Air quality in the Upper Hunter – 2020 overview

Air quality in the Upper Hunter and throughout New South Wales significantly improved in 2020 relative to 2019. This was primarily due to the cooler, wetter weather and reduced impact from dust storms and bushfires, following the end of the spring and summer 2019–20 intense drought and bushfire period.

- Particle levels at Muswellbrook and Singleton were within national benchmarks on 95% and 97% of days during 2020, respectively. Levels of nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) measured at Muswellbrook and Singleton were good to fair[1], remaining below 2020 national benchmarks[2].
- Daily average levels PM2.5[3] of were above the benchmark of 25 micrograms per cubic metre (µg/m^3) on 10 days (see Table 2). Regional maximum daily fine particle matter, PM2.5 levels in 2020 ranged from 25.1 to 49.1 µg/m^3. Seven days occurred in January due to smoke from extensive bushfires and dust storms. The remaining 3 events in June were likely due to wood smoke.
- Daily average levels of PM10 were above the benchmark of 50 µg/m^3 on 35 days (Table 3). Regional maximum daily PM10[Error! Bookmark not defined.] levels in 2020 ranged from 50.1 to 620.7 µg/m^3.
    - All stations recorded days over the PM10 benchmark, ranging from 8 days at Aberdeen and Bulga to 18 days at Camberwell (Table 1).
    - There were 16 days when one or more larger population stations recorded levels over the PM10 benchmark. All but one of these days were exceptional events due to widespread dust or bushfires.
    - All stations were over the daily PM10 benchmark during 3 widespread events in January. All were exceptional events due to long-range dust transport combining with local dust sources and/or bushfire smoke, during the intense drought and bushfire emergency period.
    - Merriwa in the Upper Hunter region, during a widespread dust storm on 11 January 2020, recorded the highest daily average since 2009 (620.7 µg/m^3, 12 times the standard).
- Annual average particle levels decreased significantly throughout the region compared to 2019, with PM10 remaining below the 25 µg/m^3 annual benchmark at all stations (Figure 1). PM2.5 levels were above the 8 µg/m^3 annual benchmark at Muswellbrook and Singleton.
- The year began influenced by a prolonged drought increasing dust storms across the state, along with extensive bushfire smoke increasing particle transport into the region. Combined with increased particles from local industrial dust sources, these greatly affected air quality during January and early February. However, widespread heavy rainfall during mid-February to April across much of the east coast brought recovery from these conditions and consequently much-improved air quality.
- The Merriwa background air quality monitoring station was upgraded in July 2020 to also monitor PM2.5, visibility, ozone, nitrogen oxides, carbon monoxide and sulfur dioxide.

The Upper Hunter seasonal newsletters and the NSW annual air quality statement 2020 provide more detail on the region's air quality in 2020, including events and sources such as dust storms and fires.

Annual particle levels 2011 to 2020

Figure 1 shows the annual average PM10 and PM2.5 particle levels from 2011 to 2020.

[1] Fair at Muswellbrook, due to one hour on 19 May 2020, when 1-hour SO_2 was 13.5 pphm (>13.3).

[2] Note: The SO_2 and NO_2 benchmarks were updated in May 2021 (2021 Air NEPM). The new, more stringent 1-hour SO_2 benchmark (10 pphm) would have been exceeded at Muswellbrook on two days in 2020.

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

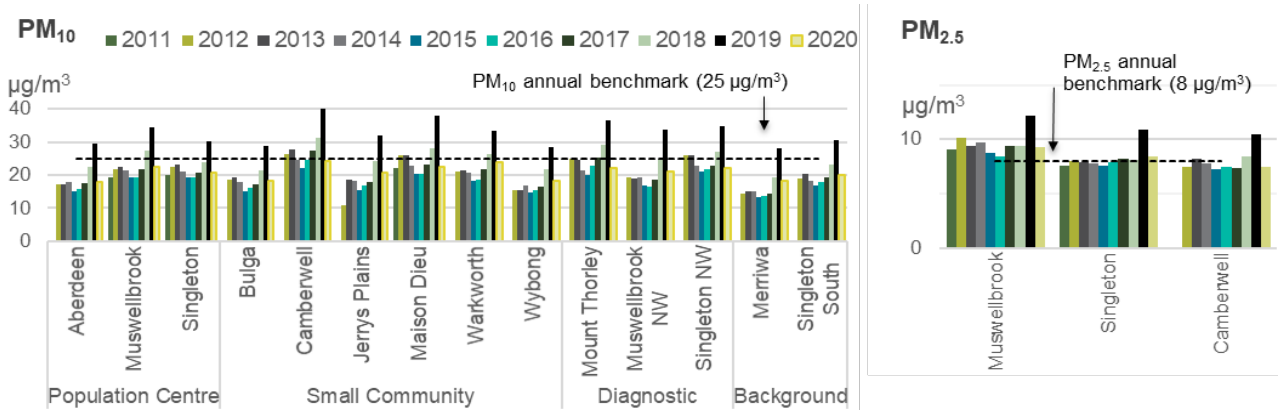

Figure 1 PM10 and PM2.5 annual averages: 2011 to 2020

- Annual average PM10 and PM2.5 particle levels decreased significantly throughout the region in 2020 compared to 2019. Air quality improved significantly due to good coastal rainfall events from February 2020, which weakened intense drought conditions, extensive bushfires and widespread dust events experienced in spring and summer 2019–20[4]. At the end of 2020, only 3% of the state was drought-affected (Figure 2), compared to 100% at the end of 2019[5]. Rainfall totals were much above average during the year (Figure 14), and maximum temperatures were average (Figure 15).
- Annual average PM10 levels were below the benchmark at all stations in 2020, ranging from 17.8 µg/m^3 at Aberdeen to 24.3 µg/m^3 at Camberwell.

  From 2011 to 2019, maximum annual PM10 levels ranged from 22.0 µg/m^3 in 2015 to 39.9 µg/m^3 in 2019. Annual PM10 levels were over the benchmark in 2012, 2013, 2017, 2018 and 2019. In 2012 and 2013, this occurred at the Camberwell and Maison Dieu smaller community stations and Singleton Northwest (NW) diagnostic station. In 2017, this occurred at the Camberwell smaller community station and Mount Thorley diagnostic station. In 2018, this occurred at Muswellbrook large population centre, Camberwell, Maison Dieu and Warkworth smaller community stations and Mount Thorley and Singleton NW diagnostic stations. In 2019, this occurred at all 14 stations.
- Annual average PM2.5 levels were below the benchmark at Camberwell in 2020 but remained above the benchmark at Muswellbrook and Singleton (with levels similar to 2011 to 2018). In 2020, annual averages for PM2.5 ranged from 7.5 µg/m^3 at Camberwell to 9.3 µg/m^3 at Muswellbrook.

  From 2011 to 2019, maximum annual PM2.5 levels ranged from 8.4 µg/m^3 in 2016 to 12.2 µg/m^3 in 2019. Annual PM2.5 levels were over the benchmark each year at Muswellbrook, 3 years at Camberwell in 2013, 2018 and 2019, and 3 years at Singleton in 2017, 2018 and 2019. Smoke from domestic wood heaters contributes significantly to particle levels at larger population centres[6].

Days above benchmark concentrations

There were 38 days over the daily particle benchmarks during 2020, with 10 days over the PM2.5 benchmark and 35 days over the PM10 benchmark (Table 1, Table 2 and Table 3). For PM10, 21 days (60% of PM10 event days) occurred between 1 January and 4 February 2020. For PM2.5, 7 days (70% of PM2.5 event days) occurred between 1 and 12 January 2020. This was the period impacted most by combined bushfire smoke and drought-driven dust storms.

There were 15 days (40% of particle event days), when particle levels were over the benchmarks only at small community or diagnostic stations – all occurring on or after 29 January 2020.

All days were below the NO_2 and SO_2 2020 national benchmarks[7] at Muswellbrook and Singleton.

Particle levels were within national benchmarks between 94% of days at Camberwell and 98% of days at Aberdeen and Bulga, during 2020 (Figure 3).

[4] Refer to the Air quality special statement spring-summer 2019-20 for more information on the extreme air pollution, smoke and dust in the NSW bushfire season 2019–20.

[5] Sourced from Department of Primary Industries NSW State seasonal update – December 2019 (accessed August 2021).

[6] The Upper Hunter Fine Particle Characterisation Study found smoke from domestic wood heaters contributed significantly to PM2.5 levels in Muswellbrook and Singleton.

[7] Note: The SO_2 and NO_2 benchmarks were updated in May 2021 (2021 Air NEPM). The new more stringent hourly SO_2 benchmark of 10 pphm would have been exceeded at Muswellbrook on 2 days in 2020.

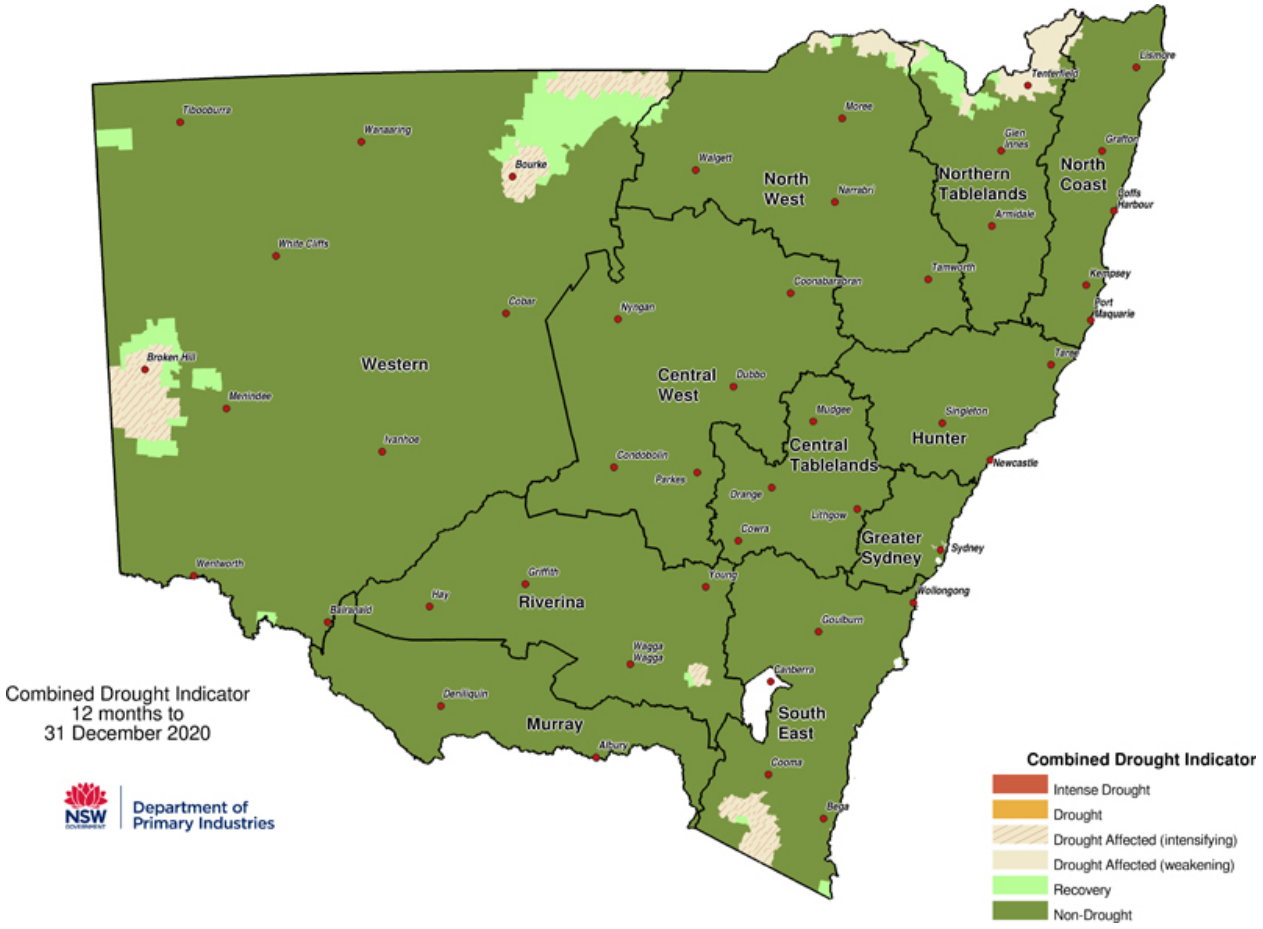

Figure 2 **Department of Primary Industries NSW Combined Drought Indicator to 31 December 2020**[8]

PM10 particle events

The number of days over the daily PM10 benchmark (PM10 particle events) at individual stations ranged from 8 days at Aberdeen and Bulga to 18 days at Camberwell (Table 1).

There were 3 widespread PM10 event days (9% of total PM10 events) in January, when all available stations[9] recorded levels over the daily benchmark. These were all exceptional events due to long-range dust transport combining with local dust sources and/or bushfire smoke, during the intense drought and bushfire emergency period.

There were 8 days when PM10 particle events occurred at only one station (23% of total PM10 events). These occurred on 2 days each at Warkworth and Wybong and on one day each at Camberwell, Jerrys Plains, Maison Dieu and Mount Thorley (Table 3).

Table 1 **Number of days above the relevant benchmarks – 2020**

Station type*	Station	PM10 daily [50 µg/m^3 benchmark]	PM2.5 daily [25 µg/m^3 benchmark]	SO_2 hourly [20 pphm benchmark]	SO_2 daily [8 pphm benchmark]	NO_2 hourly [12 pphm benchmark]
Larger population	Aberdeen	8	-	-	-	-
Larger population	Muswellbrook	15	9	0	0	0
Larger population	Singleton	10	6	0	0	0
Smaller community	Bulga	8	-	-	-	-

[8] Sourced from the Department of Primary Industries NSW State seasonal update – December 2020 (accessed July 2021).

[9] On one of these days some stations did not have sufficient hourly data available (>75%) to calculate a daily average.

Station type*	Station	PM10 daily [50 µg/m^3 benchmark]	PM2.5 daily [25 µg/m^3 benchmark]	SO_2 hourly [20 pphm benchmark]	SO_2 daily [8 pphm benchmark]	NO_2 hourly [12 pphm benchmark]
Smaller community	Camberwell	18	7	-	-	-
Smaller community	Jerrys Plains	17	-	-	-	-
Smaller community	Maison Dieu	17	-	-	-	-
Smaller community	Warkworth	17	-	-	-	-
Smaller community	Wybong	13	-	-	-	-
Diagnostic	Mount Thorley	13	-	-	-	-
Diagnostic	Muswellbrook NW	14	-	-	-	-
Diagnostic	Singleton NW	14	-	-	-	-
Background	Merriwa#	12	0	0	0	0
Background	Singleton South	11	-	-	-	-

µg/m^3 = microgram per cubic metre
pphm = parts per hundred million by volume (i.e. parts of pollutant per hundred million parts of air)
- = not monitored
The Merriwa background station was upgraded to include PM2.5, SO_2 and NO_2 monitoring from 30 July 2020
* For explanation, refer to the end of the report Definitions: Upper Hunter monitoring station types

Table 2 Days and stations above the PM2.5 daily benchmark – 2020

Date	Maximum daily PM2.5 (µg/m^3)	Number of stations over benchmark	Station and daily PM2.5 (µg/m^3) for each station
1. 01/01/2020	33.3	3	Camberwell (29.7), Muswellbrook (33.3), Singleton (27.3)
2. 02/01/2020	40.5	3	Camberwell (35.1), Muswellbrook (34.3), Singleton (40.5)
3. 05/01/2020	49.1	3	Camberwell (36.6), Muswellbrook (49.1), Singleton (37.1)
4. 08/01/2020	46.0	3	Camberwell (40.6), Muswellbrook (33.9), Singleton (46.0)
5. 09/01/2020	29.3	3	Camberwell (28.9), Muswellbrook (29.3), Singleton (25.1)
6. 11/01/2020	28.4	1	Muswellbrook (28.4)
7. 12/01/2020	32.8	2	Camberwell (30.5), Muswellbrook (32.8)
8. 06/06/2020	44.1	1	Camberwell (44.1)
9. 07/06/2020	28.6	2	Muswellbrook (28.6), Singleton (26.5)
10. 08/06/2020	28.0	1	Muswellbrook (28.0)

Table 3 Days and stations above the PM10 daily benchmark – 2020

Date	Maximum daily PM10 (µg/m³)	Stations over benchmark	Station and daily PM10 (µg/m³) for each station type			
			Large population	Smaller community	Diagnostic	Background
1. 01/01/2020	116.9	14	Aberdeen (85.3), Muswellbrook (85.2), Singleton (65.3)	Bulga (75.7), Camberwell (63.8), Jerrys Plains (116.2), Maison Dieu (88.8), Warkworth (103.6), Wybong (105.4)	Mount Thorley (62.9), Muswellbrook NW (86.4), Singleton NW (61.4)	Merriwa (116.9), Singleton South (61.8)
2. 02/01/2020	64.8	9	Muswellbrook (52.0), Singleton (53.1)	Camberwell (50.9), Jerrys Plains (51.1), Maison Dieu (52.0), Warkworth (54.2), Wybong (64.8)	Singleton NW (55.0)	Singleton South (60.7)
3. 03/01/2020	57.8	6	Aberdeen (52.6), Muswellbrook (50.6)	Jerrys Plains (50.6), Warkworth (57.1), Wybong (57.8)	Muswellbrook NW (50.7)	-
4. 04/01/2020	82.9	11	Muswellbrook (50.8), Singleton (56.5)	Bulga (72.4), Camberwell (54.3), Jerrys Plains (68.4), Maison Dieu (82.9), Warkworth (67.2)	Mount Thorley (57.2), Muswellbrook NW (66.1), Singleton NW (57.2)	Singleton South (63.5)
5. 05/01/2020	154.1	14	Aberdeen (119.7), Muswellbrook (127.0), Singleton (82.4)	Bulga (84.5), Camberwell (87.7), Jerrys Plains (134.5), Maison Dieu (118.7), Warkworth (124.0), Wybong (134.1)	Mount Thorley (89.1), Muswellbrook NW (130.9), Singleton NW (82.9)	Merriwa (154.1), Singleton South (82.4)
6. 06/01/2020	58.1	5	Muswellbrook (50.3)	Jerrys Plains (57.0), Warkworth (58.1), Wybong (54.2)	Muswellbrook NW (51.4)	-
7. 08/01/2020	84.5	12	Muswellbrook (60.8), Singleton (66.2)	Bulga (60.0), Camberwell (71.6), Jerrys Plains (65.6), Maison Dieu (77.3), Warkworth (84.5)	Mount Thorley (62.6), Muswellbrook NW (57.9), Singleton NW (67.3)	Merriwa (50.9), Singleton South (70.7)
8. 09/01/2020	54.2	3	-	Warkworth (53.3), Wybong (54.2)	-	Merriwa (54.1)
9. 10/01/2020	81.1	2	-	Jerrys Plains (65.7)	-	Merriwa (81.1)
10. 11/01/2020	620.7	13	Aberdeen (267.7), Muswellbrook (181.0), Singleton (51.1)	Bulga (61.8), Camberwell (61.8), Jerrys Plains (88.3), Maison Dieu (69.6), Warkworth (91.7), Wybong (373.6)	Mount Thorley (66.4), Muswellbrook NW (238.6), Singleton NW (53.0)	Merriwa (620.7)
11. 12/01/2020	80.1	9	Aberdeen (54.9), Muswellbrook (57.6)	Bulga (51.9), Jerrys Plains (66.5), Maison Dieu (51.8), Warkworth (71.3), Wybong (67.7)	Muswellbrook NW (75.1)	Merriwa (80.1)
12. 20/01/2020	82.9	6	Aberdeen (60.8), Muswellbrook (82.9)	Jerrys Plains (52.0), Wybong (74.6)	Muswellbrook NW (73.2)	Merriwa (82.3)
13. 21/01/2020	63.5	7	Aberdeen (55.9), Muswellbrook (60.5)	Camberwell (63.5), Maison Dieu (54.5), Wybong (50.2)	Muswellbrook NW (63.1)	Merriwa (63.0)
14. 23/01/2020	130.6	12	Aberdeen (77.9), Muswellbrook (55.5), Singleton (71.7)	Bulga (55.4), Camberwell (101.8), Maison Dieu (130.6), Warkworth (70.1)	Mount Thorley (73.4), Muswellbrook NW (72.9), Singleton NW (75.2)	Merriwa (70.6), Singleton South (67.5)

Date	Maximum daily PM10 (µg/m^3)	Stations over benchmark	Station and daily PM10 (µg/m^3) for each station type			
			Large population	Smaller community	Diagnostic	Background
15. 24/01/2020	65.7	8	Singleton (61.4)	Bulga (61.7), Jerrys Plains (53.6), Maison Dieu (61.0), Warkworth (59.5)	Mount Thorley (59.5), Singleton NW (61.9)	Singleton South (65.7)
16. 25/01/2020	52.0	2	-	Wybong (50.7)	-	Merriwa (52.0)
17. 29/01/2020	51.1	1	-	Wybong (51.1)	-	-
18. 30/01/2020	50.1	1	-	Wybong (50.1)	-	-
19. 01/02/2020	55.0	3	-	Camberwell (52.7), Jerrys Plains (55.0), Maison Dieu (50.5)	-	-
20. 02/02/2020	67.3	3	-	Camberwell (55.4), Maison Dieu (67.3)	-	Singleton South (52.2)
21. 04/02/2020	57.4	2	-	Jerrys Plains (51.8), Warkworth (57.4)	-	-
22. 19/02/2020	72.9	4	Muswellbrook (51.9)	Camberwell (58.8)	Muswellbrook NW (54.2)	Merriwa (72.9)
23. 02/03/2020	52.4	2	-	Camberwell (52.3)	Singleton NW (52.4)	-
24. 20/03/2020	63.1	2	-	Camberwell (63.1)	Singleton NW (53.0)	-
25. 24/04/2020	54.1	4	-	Maison Dieu (52.2)	Mount Thorley (52.6), Singleton NW (52.2)	Singleton South (54.1)
26. 25/04/2020	52.6	1	-	-	Mount Thorley (52.6)	-
27. 26/04/2020	67.0	4	-	Camberwell (59.2), Maison Dieu (67.0)	Mount Thorley (59.0), Singleton NW (53.8)	-
28. 19/08/2020	82.2	10	Muswellbrook (54.3), Singleton (57.6)	Camberwell (82.2), Jerrys Plains (54.4), Maison Dieu (57.5), Warkworth (56.7)	Mount Thorley (75.3), Muswellbrook NW (51.0), Singleton NW (63.2)	Singleton South (55.3)
29. 31/08/2020	51.8	1	-	Camberwell (51.8)	-	-
30. 03/09/2020	63.2	2	-	Camberwell (63.2)	Mount Thorley (53.8)	-
31. 27/11/2020	63.5	1	-	Jerrys Plains (63.5)	-	-
32. 28/11/2020	53.2	1	-	Maison Dieu (53.2)	-	-
33. 29/11/2020	105.4	10	Muswellbrook (59.1), Singleton (55.2)	Camberwell (103.3), Jerrys Plains (54.5), Maison Dieu (105.4), Warkworth (63.5)	Mount Thorley (73.9), Muswellbrook NW (69.3), Singleton NW (68.0)	Singleton South (56.8)
34. 01/12/2020	55.2	1	-	Warkworth (55.2)	-	-
35. 05/12/2020	51.6	1	-	Warkworth (51.6)	-	-

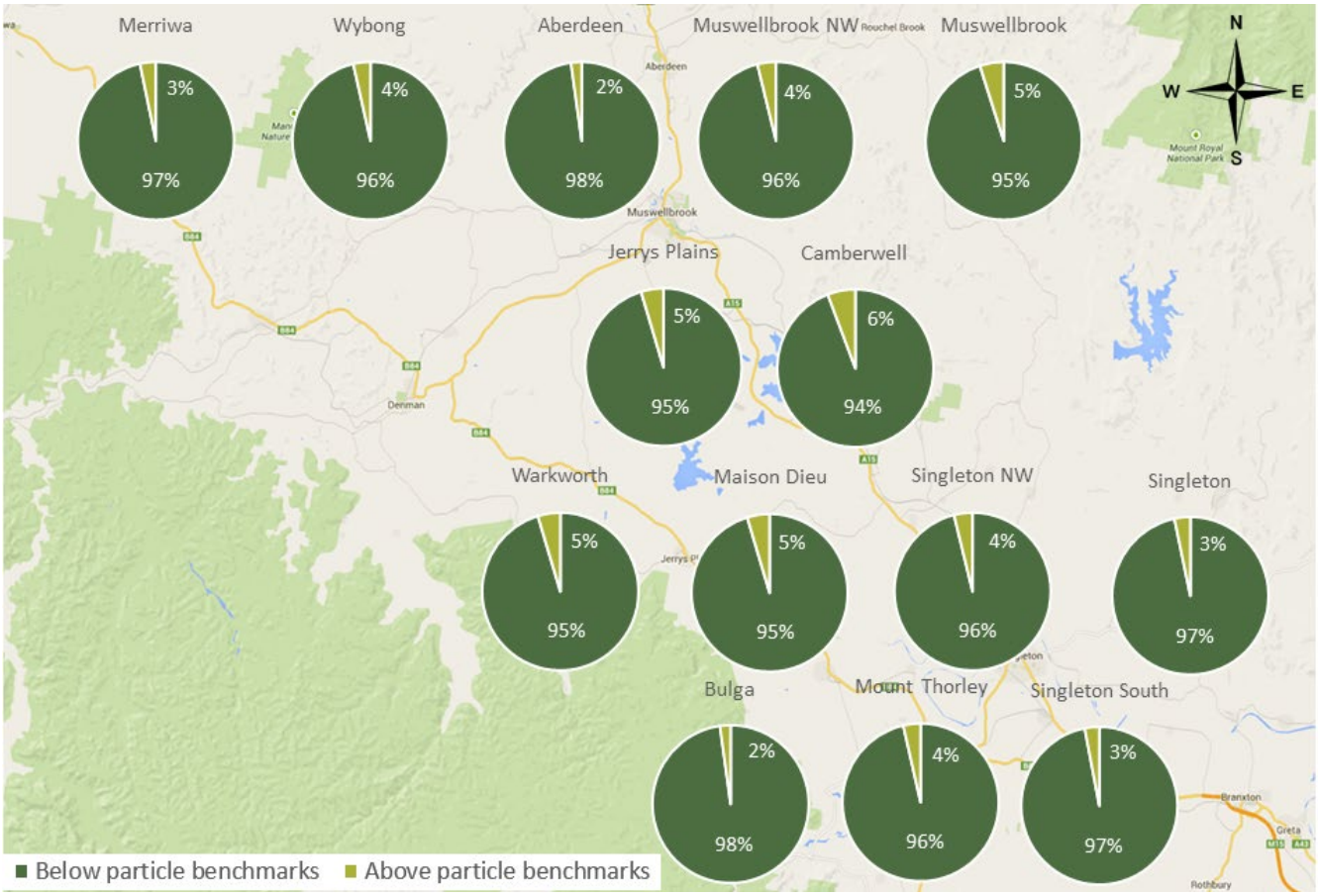

Figure 3 Percentage of days above and below particle benchmarks across the Upper Hunter – 2020

PM2.5 particle events

PM2.5 particles measurement data for 2020 was available for 3 stations within the Upper Hunter Camberwell, Muswellbrook and Singleton[10]. There were 6 days over the daily benchmark (PM2.5 particle events) at Singleton, 7 days at Camberwell and 9 days at Muswellbrook (Table 1).

Most of the PM2.5 particle events (seven out of 10 days) occurred in January (Table 2) when the region was affected by smoke from extensive bushfires and dust storms. The 3 events in June occurred over the June long weekend:

- Camberwell was over the benchmark on 6 June, with high hourly PM2.5 levels observed from 9pm to 11pm under cold calm conditions. The source for this event is undetermined, potentially woodsmoke.
- Muswellbrook recorded levels over the benchmark on 7 and 8 June and Singleton on 7 June. Elevated PM2.5 occurred overnight under cold, calm conditions, likely due to woodsmoke.

There were five widespread PM2.5 event days (50% of total PM2.5 events) when all stations recorded levels over the daily benchmark. These were all exceptional events due to bushfire smoke, occurring between 1 and 9 January, during the drought and bushfire emergency period.

Pollution roses

The PM10 and PM2.5 pollution rose maps[11] show hourly PM10 and PM2.5 concentrations, under dominant north-west and south-east prevailing winds in the Upper Hunter (Figure 4 and Figure 5).

For example, Figure 4 shows that in 2020, selected stations including Merriwa, Muswellbrook, and Jerrys Plains received the highest hourly PM10 concentrations most often under south-easterly winds. Camberwell and Singleton NW, on the other hand, had highest PM10 mostly under north-westerly winds.

[10] Merriwa background station was upgraded to include PM2.5, SO_2 and NO_2 monitoring from 30 July 2020.

[11] Pollution roses show the 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 that compass direction. The colours along the bars indicate the levels of particle concentrations, as presented in the key.

The pollution roses show elevated hourly[12] PM10 and PM2.5 levels occurred at all stations during 2020.

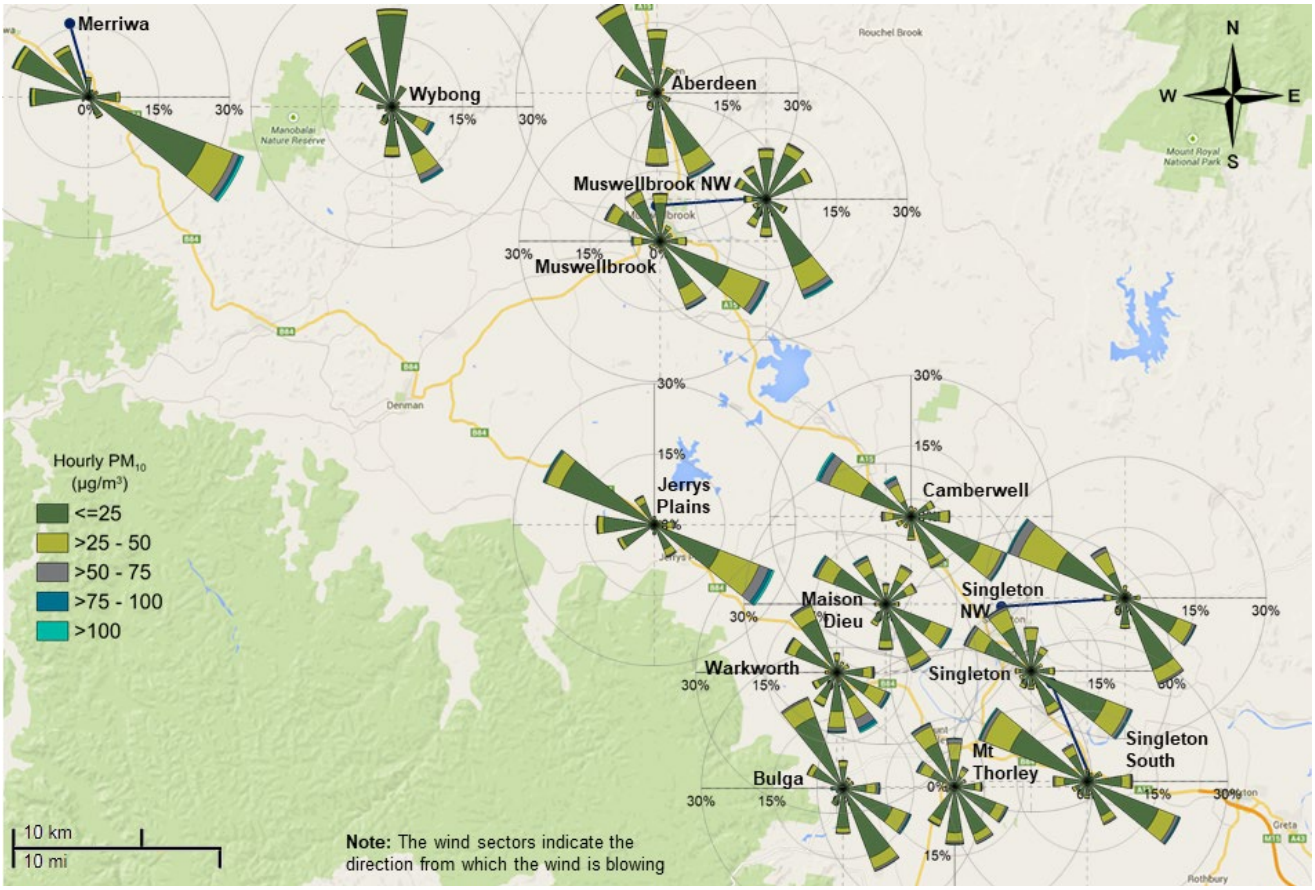

Figure 4 Hourly PM10 pollution rose map for the Upper Hunter region – 2020

Figure 5 Hourly PM2.5 pollution rose map for the Upper Hunter region – 2020

Daily time series plots

Figure 6 to Figure 12 show daily average time series plots for PM10 and PM2.5 and daily one-hour maximum plots for NO_2 and SO_2. The shaded areas in the figures indicate the seasons. High PM10 and

[12] The Air NEPM sets no standard for hourly particle concentrations.

PM2.5 levels were observed in January and early February, at the end of the intense drought and bushfire emergency period. The highest daily PM10 level recorded in New South Wales since 2009 occurred at Merriwa on 11 January, when the daily PM10 reached 620.7 µg/m^3 during a widespread dust event. Note: The PM10 graphs have been truncated to better graphically represent the timeseries.

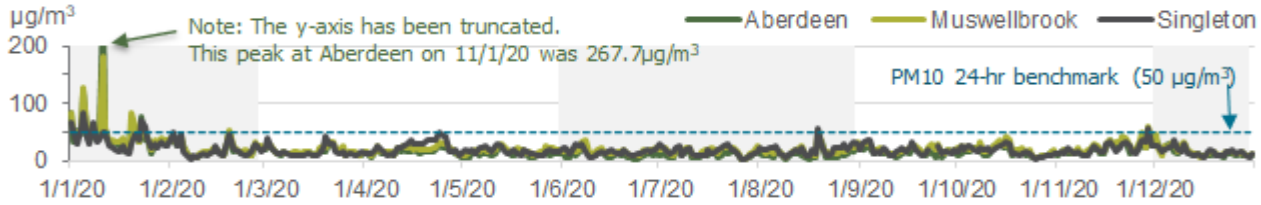

Figure 6 **Population centre stations: daily average PM10 – 2020**

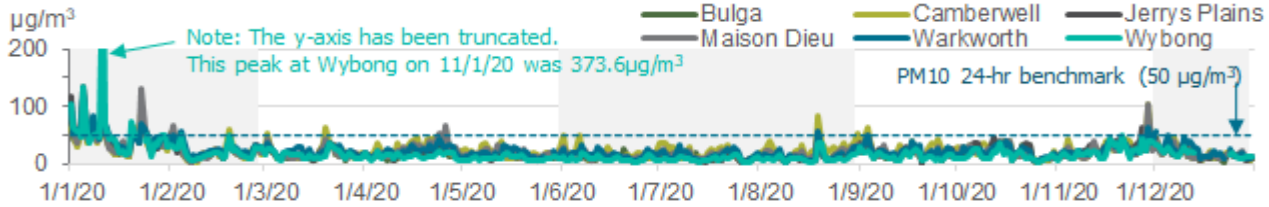

Figure 7 **Smaller community stations: daily average PM10 – 2020**

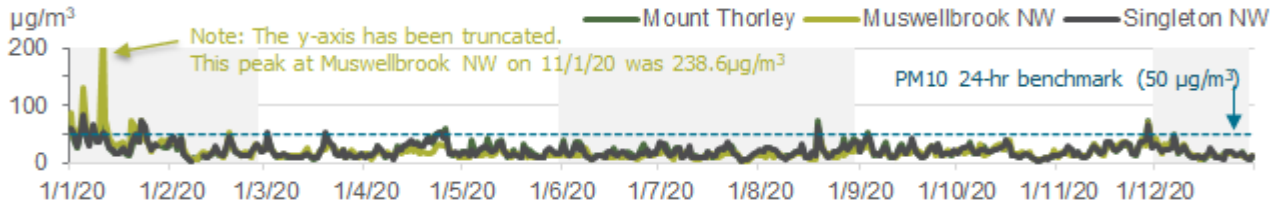

Figure 8 **Diagnostic stations: daily average PM10 – 2020**

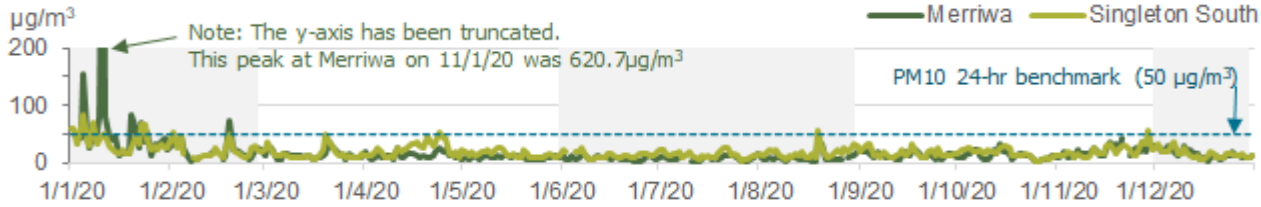

Figure 9 **Background stations: daily average PM10 – 2020**

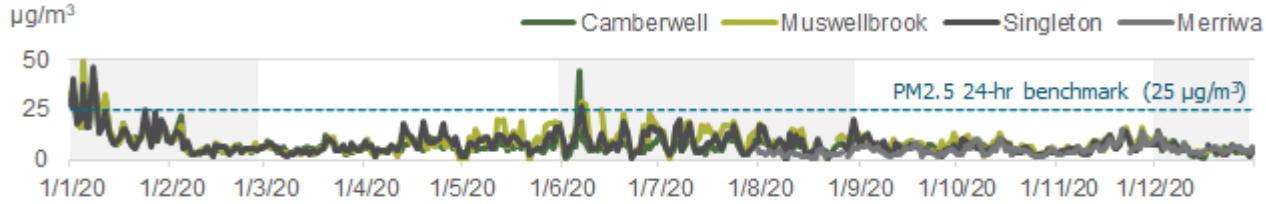

Figure 10 **Daily average PM2.5 – 2020**

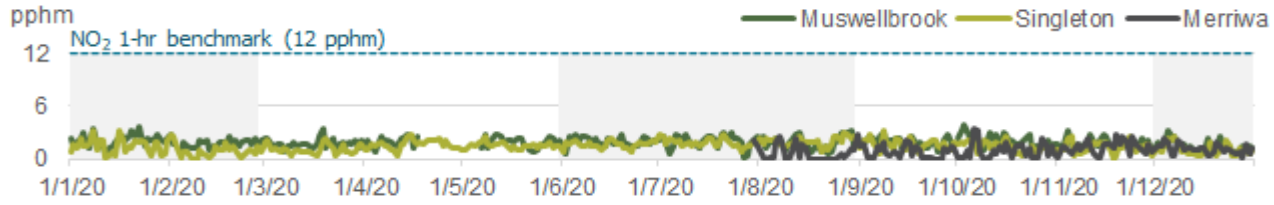

Figure 11 **Daily 1-hr maximum NO_2 – 2020**

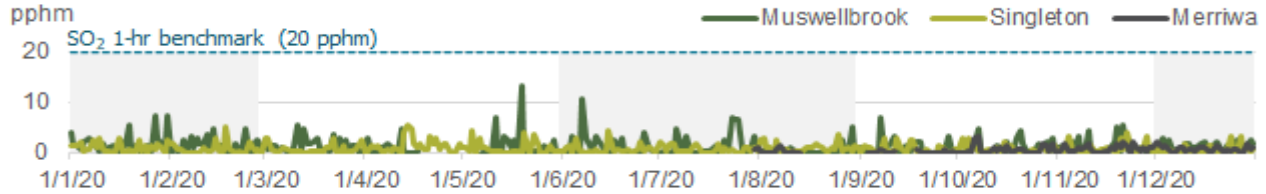

Figure 12 **Daily 1-hr maximum SO_2 – 2020**

Annual comparisons 2012 to 2020

NO_2 and SO_2 levels at Muswellbrook and Singleton were below 2020 national benchmarks[13] throughout 2020. Previously, Muswellbrook alone exceeded the SO_2 hourly benchmark of 20 parts per hundred million (pphm), recording 21 pphm during one hour on 23 December 2016.

In 2020, the region recorded 35 days above the PM10 benchmark, with 60% occurring on or before 4 February. This was significantly fewer than 2019, when there were 120 days over the benchmark, due to prolonged intense drought, extreme bushfires and dust storms (Figure 13). The number of days over the PM10 benchmark in earlier years ranged from 14 days in 2016 to 73 days in 2018.

At the larger population centres in 2020, Aberdeen had 8 days over the PM10 benchmark, 10 days at Singleton and 15 days at Muswellbrook. Previously, 2019 had recorded the most days with 40 days at Singleton, 51 days at Aberdeen and 58 days at Muswellbrook.

At smaller community and diagnostic stations, closer to mining operations, days over the PM10 benchmark in 2020 ranged from 8 days at Bulga to 18 days at Camberwell. Previously, the most days were recorded in 2019, with 87 days at Camberwell.

Background stations at Singleton South and Merriwa in 2020 recorded 11 and 12 days over the PM10 benchmark, respectively. Previously, 2019 recorded the most days, with 47 days at Merriwa.

For PM2.5, 10 days over the benchmark were recorded in 2020, with 70% of these occurring on or before 12 January. This was a large decrease compared to 2019, when there were 32 days over the PM2.5 benchmark. From 2012 to 2018, up to 3 days a year were over the benchmark (Figure 13). Generally, Muswellbrook recorded the most days in previous years, due to domestic woodsmoke[14].

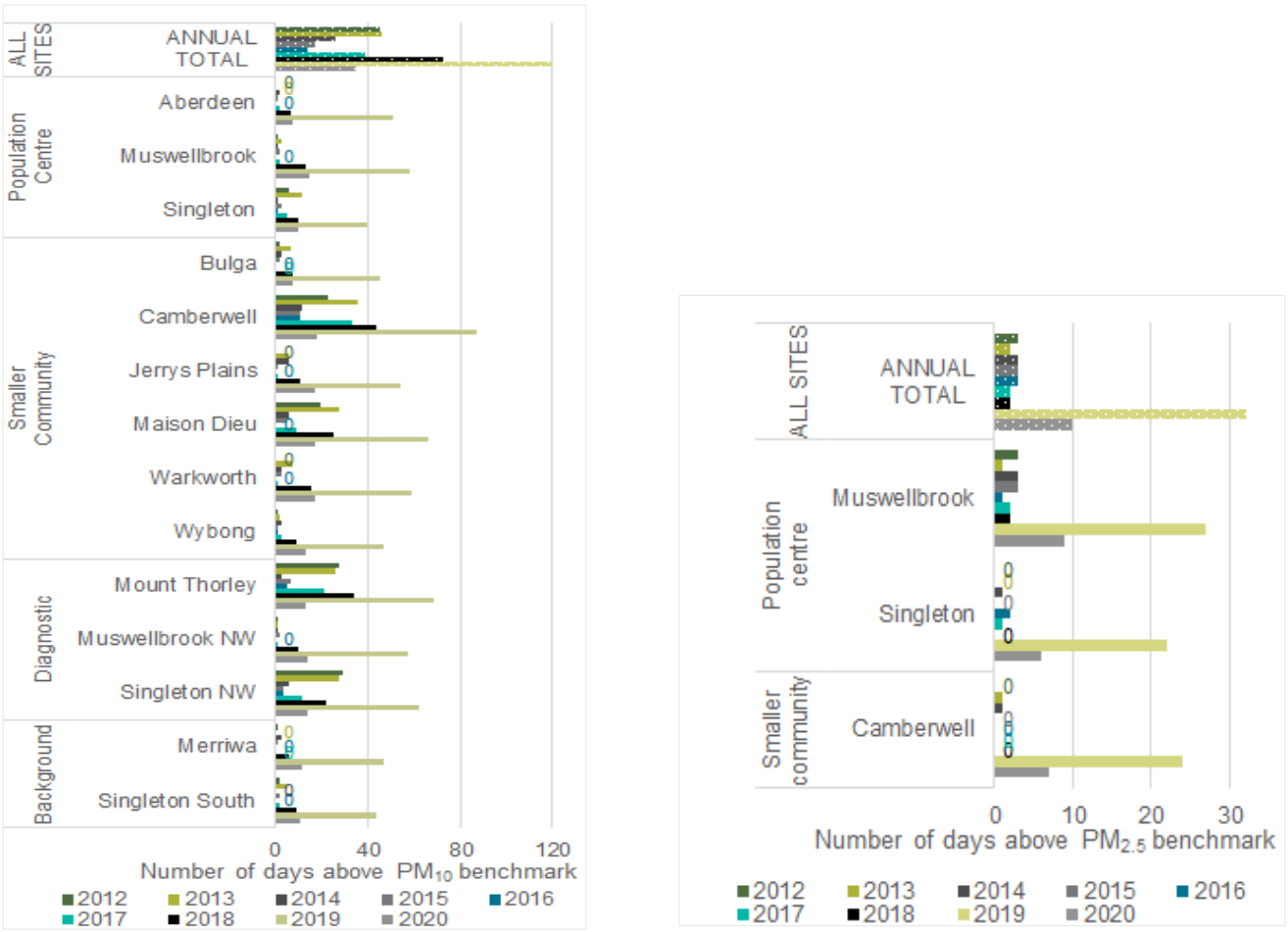

Figure 13 Number of days, including exceptional events, above the daily PM10 (left plot) and PM2.5 (right) benchmarks from 2012 to 2020

[13] Note: The SO_2 and NO_2 benchmarks were updated in May 2021 (2021 Air NEPM). The new more stringent SO_2 hourly benchmark of 10 pphm would have been exceeded at Muswellbrook in 2020 and earlier years. The new more stringent SO_2 daily benchmark of 2 pphm would have been exceeded at Muswellbrook in five years: 2013 and 2016-2019.

[14] The Upper Hunter Fine Particle Characterisation Study found smoke from domestic wood heaters contributes significantly to PM2.5 levels in Muswellbrook and Singleton during the cooler months.

Meteorological summary

Rainfall and temperature[15]

Rainfall across the Upper Hunter was very much above average in 2020 (Figure 14). The Bureau of Meteorology Bulga and Merriwa rainfall gauges recorded their highest annual total rainfall on record. The region was wetter compared with previous years, with rainfall totals 400 to 800 millimetres higher than 2017, 2018 and 2019. Most months in 2020 recorded average or above average rainfall (Figure 16). Rainfall levels were very much above average during February, July, October and December.

Maximum temperatures were average (Figure 15) and minimum temperatures very much above average.

Winds

Upper Hunter winds were predominantly from the south-east in summer and north-west in winter in 2020 (Figure 17). During autumn and spring, winds were variable as they turned from south-easterly to north-westerly in autumn and north-westerly to south-easterly in spring. Seasonal wind patterns observed in 2020 were typical for the region with stronger north-west winds in winter and south-east summer winds.

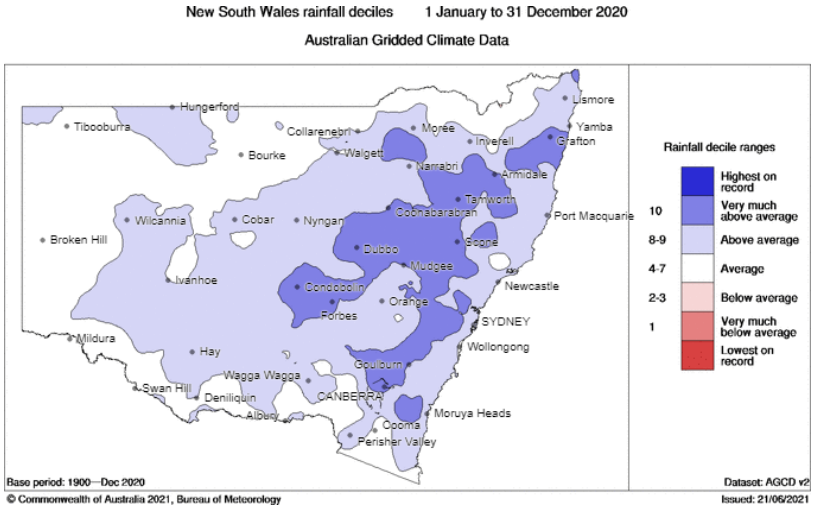

Figure 14 NSW rainfall deciles – 2020

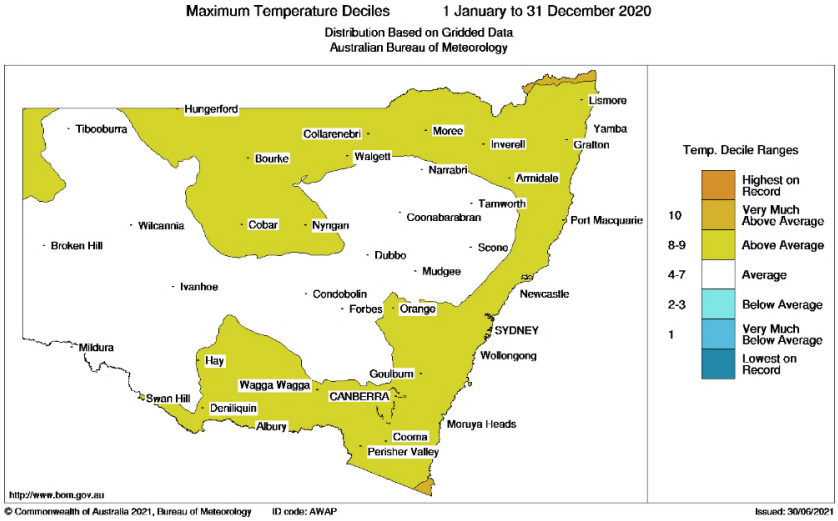

Figure 15 NSW maximum temperature deciles – 2020

[15] Rainfall and temperature information are from the Bureau of Meteorology New South Wales 2020 annual climate summary and climate maps (accessed July 2021).

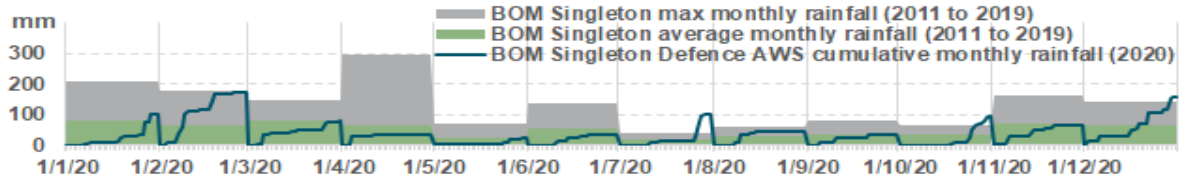

Figure 16 **Bureau of Meteorology Singleton Defence AWS[16] cumulative monthly rainfall in 2020 plotted against maximum and average monthly rainfall from 2011 to 2019**

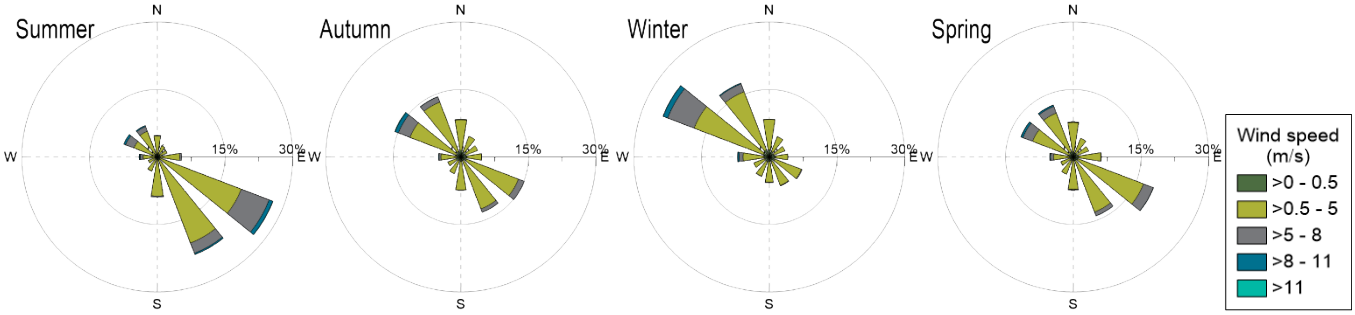

Figure 17 **Seasonal wind roses using pooled wind data from all the Upper Hunter stations – 2020**

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.

In 2020, particle and meteorological parameters at all stations operating since the start of the year met this target (Table 4).

Table 4 **Online performance (%) during 2020**

Station	Particles PM10 daily	Particles PM2.5 daily	Gases SO_2 hourly	Gases NO_2 hourly	Meteorology Wind hourly
Aberdeen	99	-	-	-	100
Bulga	99	-	-	-	100
Camberwell	99	96	-	-	100
Jerrys Plains	98	-	-	-	99
Maison Dieu	99	-	-	-	99
Merriwa	98	41	33	40	98
Mount Thorley	98	-	-	-	99
Muswellbrook	99	98	89	89	100
Muswellbrook NW	99	-	-	-	99
Singleton	99	98	95	92	99
Singleton NW	99	-	-	-	99
Singleton South	99	-	-	-	99
Warkworth	98	-	-	-	100
Wybong	97	-	-	-	100

- = not monitored

The overall reduced times were mainly due to:

- Merriwa PM2.5, SO_2 and NO_2 – new parameters as part of a station upgrade in July 2020
- Muswellbrook SO_2 and NO_2 – equipment fault (19 days).

[16] Sourced from the BOM Climate Data Online website (accessed July 2021). The BOM 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.

Definitions: Upper Hunter monitoring station types

The 14 monitoring stations in the Upper Hunter (Figure 18) serve different purposes:

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

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

Diagnostic: stations provide data to help diagnose the likely sources and movement of particles across the region. Diagnostic stations do not provide information about air quality in population centres.

Background: the stations at Merriwa and Singleton South measure air quality at the north-west and south-east extents of the region. They provide background data by measuring the quality of air entering and leaving the Upper Hunter Valley under predominant winds (south-easterlies and north-westerlies).

The Upper Hunter Air Quality Monitoring Network is operated by the NSW Government and funded by Upper Hunter coal and power industries, in accordance with the Protection of the Environment Operations (General) Regulation 2021.

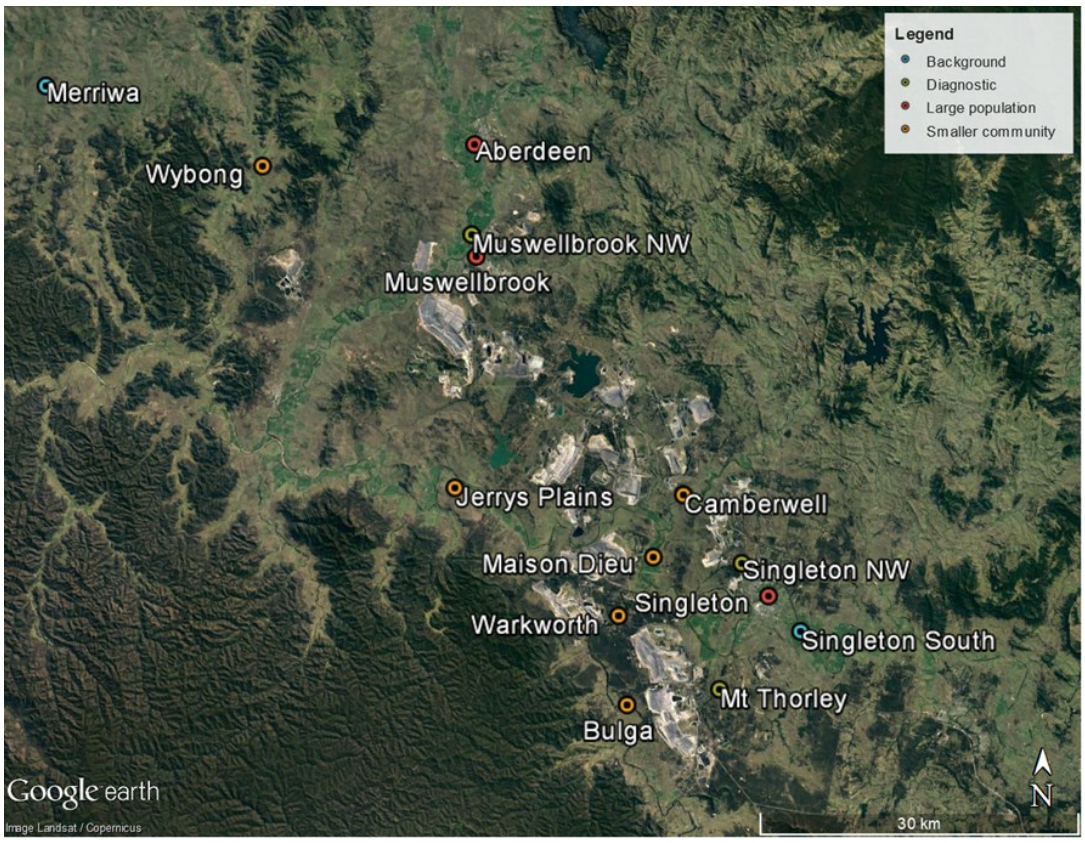

Figure 18 Upper Hunter air quality monitoring stations

This report was prepared by Loredana Warren and reviewed by Upma Dutt and Stephen White.

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