Air quality in Newcastle: Winter 2020

Air quality in the Newcastle region was predominantly good during winter 2020. Daily particle levels were within national benchmarks 98% of the time at Stockton, 99% of the time at Mayfield and Newcastle and 100% of the time at all other sites. Hourly particle levels were in the good to fair air quality categories from 99.0% to 99.8% of the time throughout the region. Regional air quality improved compared to the previous two winters.

- Levels of nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and ammonia (NH_3) were good, all remaining below national benchmark concentrations and assessment goals.
- Daily average levels of fine particulate matter PM2.5 (particles less than or equal to 2.5 microns in diameter) were above the 25 micrograms per cubic metre (µg/m^3) benchmark on one day at Newcastle (6 June). This event occurred overnight during the June long weekend, under cold calm conditions, most likely due to woodsmoke sources. PM2.5 levels were elevated throughout the region on this day, along with many other NSW regions.
- Daily average levels of particulate matter PM10 (particles less than or equal to 10 microns in diameter) were above the 50 µg/m^3 benchmark on two days (9 July at Stockton and 19 August at Stockton and Mayfield). Regional maximum daily PM10 levels on these days ranged from 55.3 to 63.5 µg/m^3.
  - At Stockton, elevated PM10 levels occurred on 9 July under onshore winds, indicating the potential contribution from sea salt[1] and dust re-circulation. See Stockton section for further details.
  - Elevated PM10 levels were observed throughout the Newcastle region and in the Upper Hunter on 19 August, during a widespread dust storm.

Annual air quality trends in the Newcastle region

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, based on the 12-month periods to the end of winter, for 2015 to 2020.

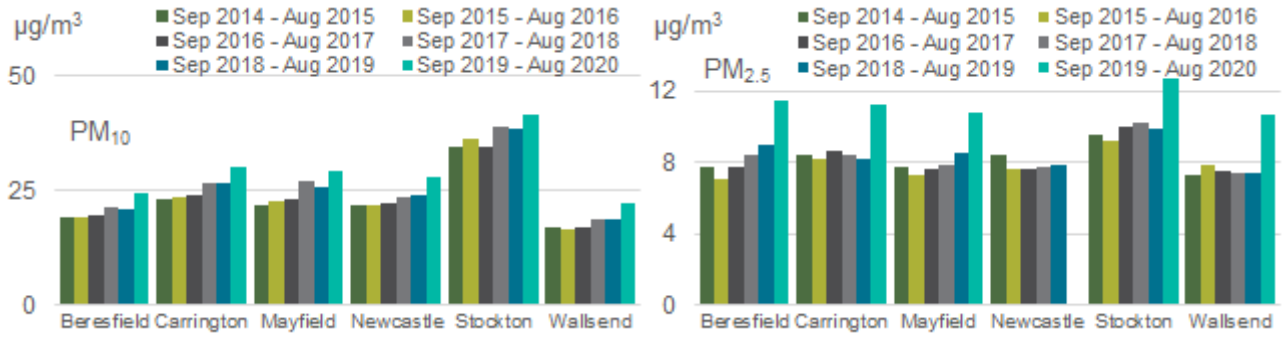

Figure 1 PM10 and PM2.5 rolling annual averages to the end of winter 2020

The comparison in Figure 1 shows that rolling annual average particle levels during the 12 months from September 2019 to August 2020 were higher throughout the region, compared to the same 12-month period in earlier years.

Particle levels in the 12 months to the end of winter 2020 were a result of deteriorating air quality in spring–summer 2019–20. These elevated particle levels were associated with extensive bushfires

[1] Lower Hunter Particle Characterisation Study

across eastern parts of the State and intense drought preceding the February coastal rainfall events. More information on the spring–summer 2019–20 bushfire season can be found in the NSW air quality special statement spring-summer 2019-20 and the Newcastle spring 2019 and summer 2019–20 seasonal newsletters.

Weakening drought conditions in the region (Figure 2) following the rainfall events in February have continued to improve air quality with fewer days over the particle benchmarks during winter 2020 (Table 1).

Rolling annual averages are not intended to be compared to 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 2015 to 2019 calendar years can be found in the Newcastle spring 2019 seasonal newsletter.

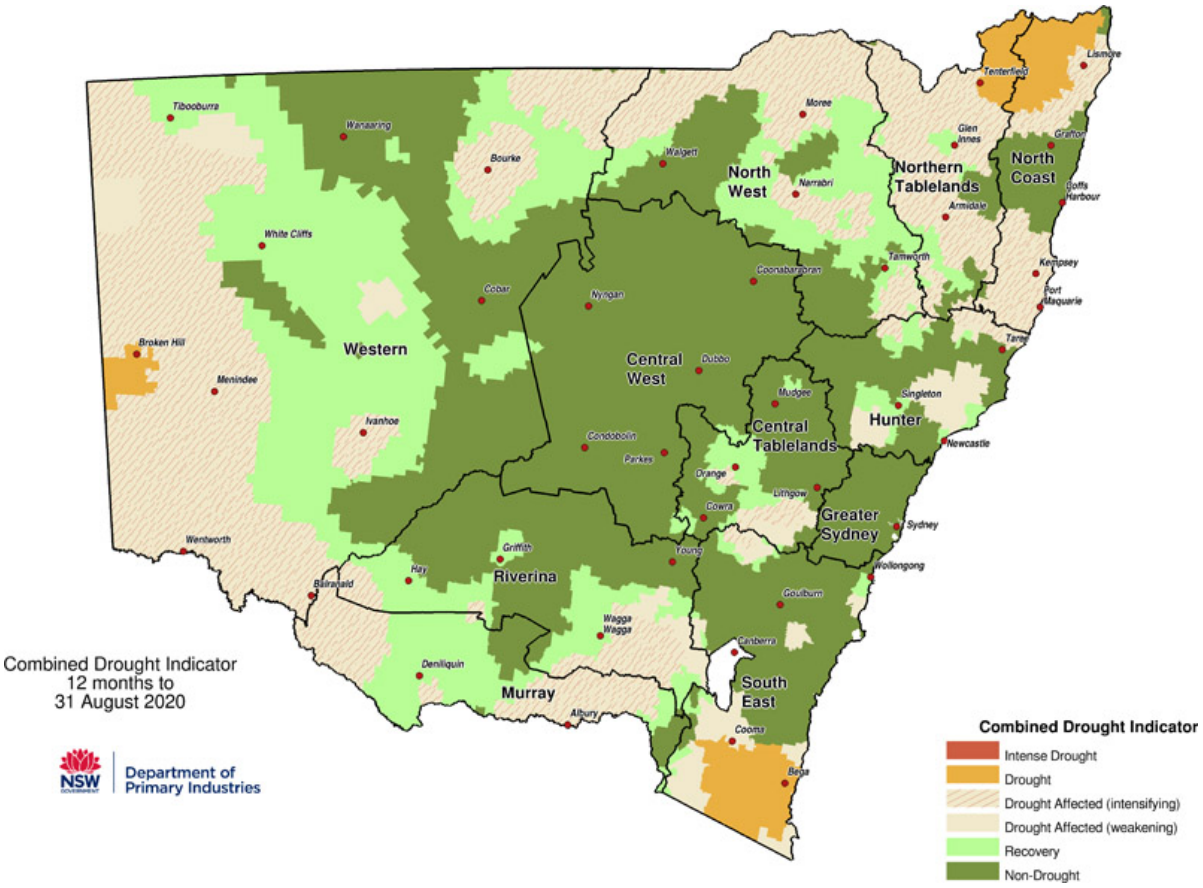

Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 31 August 2020[2]

[2] Sourced from Department of Primary Industries NSW State seasonal update - August 2020 (accessed January 2021)

Days above benchmark concentrations

There were two days over the PM10 daily benchmark in winter 2020, at Mayfield (one day) and Stockton (two days). There was one day over the PM2.5 daily benchmark in winter 2020, at Newcastle.

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

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]	NH_3 **hourly** [46 pphm benchmark]
Beresfield	0	0	0	0	0	-
Carrington	0	0	0	0	0	-
Mayfield	1	0	0	0	0	-
Newcastle	0	1	0	0	0	-
Stockton	2	0	0	0	0	0
Wallsend	0	0	0	0	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

Daily time series plots

Daily average time series plots for PM10 and PM2.5 and daily one–hour maximum plots for NO_2, SO_2 and NH_3 show the concentrations throughout the winter season (Figure 3 to Figure 7).

Levels of NO_2, SO_2 and NH_3 remained below the benchmarks and assessment criteria throughout the season.

PM2.5 levels remained below the benchmark at all sites, except one day at Newcastle on 6 June, most likely due to woodsmoke sources.

PM10 levels remained below the benchmark at most sites, except on two days (9 July at Stockton and 19 August at Stockton and Mayfield). Stockton PM10 levels were most likely affected by sea salt on 9 July due to its proximity to the coast and potential onshore dust re-circulation. See Stockton section for further details. The region was affected by a widespread dust storm on 19 August.

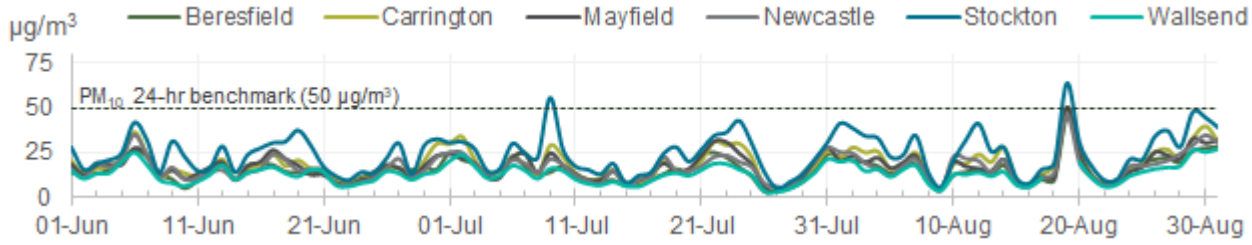

Figure 3 Daily average PM10 during winter 2020

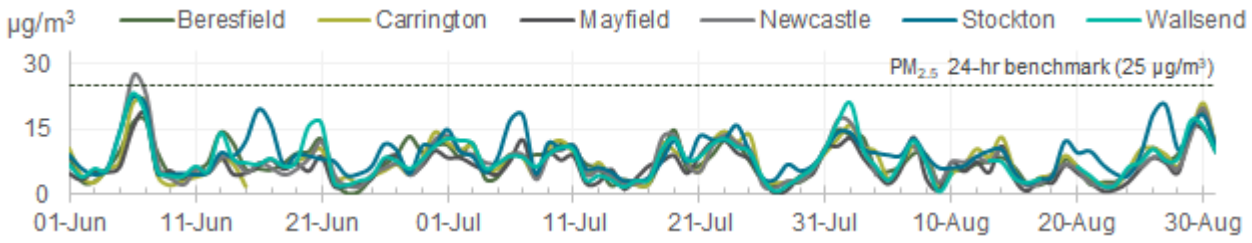

Figure 4 Daily average PM2.5 during winter 2020

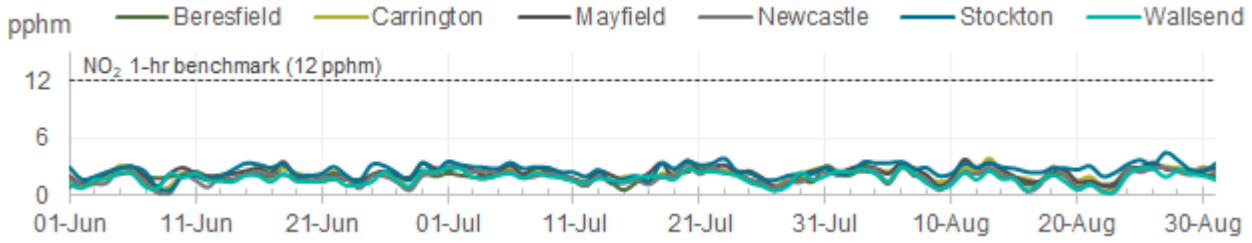

Figure 5 Daily maximum 1-hr NO_2 during winter 2020

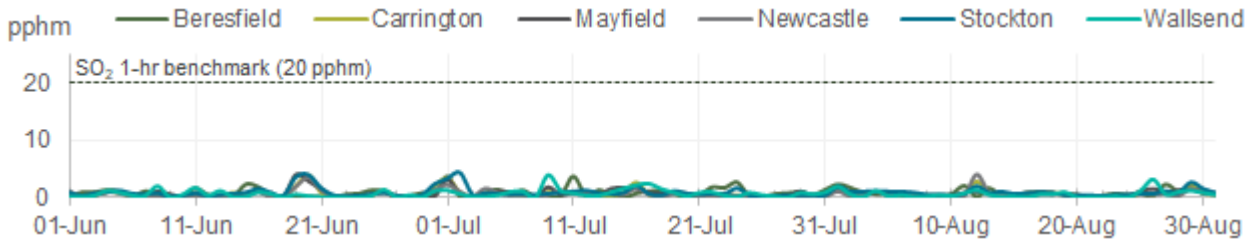

Figure 6 Daily maximum 1-hr SO_2 during winter 2020

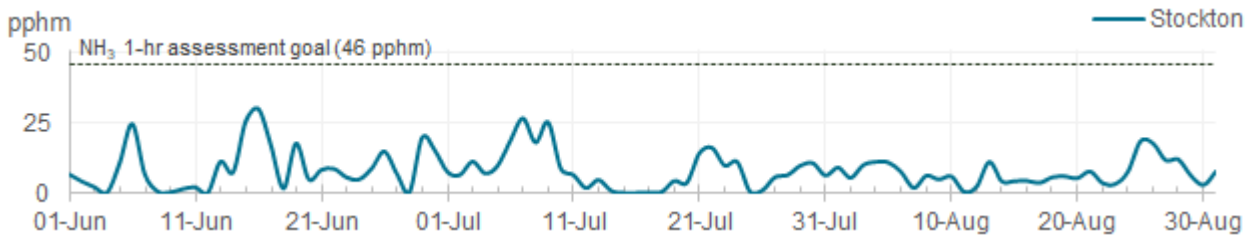

Figure 7 Daily maximum 1-hr NH_3 during winter 2020

Pollution roses from hourly particle data

The seasonal pollution rose maps[3] (Figure 8 and Figure 9) show that hourly[4] PM10 and PM2.5 levels generally remained low during the season.

Figure 8 **Hourly PM10 pollution roses for the Newcastle region for winter 2020**

Figure 9 **Hourly PM2.5 pollution roses for the Newcastle region for winter 2020**

[3] 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 a particular direction. The colours along the bars indicate categories of particle levels.

[4] There are no standards for hourly PM10 or PM2.5 in the National Environment Protection (Ambient Air Quality) Measure (Air NEPM).

Seasonal comparisons

This section compares air quality levels in winter 2020 with previous winter seasons, where data were available[5] (Figure 10).

All days were below benchmark concentrations for NO_2 and SO_2 in winter during the past eight years at Beresfield, Newcastle, Stockton and Wallsend and since monitoring began at Carrington and Mayfield.

For NH_3 at Stockton, there were no days over the assessment criterion in winter 2020. Previously, Orica reported two-hourly concentrations over the assessment criterion in winter 2013.

There were two days over the PM10 benchmark during winter 2020, with one day at Mayfield and two days at Stockton. This was fewer days compared to the previous two winters, with five days over the PM10 benchmark in winter 2019 and eight days in winter 2018.

There was one day over the PM2.5 benchmark during winter 2020. In earlier years, there were three days over the PM2.5 benchmark in 2013 at Stockton; five days in 2015, at Beresfield, Carrington, Mayfield and Newcastle (each one day) and Stockton (three days); and one day in 2019 at Stockton.

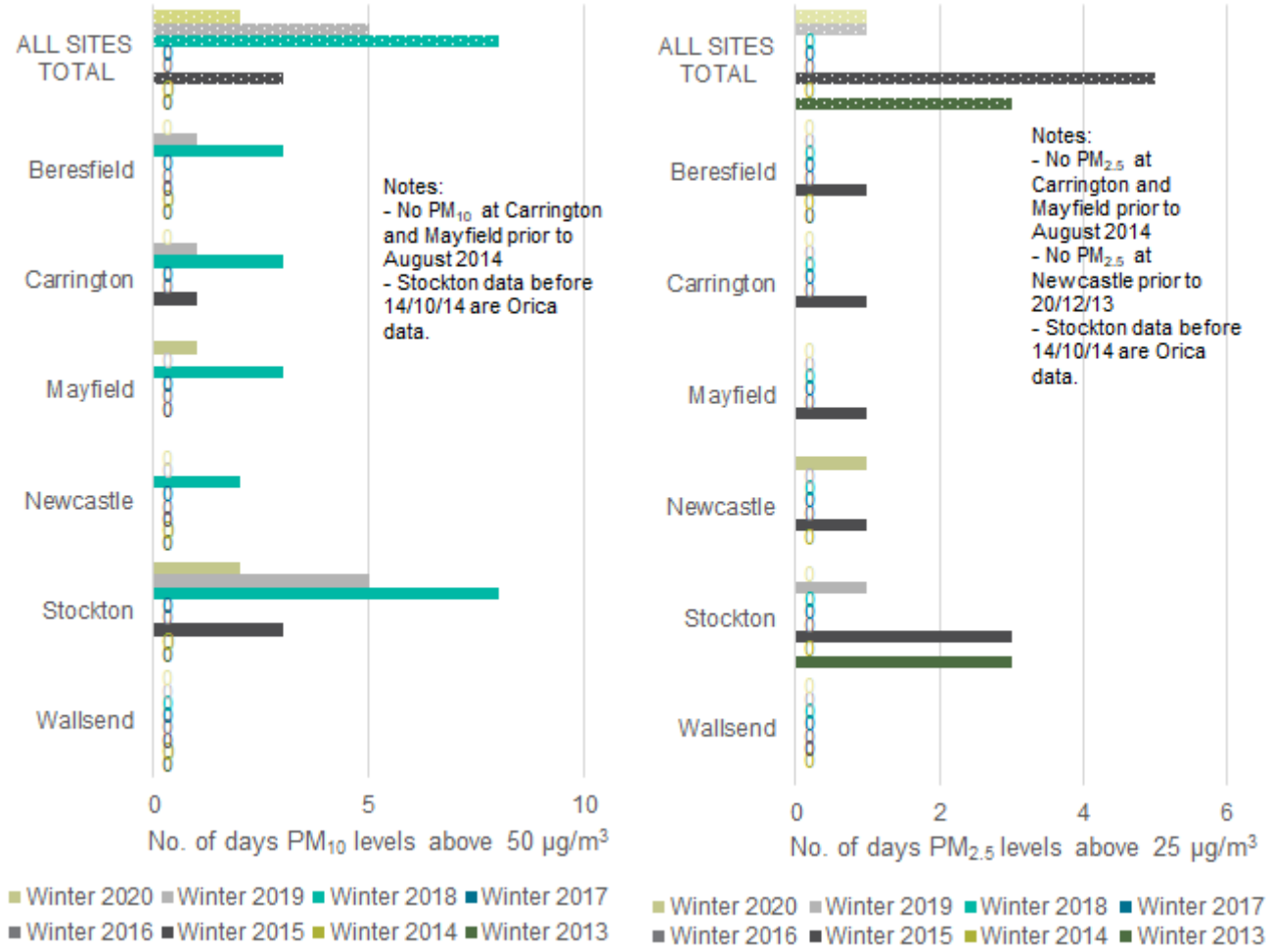

Figure 10 **Number of days above the PM10 and PM2.5 daily benchmarks: winter 2013 to 2020**

[5] Monitoring at Stockton commenced in October 2012 and at Mayfield and Carrington in August 2014. Monitoring of PM2.5 at Newcastle commenced in December 2013. Stockton air quality monitoring was undertaken by Orica from October 2012 to October 2014. From October 2014 it was undertaken by the NSW government as part of the Newcastle Local Air Quality Monitoring Network.

Particle air quality trends in the Newcastle region

Figure 11 and Figure 12 show daily average PM10 during winter 2020, compared to the daily maximum and minimum PM10 levels (i.e. shaded range) from winter 2013 to 2019, at Stockton and Newcastle. Daily PM10 levels were generally within the historical range throughout the season. Newcastle recorded good rainfall levels in July compared to average levels (Figure 13). Variability during the season may also reflect the relatively low number of years of historical data available for comparison.

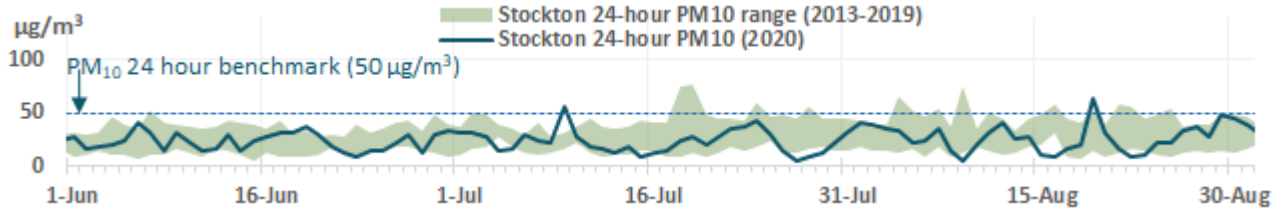

Figure 11 **Stockton daily average PM10 during winter 2020 plotted against the daily maximum and minimum PM10 levels from 2013 to 2019**

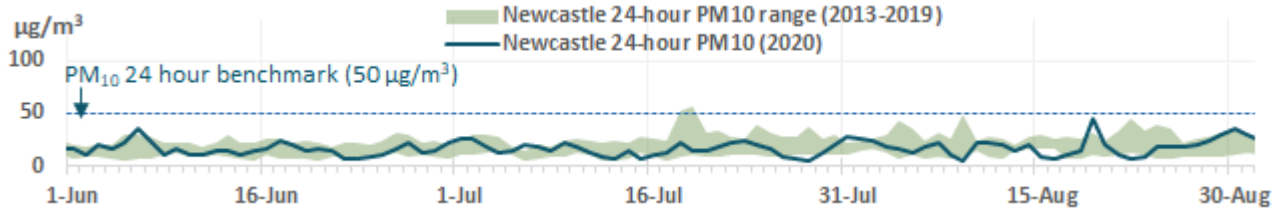

Figure 12 **Newcastle daily average PM10 during winter 2020 plotted against the daily maximum and minimum PM10 levels from 2013 to 2019**

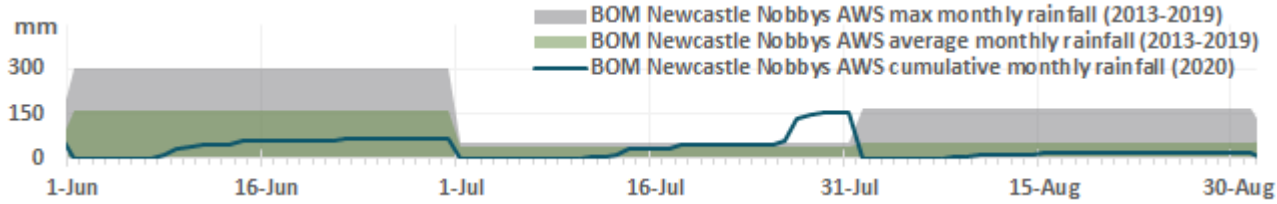

Figure 13 **Bureau of Meteorology Newcastle Nobbys Signal Station AWS[6] cumulative rainfall during winter 2020 plotted against maximum and average rainfall from 2013 to 2019**

Figure 14 and Figure 15 show daily average PM2.5 during winter 2020, compared to the daily maximum and minimum PM2.5 levels (shaded range) from winter 2014 to 2019, at Stockton and Newcastle. Daily PM2.5 levels were generally within the historical range throughout the season, except for a spike at Newcastle on 6 June, most likely due to woodsmoke. Variability during the season may also reflect the relatively low number of years of historical data available for comparison.

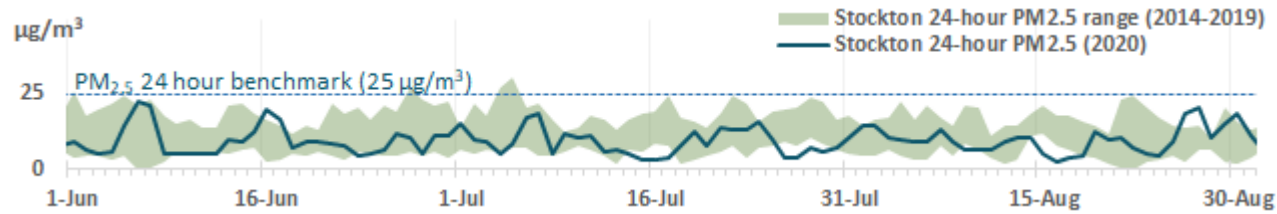

Figure 14 **Stockton daily average PM2.5 during winter 2020 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2019**

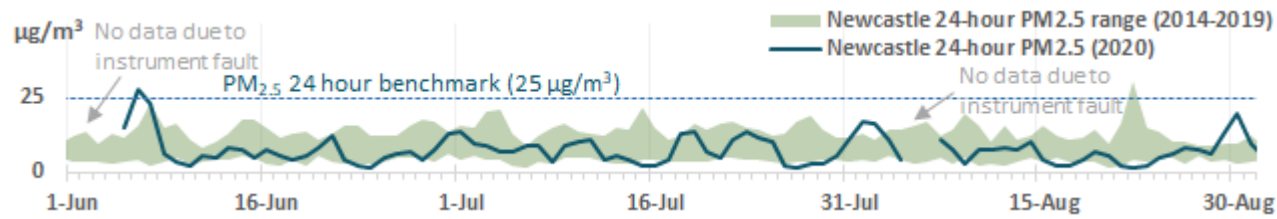

Figure 15 **Newcastle daily average PM2.5 during winter 2020 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2019**

[6] Data from Bureau of Meteorology Newcastle Nobbys Signal Station AWS monthly rainfall page (accessed January 2021)

Meteorological summary

Rainfall and temperature[7]

The Newcastle Nobby's Signal Station AWS recorded 241 millimetres of rain in winter 2020, compared to the long-term average of 283 millimetres, with very much above average rainfall during July (Figure 16).

Maximum and minimum temperatures were above average during the season (Figure 17).

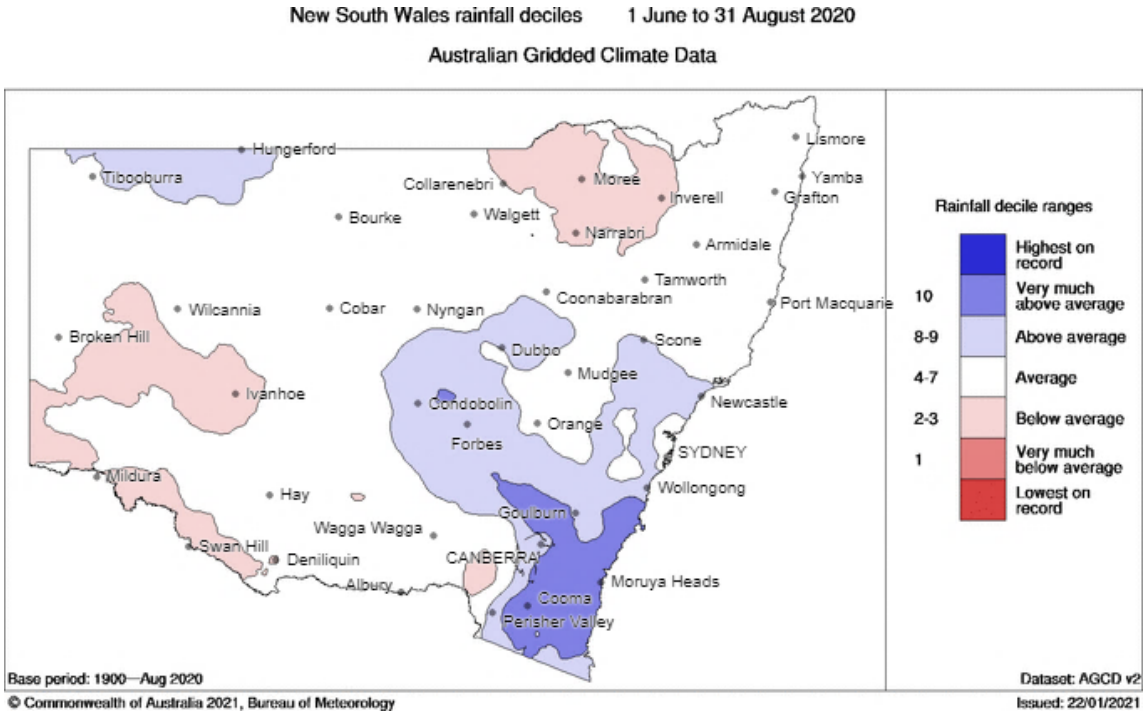

Figure 16 NSW rainfall deciles – winter 2020

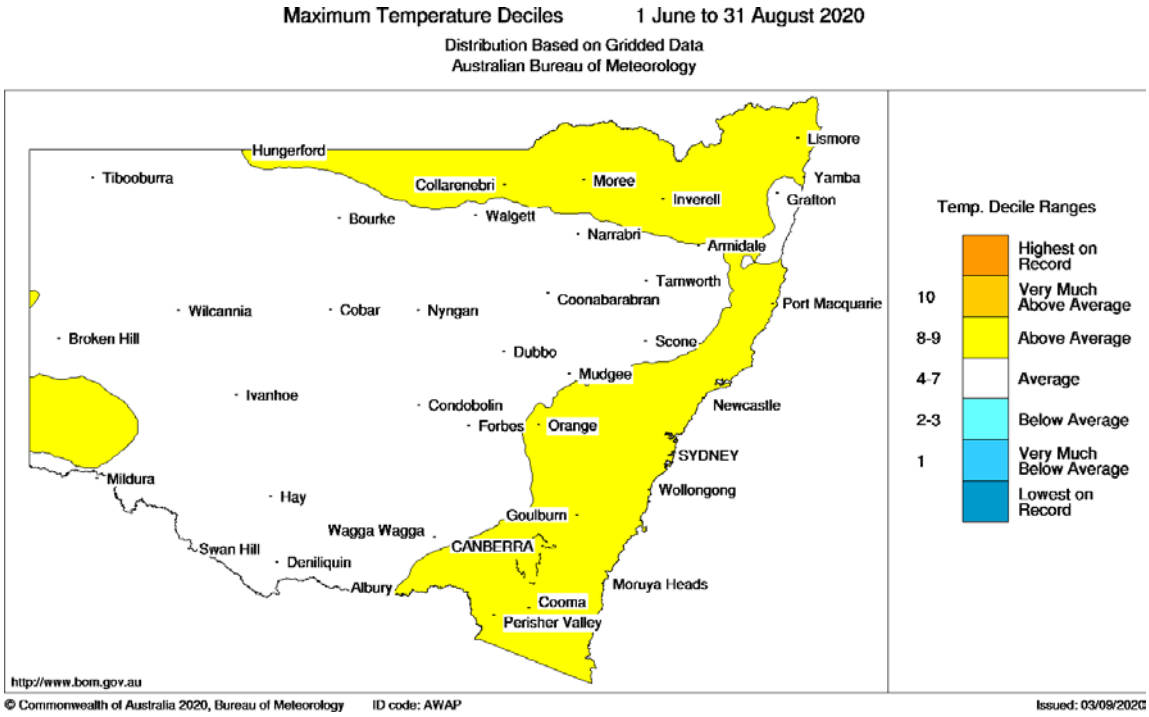

Figure 17 NSW maximum temperature deciles – winter 2020

[7] Rainfall and temperature information is from the Bureau of Meteorology New South Wales winter 2020 climate statement (access January 2021) and climate maps (accessed January 2021)

Wind

The winds were predominantly from the north-west in the region during winter 2020, which was typical for this time of year. As an example, Figure 18 shows that at Stockton, north west winds prevailed 42% of the time, with moderate or stronger (above five metres per second) north west winds occurring 20% of the time.

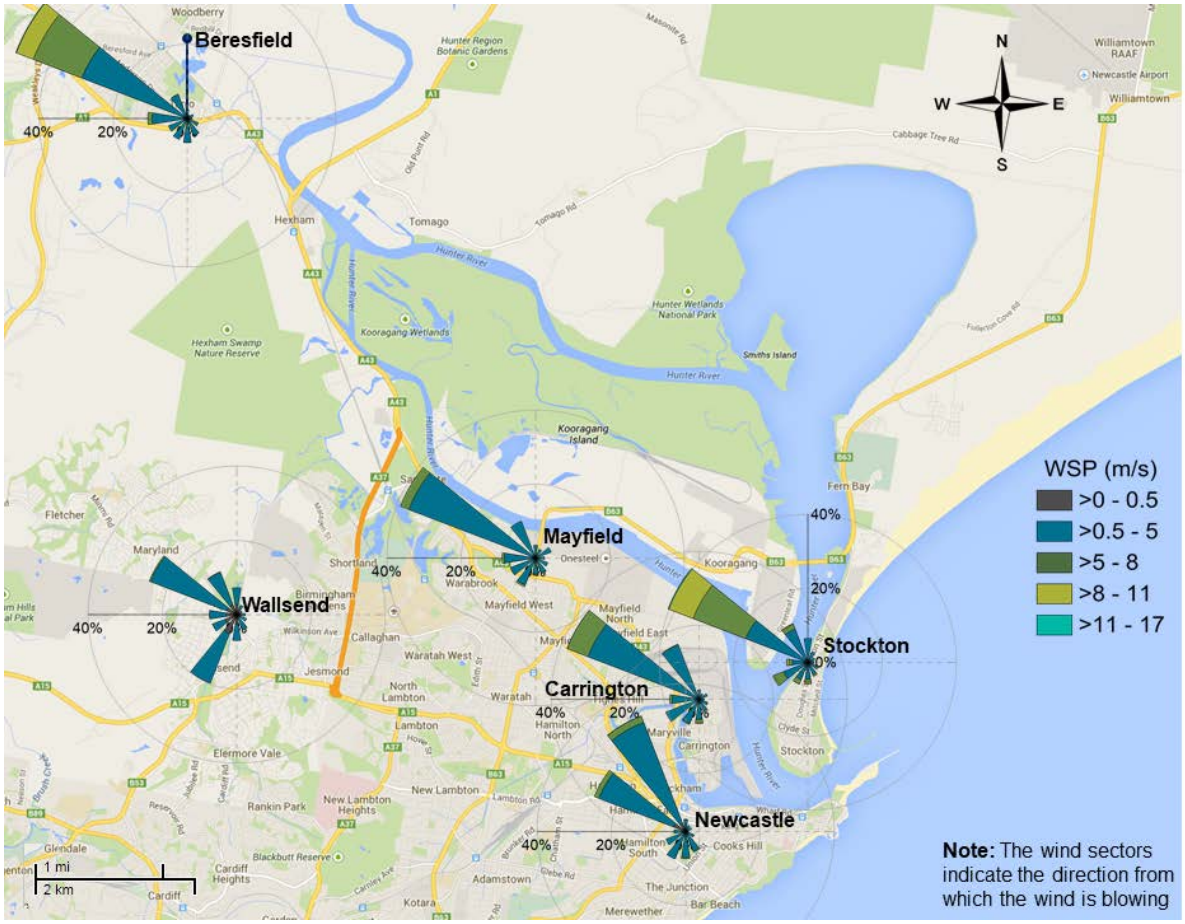

Figure 18 Wind rose map[8] for the Newcastle region for winter 2020

[8] Wind roses show the wind direction and speed at a location. The length of each bar around the circle in these wind roses shows the percentage of time the wind blows from a particular direction. The colours along the bars indicate the wind speeds.

Stockton

Particles at Stockton in winter 2020

The Stockton monitoring site recorded two days over the PM10 daily benchmark during winter 2020 (9 July and 19 August). This was three days fewer than winter 2019, when there were five days over the PM10 benchmark. From 2013 to 2018, Stockton recorded between no days (winters 2013, 2014, 2016 and 2017) and eight days (winter 2018) over the PM10 daily benchmark.

In winter 2020, elevated hourly PM10 levels (>75 µg/m^3)[9] were recorded at Stockton 1.9% of the time (Figure 19). These occurred under:

- onshore north-easterly to south-easterly winds 68% of the time (28 hours, 1.3% total for winter)
- north-westerly winds 24% of the time (10 hours, 0.5% total for winter).

Elevated PM10 under predominant onshore winds at Stockton indicates the potential contribution of sea salt under. The Lower Hunter Particle Characterisation Study found sea salt was a major contributor of particles at the site under onshore winds.

Elevated PM10 levels under north-westerly winds mainly occurred on 19 August, during a widespread dust storm. Elevated PM10 levels were also observed at other sites in the region on this day (Figure 3) and in the Upper Hunter.

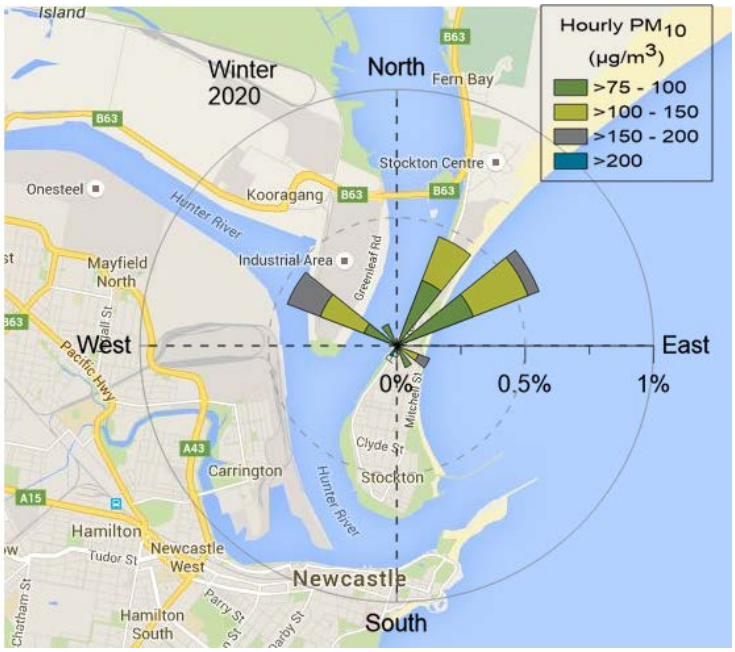

Figure 19 Stockton winter 2020 PM10 pollution rose – proportion of hourly averaged PM10 levels >75 µg/m^3 by wind direction

The Stockton monitoring site did not record any days over the PM2.5 benchmark during winter 2020. Elevated hourly PM2.5 levels (>40 µg/m^3)[9] occurred 0.5% of the time (10 hours) during winter, from the north-west (Figure 20).

[9] There are no standards for hourly PM10 or PM2.5 in the National Environment Protection (Ambient Air Quality) Measure.

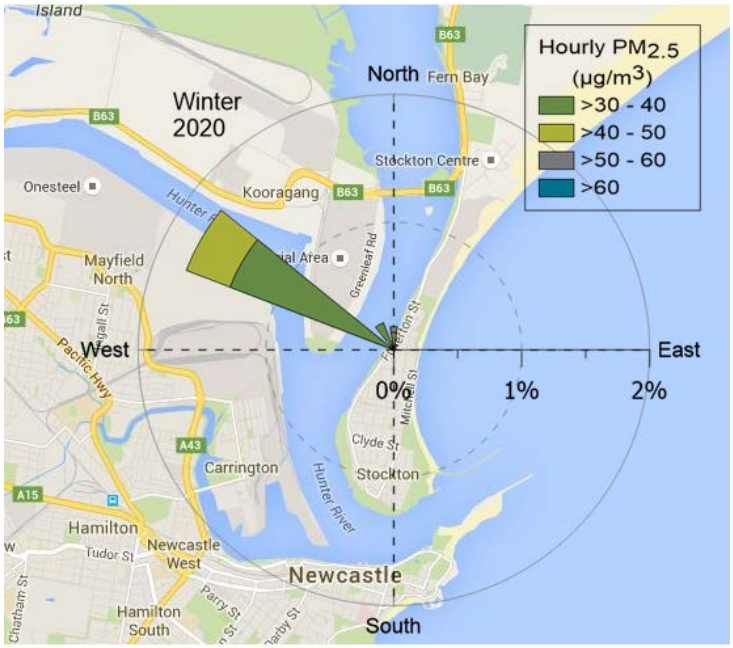

Figure 20 **Stockton winter 2020 PM2.5 pollution rose – proportion of hourly averaged PM2.5 levels >30 µg/m^3 by wind direction**

Ammonia at Stockton in autumn and winter 2020

There were no days over the hourly NH_3 assessment goal of 46 pphm at Stockton during autumn and winter 2020.

NH_3 levels at Stockton follow a seasonal pattern with levels increasing in cooler months (when winds are predominantly from the north-west) and decreasing in warmer months (when winds are predominantly onshore easterly) (Figure 21). The primary ammonia source at Stockton is Orica's ammonium nitrate manufacturing facility on Kooragang Island, located to the north-west of the station.

Figure 21 shows that the maximum 1-hour average NH_3 concentrations from 2013 to 2020, were highest in 2013 and lowest in 2016 and 2019.

Figure 22 shows the daily NH_3 1-hour maximum concentrations in 2020, plotted against the daily minimum and maximum levels from 2013 to 2019. This shows that daily 1-hour maximum NH_3 levels in autumn and winter 2020 were generally within the range of autumn and winter periods in earlier years.

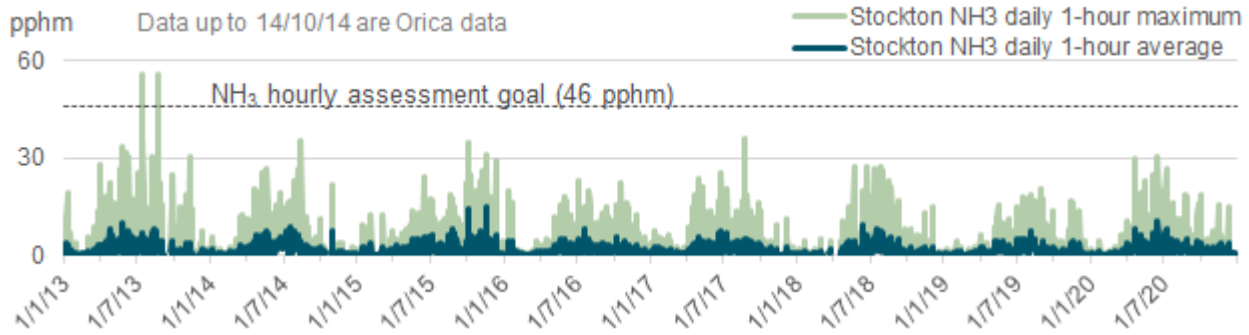

Figure 21 **Stockton daily 1-hour maximum and average NH_3 from 2013 to 2020**

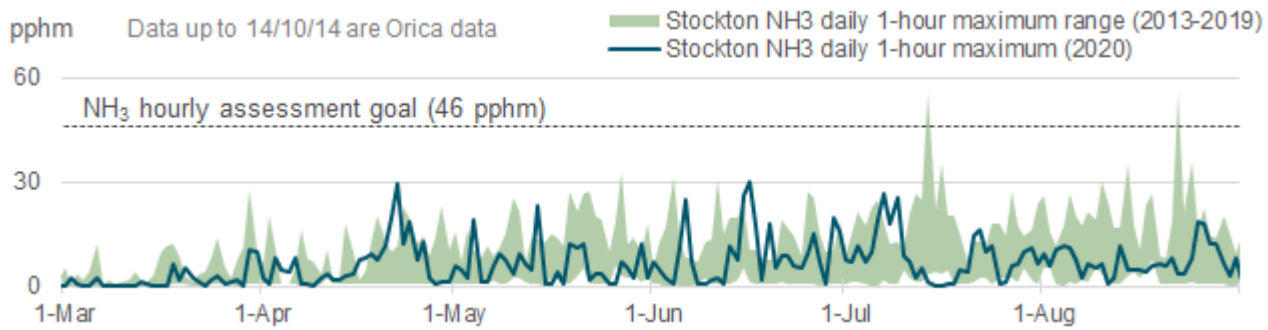

Figure 22 **Stockton daily 1-hour maximum NH_3 for autumn and winter 2020 compared to daily levels from autumn and winter 2013 to 2019**

Network performance

The target network performance is at least 95% available data for all parameters. For NO_2, SO_2 and NH_3, due to daily calibrations, the maximum online time that can be attained is 96%.

Table 2 Online performance (%) during winter 2020

Station	Particles PM10 daily	Particles PM2.5 daily	Gases SO_2 hourly	Gases NO_2 hourly	Gases NH_3 hourly	Meteorology Wind hourly
Beresfield	100	100	95	94	-	100
Carrington	100	97	96	95	-	100
Mayfield	100	100	96	96	-	100
Newcastle	100	93	95	95	-	97
Stockton	100	100	95	95	95	99
Wallsend	98	96	95	95	-	98

- = not monitored

The reduced online times were mainly due to:

- Newcastle PM2.5 – instrument problems (6 days)

This document was prepared by Loredana Warren and reviewed by Leanne Graham.

Published by: Department of Planning, Industry and Environment, Locked Bag 5022, Parramatta NSW 2124.
Ph: 131 555 Email: info@environment.nsw.gov.au; Web: www.environment.nsw.gov.au
ISSN 2206-0421 EES 2021/0047 February 2021