and in the morning on this day, under light to moderate west-northwest to northwest winds.
  - Other than these two exceptional dust events, at the larger population sites PM_{10} levels were over the benchmark on 2 May at Muswellbrook, potentially affected by bushfire smoke[2].

Annual air quality trends in the Upper Hunter

A comparison of annual average PM_{10} and $PM_{2.5}$ levels shows the long-term trends. The national annual average benchmarks are 25 µg/m^3 for PM_{10} and 8 µg/m^3 for $PM_{2.5}$, based on a calendar year.

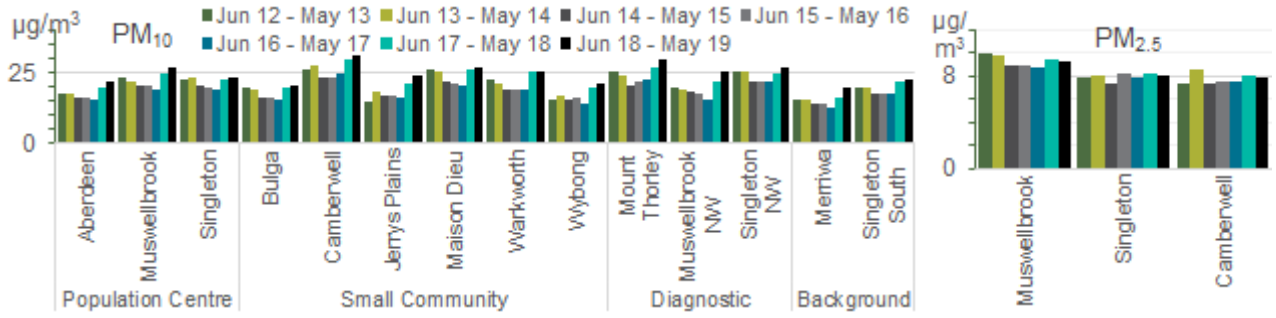

Figure 1 PM_{10} and $PM_{2.5}$ rolling annual averages to the end of autumn – 2013 to 2019

Figure 1 shows the PM_{10} and $PM_{2.5}$ rolling annual averages, based on the 12-month periods, from autumn to autumn 2013 to 2019.

[1] DustWatch report March 2019 'March 2019 was the dustiest March since DustWatch records began in 2005. This dust is caused by the very low groundcover across much of New South Wales coupled with stronger than average wind conditions.'

[2] Rural Fire Services ICON database: A number of large hazard reduction burns, including 532ha 'Forest Gully West HR NPWS' HRB from 2/5 11:00 to 7/5 11:02; and 5124ha 'Wambo West HR' from 14/4 11:00 to 7/5 11:01

The comparison shows that rolling annual average PM_{10} particle levels increased at all sites at the end of autumn 2019 compared to the same 12-month periods in previous years. The majority of New South Wales experienced below to very much below-average rainfall in the past 12 months (Figure 2) and continued to be drought-affected (Figure 3). This is particularly evident in the intensely drought-affected North West and Northern Tablelands regions. Long-range dust transported from drought-affected areas in New South Wales contributed to the increase in PM_{10} particle levels observed at most sites in the region to the end of autumn 2019.

For $PM_{2.5}$, rolling annual average particle levels remained similar to those observed in previous years. Long-range dust from drought-affected areas also would have contributed to $PM_{2.5}$ levels observed in the region over the previous 12 months.

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

The annual averages for the 2011 to 2018 calendars years can be found in the Upper Hunter spring 2018 seasonal newsletter.

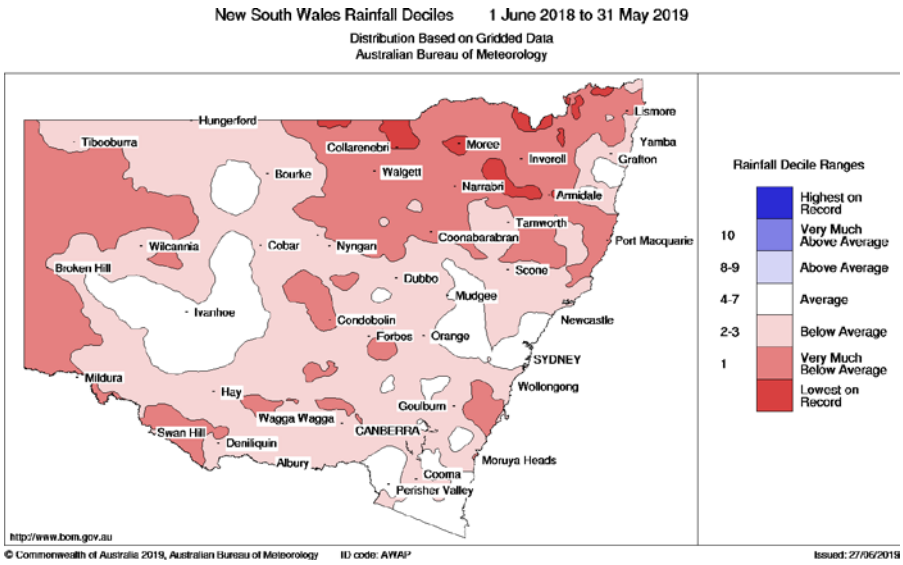

Figure 2 NSW rainfall deciles – 1 June 2018 to 31 May 2019[3]

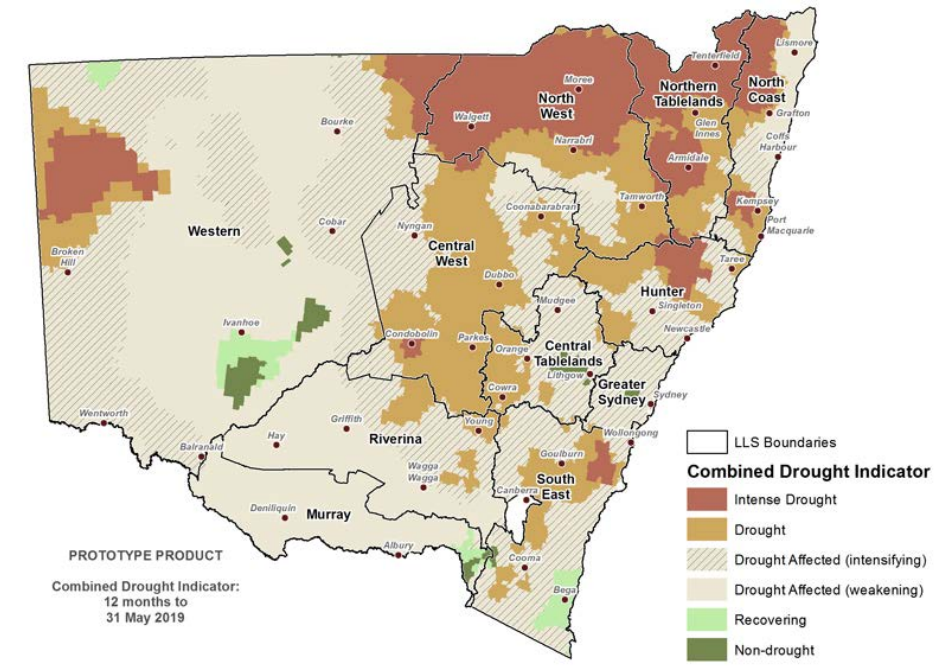

Figure 3 Department of Primary Industries NSW Combined Drought Indicator to 31 May 2019[4]

[3] Rainfall deciles map sourced from the Bureau of Meteorology (accessed July 2019)

[4] Sourced from Department of Primary Industries NSW State seasonal update - May 2019 (accessed June 2019).

Days above benchmark concentrations

There was were 13 days over the PM_{10} benchmark in autumn 2019, with all sites recording days over the benchmark. There were no days over the $PM_{2.5}$ benchmark in autumn 2019.

Table 1 Number of days above the relevant national benchmarks – autumn 2019

Station type*	Station	PM_{10} daily [50 µg/m^3 benchmark]	$PM_{2.5}$ daily [25 µg/m^3 benchmark]	SO_2 hourly [20 pphm benchmark]	SO_2 daily [8 pphm benchmark]	NO_2hourly [12 pphm benchmark]
Population centre	**Aberdeen**	2	-	-	-	-
Population centre	**Muswellbrook**	3	0	0	0	0
Population centre	**Singleton**	2	0	0	0	0
Smaller community	**Bulga**	2	-	-	-	-
Smaller community	**Camberwell**	8	0	-	-	-
Smaller community	**Jerrys Plains**	2	-	-	-	-
Smaller community	**Maison Dieu**	3	-	-	-	-
Smaller community	**Warkworth**	4	-	-	-	-
Smaller community	**Wybong**	2	-	-	-	-
Diagnostic	**Mount Thorley**	10	-	-	-	-
Diagnostic	**Muswellbrook NW**	3	-	-	-	-
Diagnostic	**Singleton NW**	5	-	-	-	-
Background	**Merriwa**	3	-	-	-	-
Background	**Singleton South**	4	-	-	-	-

µg/m^3 = microgram per cubic metre and 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 data

The seasonal PM_{10} pollution rose map[5] shows elevated hourly PM_{10} levels[6] during autumn occurred predominantly under north-west winds and at sites along the central part of the valley.

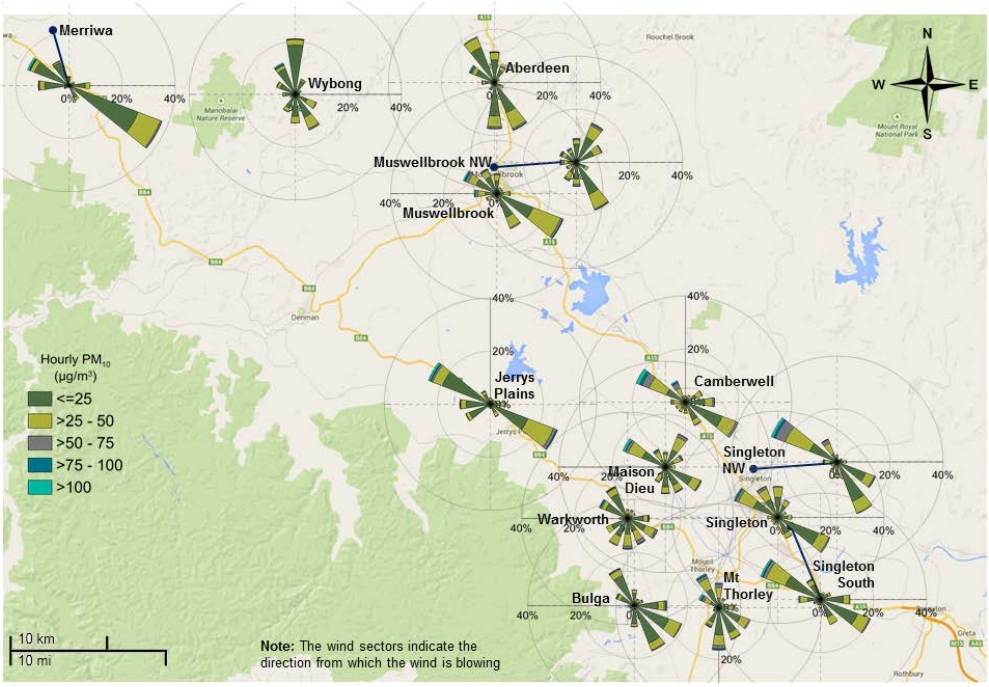

Figure 4 Hourly PM_{10} pollution rose map for the Upper Hunter region for autumn 2019

[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 (as outlined in the key).

[6] The Air NEPM sets no standard for the hourly PM_{10} concentrations. An hourly PM_{10} concentration of 75 µg/m^3 generally indicates relatively elevated PM_{10} levels and a higher likelihood that the daily PM_{10} benchmark of 50 µg/m^3 may be exceeded.

Daily time series plots

Daily average time series plots for PM_{10} and $PM_{2.5}$ and daily one-hour maximum plots for NO_2 and SO_2 show the daily concentrations throughout the autumn season.

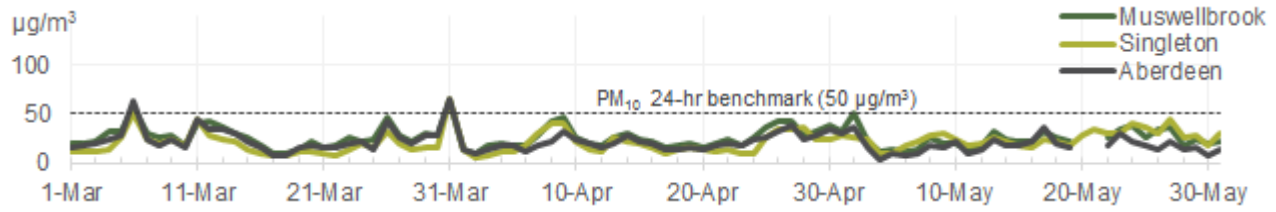

Figure 5 **Population centre sites: daily average PM_{10} – autumn 2019**

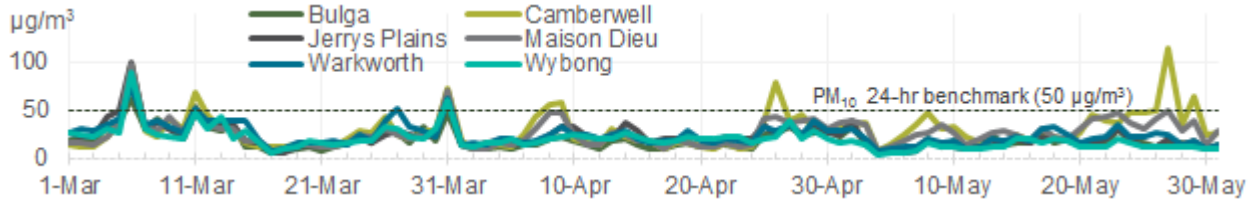

Figure 6 **Smaller community sites: daily average PM_{10} – autumn 2019**

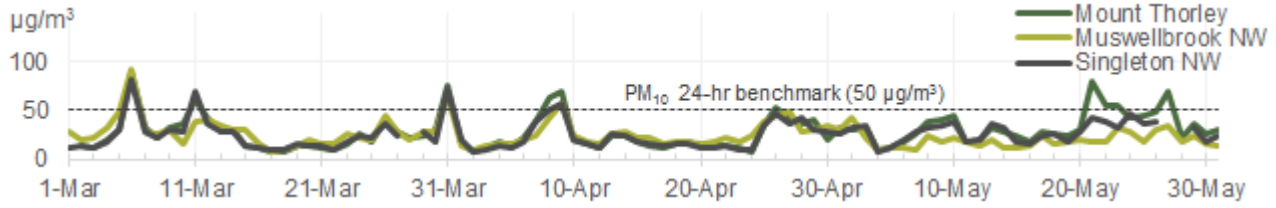

Figure 7 **Diagnostic sites: daily average PM_{10} – autumn 2019**

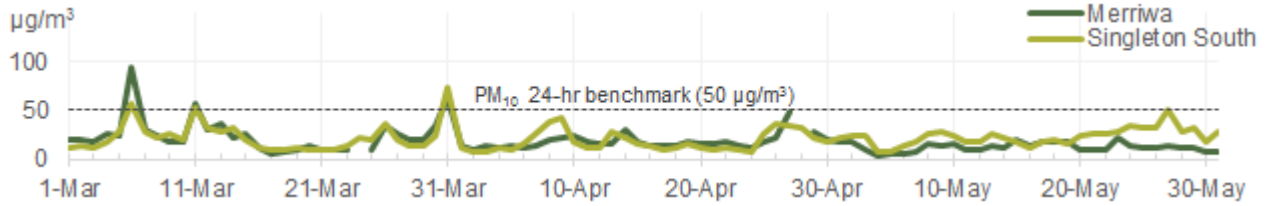

Figure 8 **Background sites: daily average PM_{10} – autumn 2019**

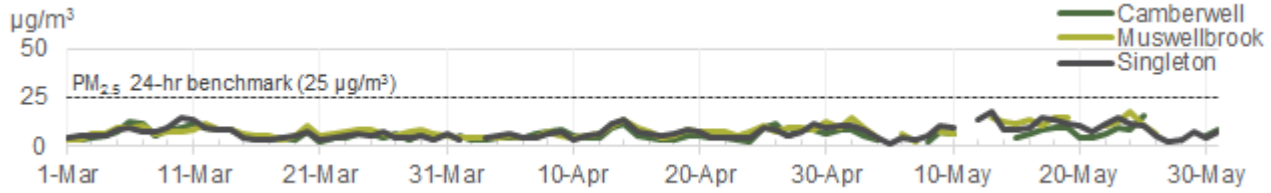

Figure 9 **Daily average $PM_{2.5}$ – autumn 2019**

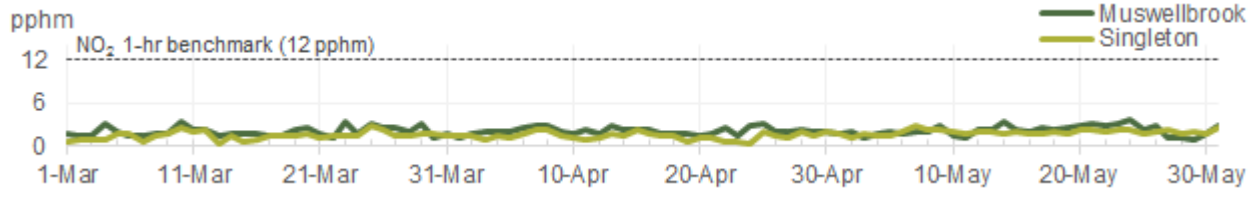

Figure 10 **Daily 1-hr maximum NO_2 – autumn 2019**

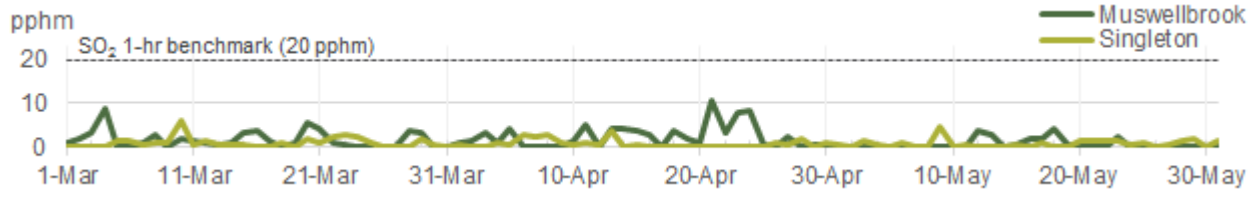

Figure 11 **Daily 1-hr maximum SO_2 – autumn 2019**

Seasonal comparisons

This section compares air quality levels in autumn 2019 with previous autumn seasons.

All days were below the national benchmark concentrations for NO_2 and SO_2 in autumn in the past eight years.

All days were below the daily average $PM_{2.5}$ benchmark at all sites during autumn 2019, which is the same as autumns 2012 to 2015 and 2018. During autumn 2017 there was one day over the $PM_{2.5}$ benchmark at Singleton and Muswellbrook, while during autumn 2016 there were two days at Singleton.

The daily average PM_{10} concentrations were above the benchmark on 13 days autumn 2019. This is less days compared to autumn 2018 when there were 17 days over the benchmark. Fewer days over the benchmark were recorded in autumn in earlier years, with between one and eight days over the benchmark from 2012 to 2017.

New South Wales continued to experience drought conditions, including in the Upper Hunter. These dry conditions, with long-range and local dust transport, contributed to elevated particle levels in the region.

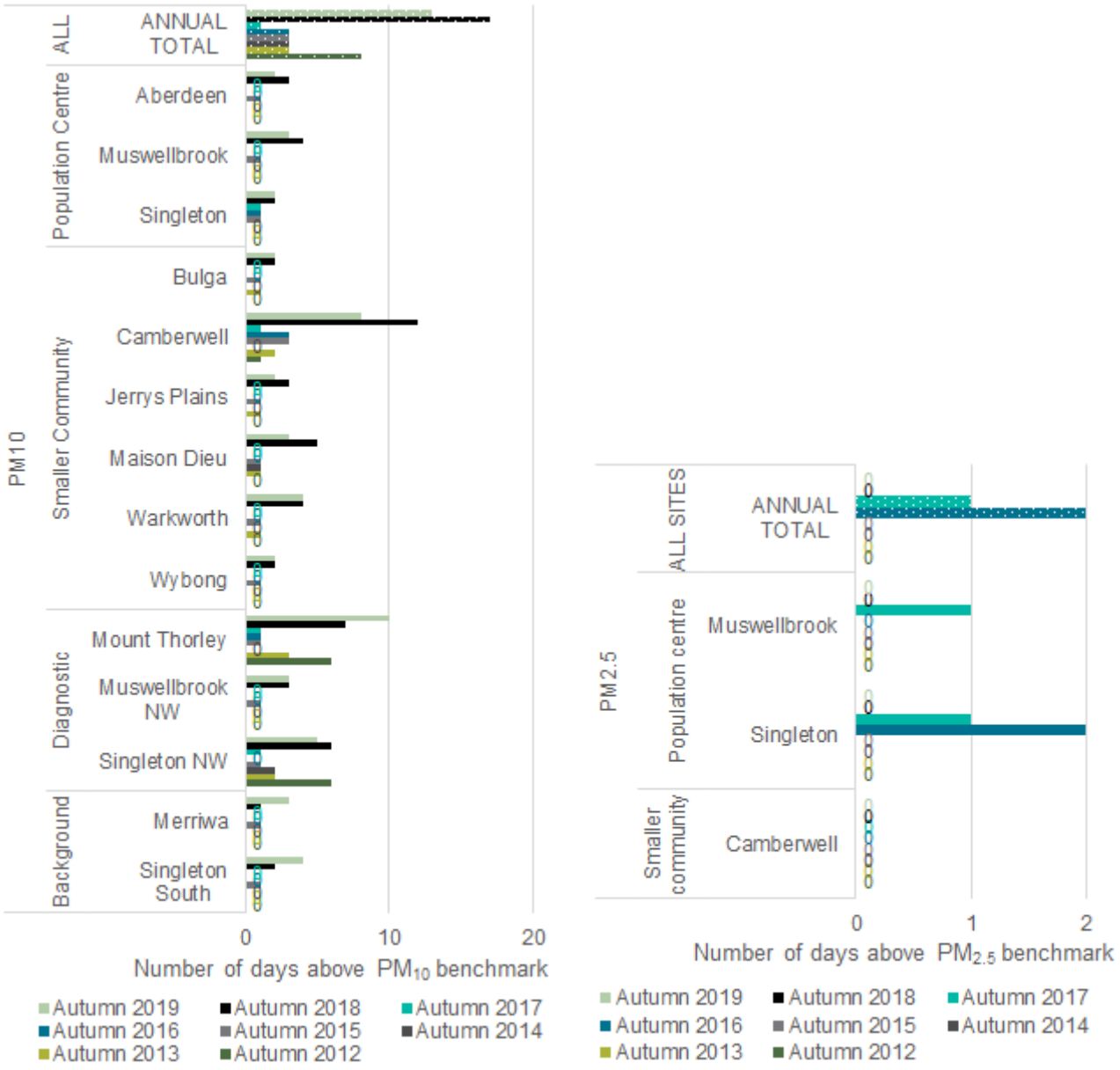

Figure 12 Number of days above the PM_{10} and $PM_{2.5}$ benchmarks – autumn 2012 to 2019

Particle air quality trends in the Upper Hunter

Figure 13 and Figure 14 show daily average levels of PM_{10} during autumn 2019, compared to the daily maximum and minimum (i.e. shaded range) of PM_{10} levels for the autumn periods from 2011 to 2018, at Singleton and Muswellbrook. Daily PM_{10} levels in 2019 were generally within the same range as earlier years, except for peaks on 6 and 31 March, which were affected by long-range dust. Very dry conditions occurred in April, although particle levels generally remained within previously observed levels.

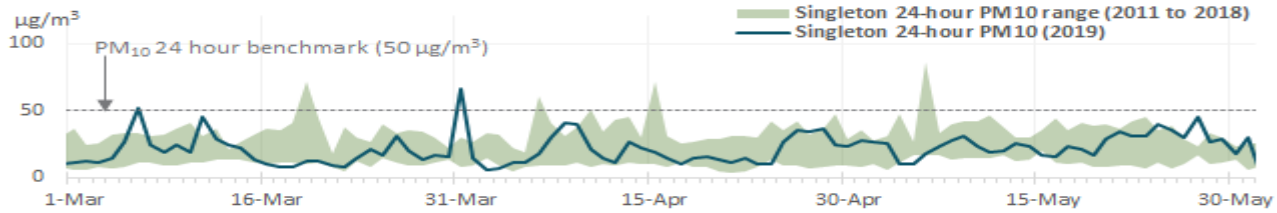

Figure 13 **Singleton daily average PM_{10} during autumn 2019 plotted against the daily maximum and minimum PM_{10} levels recorded from autumns 2011 to 2018**

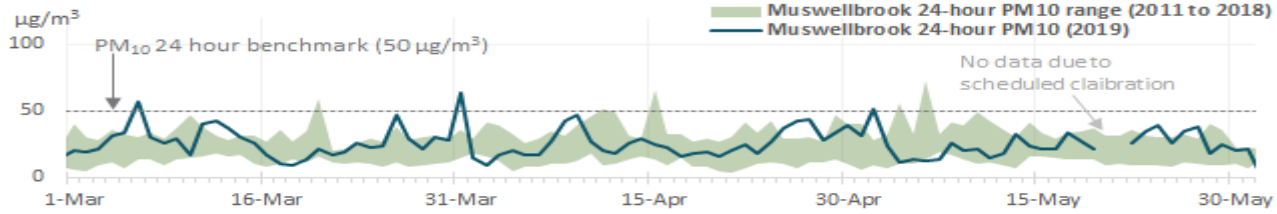

Figure 14 **Muswellbrook daily average PM_{10} during autumn 2019 plotted against the daily maximum and minimum PM_{10} levels recorded from autumns 2011 to 2018**

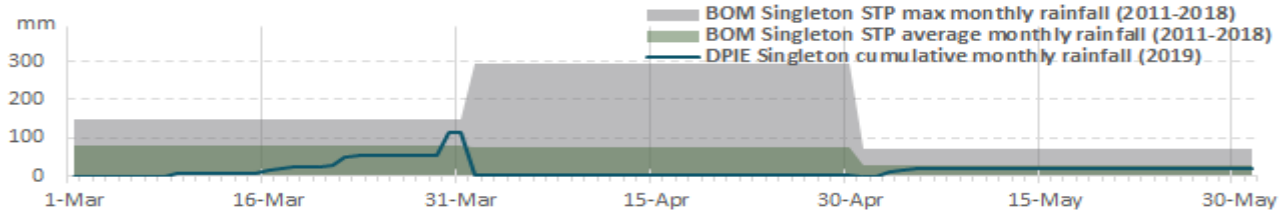

Figure 15 **DPIE Singleton[7] cumulative monthly rainfall in autumn 2019 against Bureau of Meteorology Singleton STP[8] maximum and average monthly rainfall from autumn 2011 to 2018**

Figure 16 and Figure 17 show daily average levels of $PM_{2.5}$ during autumn 2019, compared to the daily maximum and minimum levels (shaded range) for autumn periods from 2011 to 2018, at Singleton and Muswellbrook. Daily $PM_{2.5}$ levels in autumn 2019 were generally within the same range as earlier years.

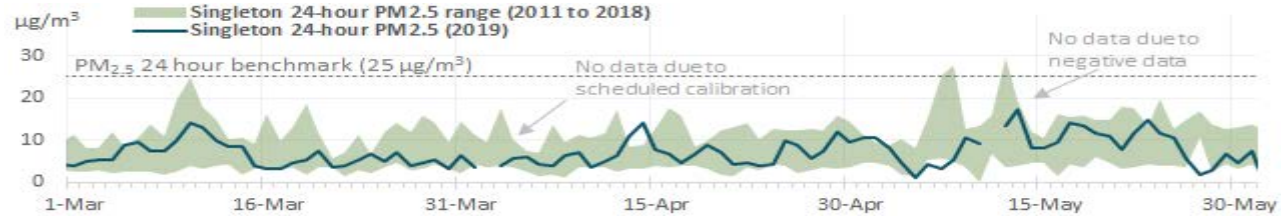

Figure 16 **Singleton daily average $PM_{2.5}$ during autumn 2019 plotted against the daily maximum and minimum $PM_{2.5}$ levels recorded from autumns 2011 to 2018**

Figure 17 **Muswellbrook daily average $PM_{2.5}$ during autumn 2019 plotted against the daily maximum and minimum $PM_{2.5}$ levels recorded from autumns 2011 to 2018**

[7] The Department of Planning Industry and Environment (DPIE) (formally OEH) Singleton rainfall data for autumn 2019 was used in lieu of the Bureau of Meteorology Singleton STP rainfall data, as no data available from this site since 21 January 2019.

[8] Data obtained from the Bureau of Meteorology Singleton STP monthly rainfall data web page (accessed April 2019)

Meteorological summary

Rainfall and temperature[9]

The Upper Hunter experienced average rainfall overall during autumn 2019, with very much above average rainfall in March, very much below-average rainfall in April and generally average rainfall in May. The region received up to 200 millimetres more rainfall in autumn 2019 compared to autumn 2018, 25 to 100 millimetres less than autumn 2017 and 50 to 200 millimetres more than autumn 2016.

Maximum temperatures were very much above average during the season, while minimum temperatures were above to very much above average.

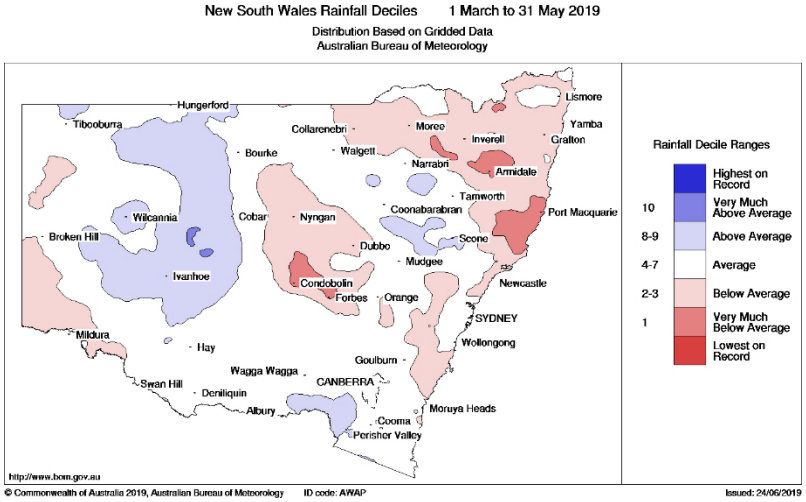

Figure 18 NSW rainfall deciles – autumn 2019

Wind

The winds were variable during autumn 2019, which is typical for this time of year. Winds typically change from south-easterly during the warmer months to north-westerly as conditions cool. Wind speeds in autumn 2019 were similar to 2015, 2016 and 2018, while generally higher than other autumns.

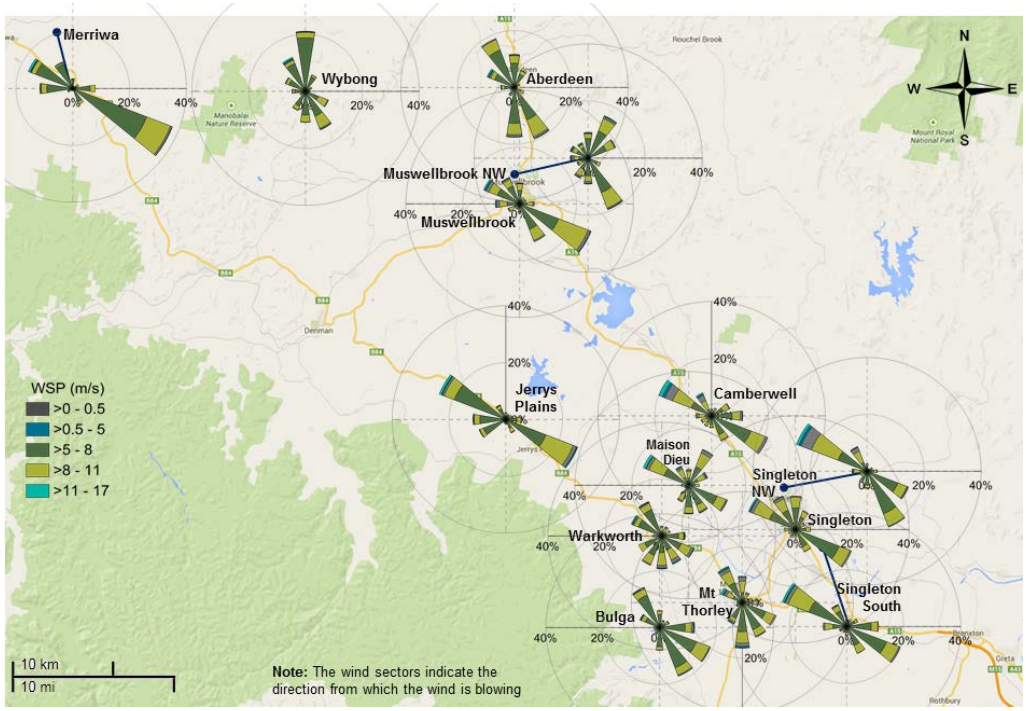

Figure 19 Wind rose map[10] for the Upper Hunter region for autumn 2019

[9] Rainfall and temperature information is from the Bureau of Meteorology New South Wales autumn 2019 climate statement and climate maps (accessed June 2019)

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

Table 2 Online performance (%) during autumn 2019

Station	Particles PM_{10} daily	Particles $PM_{2.5}$ daily	Gases SO_2 hourly	Gases NO_2 hourly	Meteorology Wind hourly
Aberdeen	98	-	-	-	100
Bulga	100	-	-	-	100
Camberwell	98	88	-	-	99
Jerrys Plains	100	-	-	-	95
Maison Dieu	100	-	-	-	99
Merriwa	98	-	-	-	98
Mount Thorley	99	-	-	-	99
Muswellbrook	98	89	94	95	100
Muswellbrook NW	100	-			100
Singleton	100	98	95	94	100
Singleton NW	97	-	-	-	99
Singleton South	100	-	-	-	99
Warkworth	100	-	-	-	100
Wybong	100	-	-	-	100

- = not monitored

The overall reduced online times were mainly due to:

- Camberwell $PM_{2.5}$ – scheduled maintenance (two days), intermittent negative data (nine days)
- Muswellbrook $PM_{2.5}$ – scheduled maintenance (two days), intermittent negative data (eight 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 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.

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).

This document was prepared by Loredana Warren.

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