Air quality in Newcastle: Autumn 2021

Air quality in the Newcastle region was predominantly good during autumn 2021. Daily particle levels were within national benchmarks for 97% of the time at Stockton and 100% of the time at all other stations. Stockton particle levels are affected by sea salt due to its proximity to the coast. Hourly particle levels were in the good to fair air quality categories from 99.1% to 100% of the time throughout the region. Regional air quality continued to improve compared to recent bushfire and drought-impacted years.

- 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) remained below the 25 micrograms per cubic metre (µg/m^3) benchmark.
- 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 3 days (7 and 19 March, and 14 April 2021), all occurring at Stockton. Regional maximum daily PM10 levels on these days ranged from 51.3 to 55.3 µg/m^3.
  - At Stockton, elevated PM10 levels (> 75 µg/m^3) predominantly occurred under onshore north-easterly to south-easterly winds (58% of the time that levels were elevated). The 7 and 19 March events were likely due to sea salt. Stockton particle levels are influenced by sea salt spray transported by onshore winds[1], which prevail during the warmer months. See Stockton section for further details.
  - On 14 April, elevated levels at Stockton occurred under north-west winds, due to an undetermined upwind source, with levels remaining good to fair at other stations in the region.

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[2], based on the 12-month periods to the end of autumn, for 2015 to 2021.

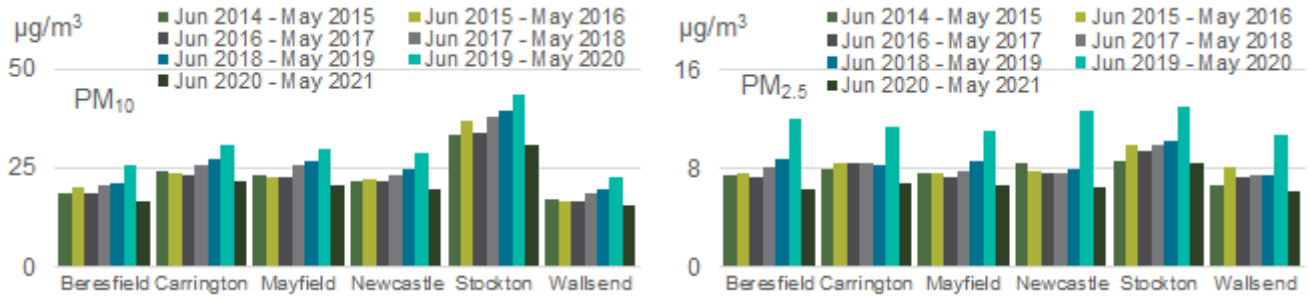

Figure 1 PM10 and PM2.5 annual averages – 2015 to 2021

The comparison in Figure 1 shows a large decrease in particle levels throughout the region during the 12-month to the end of autumn 2021, compared to the same 12-month period in previous years (especially compared to the end of autumn 2020). Annual average PM10 and PM2.5 levels were below the benchmarks at all stations in the 12 months to the end of autumn 2021, except Stockton.

[1] Lower Hunter Particle Characterisation Study.

[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.

Greatly improved particle levels resulted from cooler, wetter conditions in 2020 and early 2021, which reduced impact from dust storms and bushfires. At the end of autumn 2021, 16% of New South Wales was drought affected (Figure 2), compared to 90.8% of the state drought declared by the end of autumn 2020[3].

The higher PM10 and PM2.5 annual averages at Stockton were consistent with the Lower Hunter Particle Characterisation Study. This study found two and a half times higher PM10 at Stockton compared to Mayfield, mainly due to fresh sea salt. It also found 40% more PM2.5 at Stockton compared to Mayfield, Beresfield and Newcastle. This was due to more sea salt in onshore winds and primary ammonium nitrate in north-west winds, particularly in winter (and very likely due to Orica's ammonium nitrate manufacturing facility on Kooragang Island).

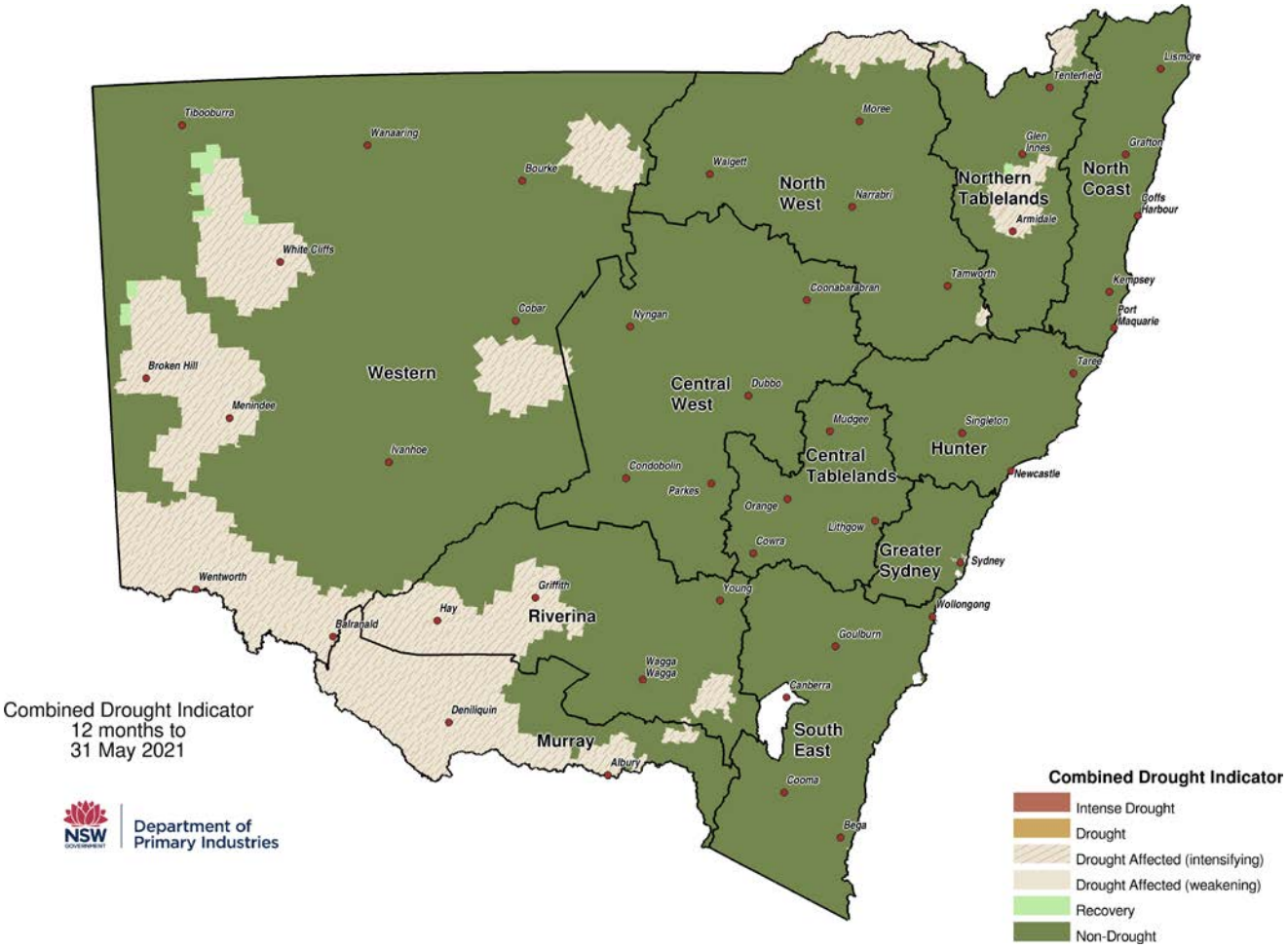

Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 31 May 2021[4]

[3] Sourced from Department of Primary Industries NSW State seasonal update – May 2020 (accessed August 2021).

[4] Sourced from Department of Primary Industries Monthly State Seasonal Update Figures (accessed July 2021).

Days above benchmark concentrations

There were 3 days over the PM10 daily benchmark in autumn 2021, all occurring at Stockton. There were no days over the PM2.5 daily benchmark in autumn 2021.

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

Station	PM10 **daily** [50 µg/m^3 benchmark]	PM2.5 **daily** [25 µg/m^3 benchmark]	SO_2 **hourly**[5] [20 pphm benchmark]	SO_2 **daily**[5] [8 pphm benchmark]	NO_2 **hourly**[5] [12 pphm benchmark]	NH_3 **hourly** [46 pphm benchmark]
Beresfield	0	0	0	0	0	-
Carrington	0	0	0	0	0	-
Mayfield	0	0	0	0	0	-
Newcastle	0	0	0	0	0	-
Stockton	3	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

[5] 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 SO_2 (now 2 pphm) and hourly NO_2 (now 8 pphm).

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 autumn season (Figure 3 to Figure 7).

Levels of PM2.5, NO_2, SO_2 and NH_3 remained below the benchmarks[5] and assessment criteria throughout the season.

PM10 levels remained below the benchmark at most stations, except for 3 days at Stockton. Stockton PM10 levels were most likely affected by sea salt on 7 and 19 March, due to its proximity to the coast. See Stockton section for further details. On 14 April, elevated PM10 levels occurred under north-west winds, likely due to local sources.

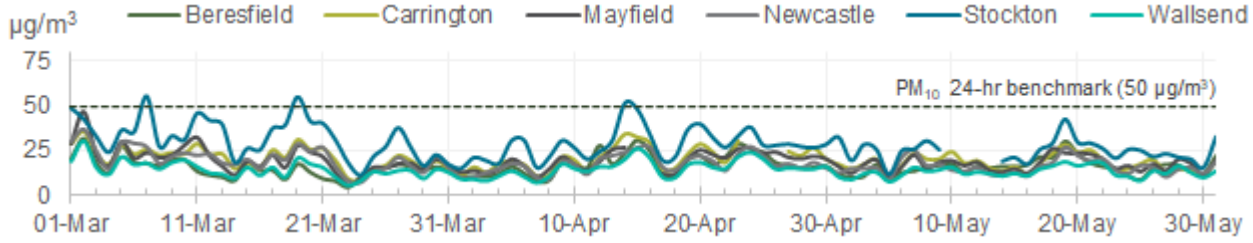

Figure 3 **Daily average PM10 during autumn 2021**

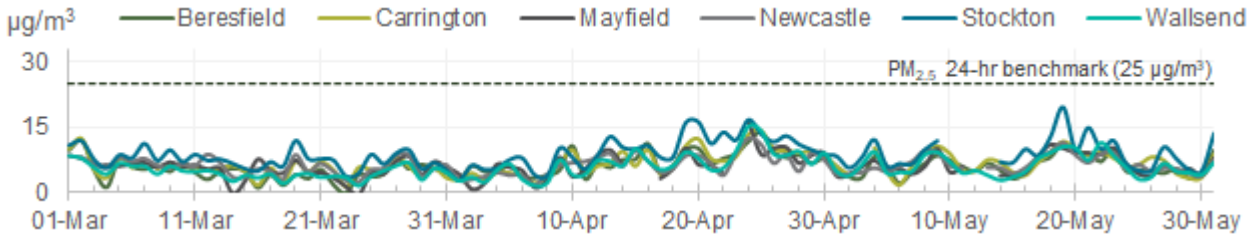

Figure 4 **Daily average PM2.5 during autumn 2021**

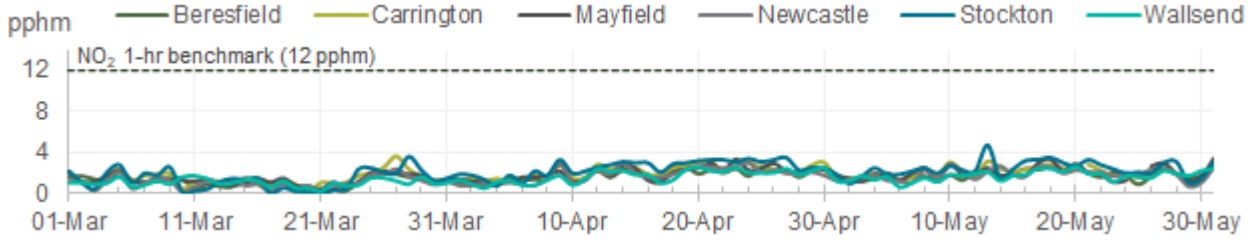

Figure 5 **Daily maximum 1-hr NO_2 during autumn 2021**

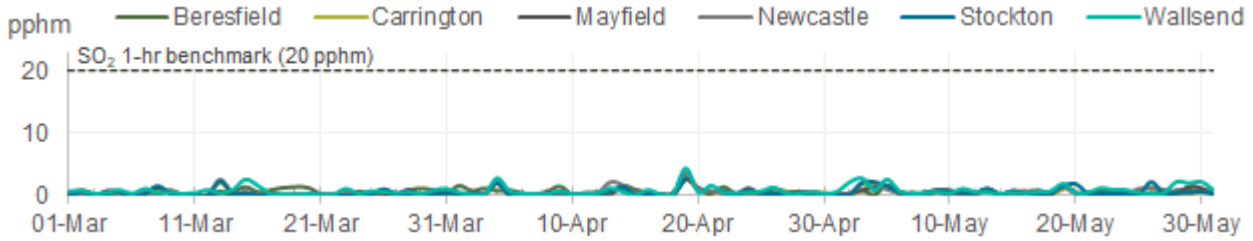

Figure 6 **Daily maximum 1-hr SO_2 during autumn 2021**

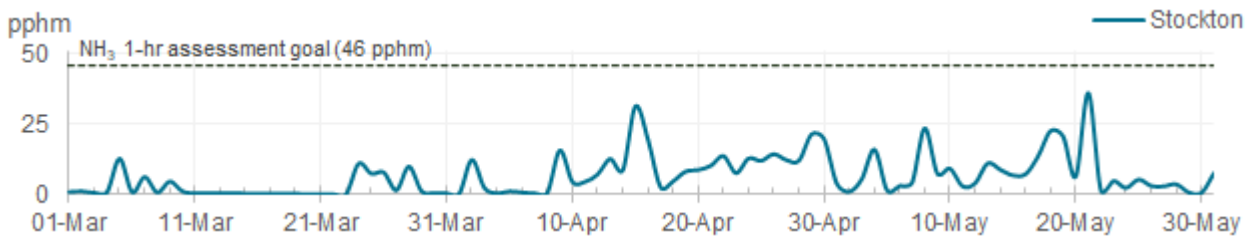

Figure 7 **Daily maximum 1-hr NH_3 during autumn 2021**

Pollution roses from hourly particle data

The seasonal pollution rose maps[6] (Figure 8 and Figure 9) show that hourly[7] PM10 and PM2.5 levels generally remained low during the season.

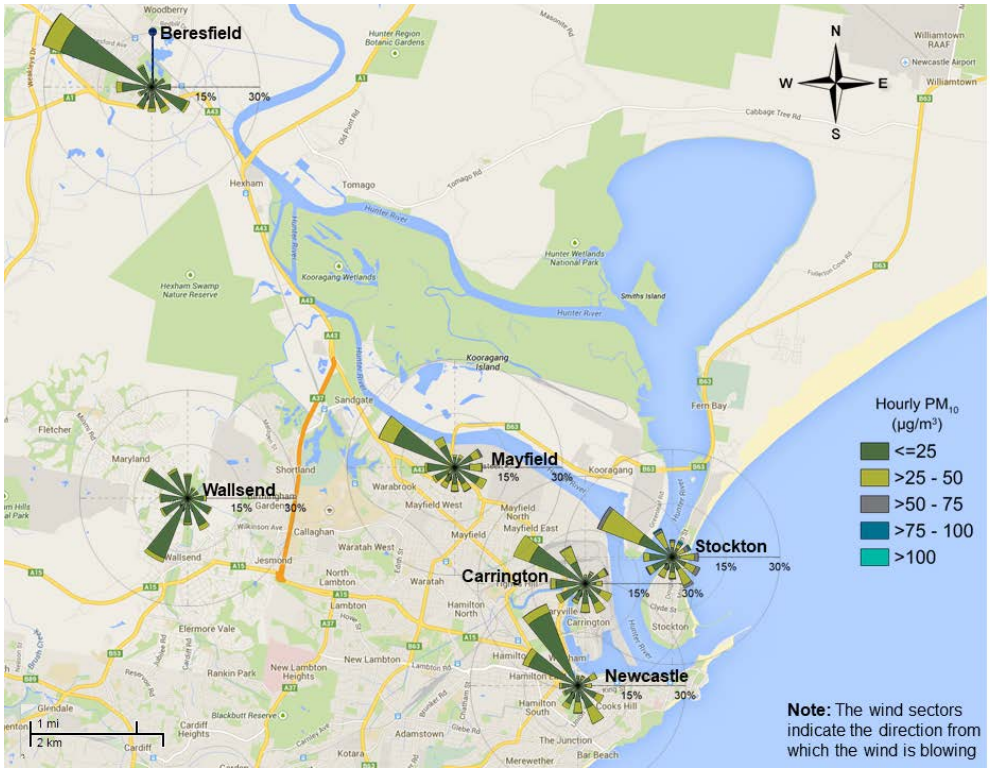

Figure 8 **Hourly PM10 pollution roses for the Newcastle region for autumn 2021**

Figure 9 **Hourly PM2.5 pollution roses for the Newcastle region for autumn 2021**

[6] 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.

[7] There are no standards for hourly PM10 or PM2.5 in the Air NEPM.

Seasonal comparisons

This section compares air quality levels in autumn 2021 with previous autumn seasons, where data were available[8].

All days were below benchmark concentrations for NO_2 and SO_2 in autumn during the past 9 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 autumn during the past 9 years.

There were no days above the PM2.5 benchmark during autumn 2021. In earlier years, Wallsend recorded one day above the PM2.5 benchmark during autumn 2013.

There were 3 days over the PM10 benchmark during autumn 2021, at Stockton alone. This was a large decrease compared to earlier years back to autumn 2015.

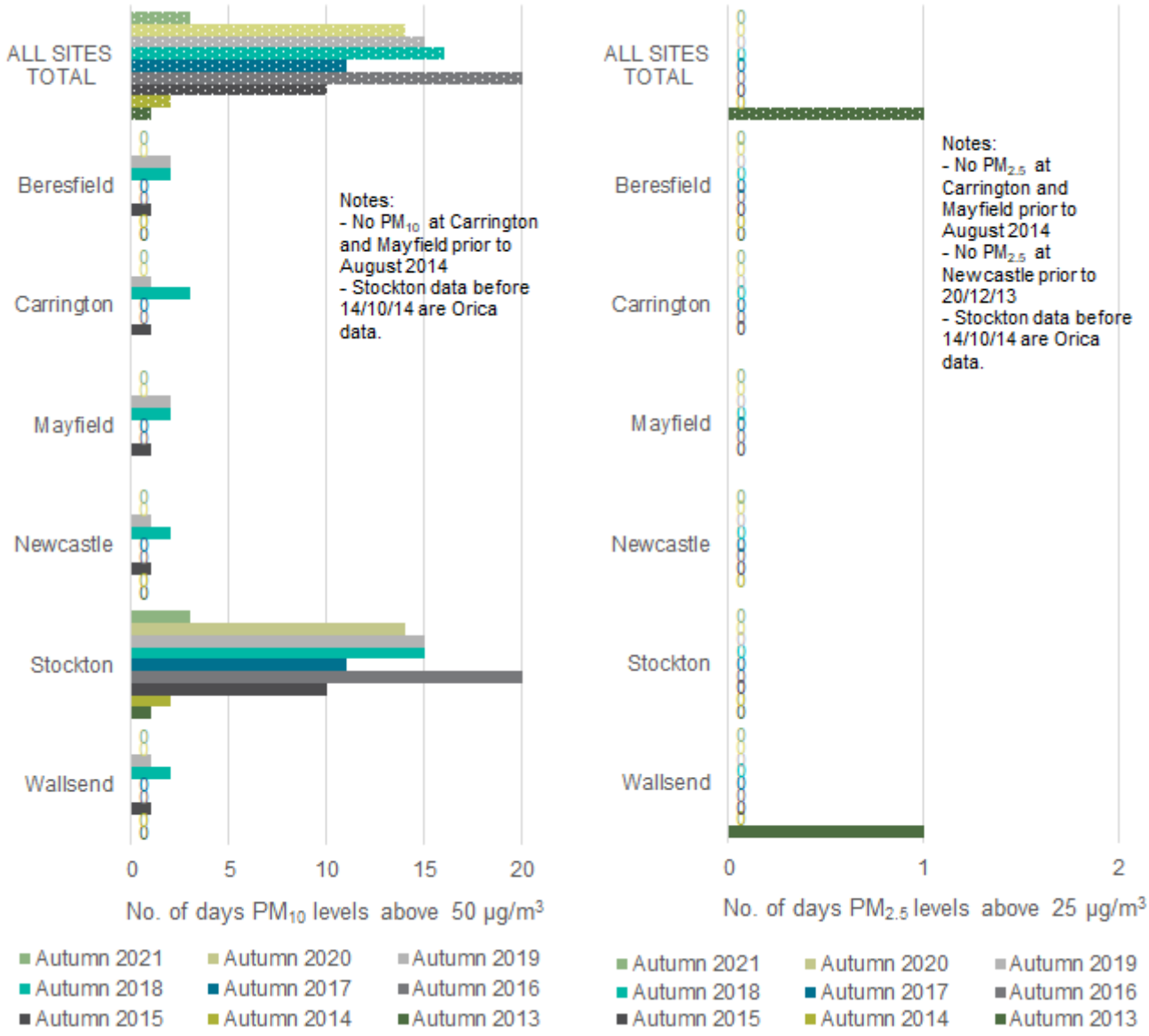

Figure 10 Number of days above the PM10 and PM2.5 daily benchmarks: autumn 2013 to 2021

[8] 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 autumn 2021, compared to the daily maximum and minimum PM10 levels (i.e. shaded range) from autumn 2013 to 2020, at Stockton and Newcastle. Daily PM10 levels were generally within the historical range throughout the season, and often at the lower levels. Rainfall in Newcastle was above to very much above average during autumn, with a very wet March (refer to the Meteorological summary section)[9].

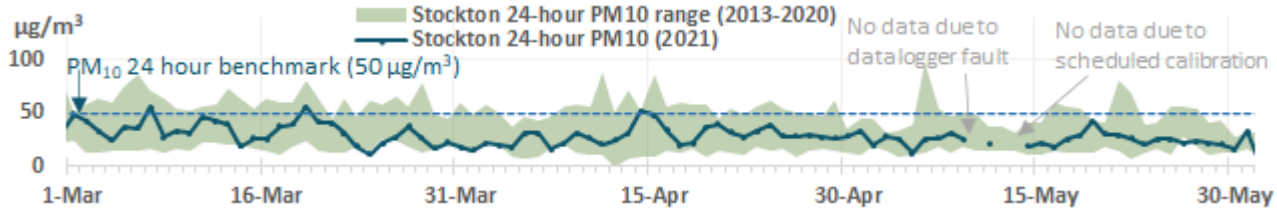

Figure 11 **Stockton daily average PM10 during autumn 2021 plotted against the daily maximum and minimum PM10 levels from 2013 to 2020**

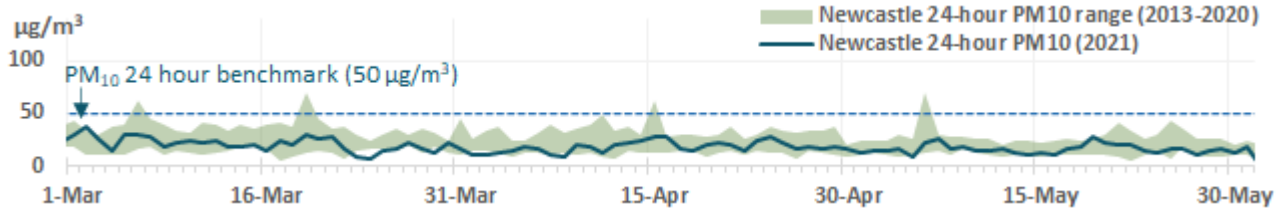

Figure 12 **Newcastle daily average PM10 during autumn 2021 plotted against the daily maximum and minimum PM10 levels from 2013 to 2020**

Figure 13 and Figure 14 show daily average PM2.5 during autumn 2021, compared to the daily maximum and minimum PM2.5 levels (shaded range) from 2014 to 2020, at Stockton and Newcastle. Daily PM2.5 levels were generally within the historical range throughout the season, and often at the lower levels.

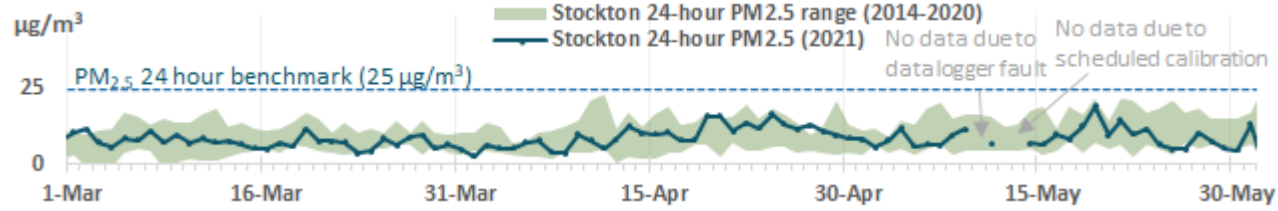

Figure 13 **Stockton daily average PM2.5 during autumn 2021 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2020**

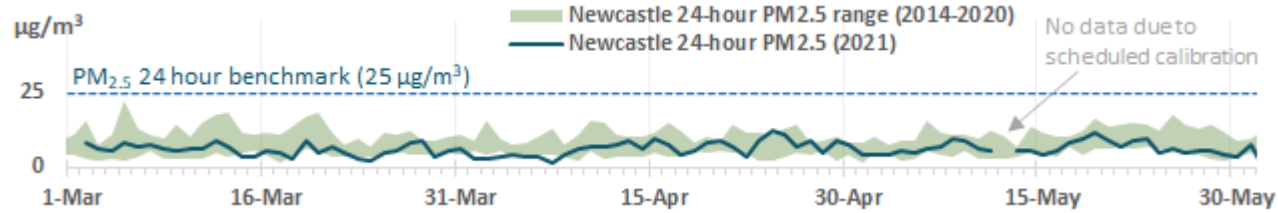

Figure 14 **Newcastle daily average PM2.5 during autumn 2021 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2020**

[9] Note: The Bureau of Meteorology Newcastle Nobbys Signal Station AWS cumulative rainfall graph was not included in this seasonal newsletter as a result of a large amount of missing rainfall data during autumn 2021.

Meteorological summary

Rainfall and temperature[10]

The Newcastle region experienced above to very much above average rainfall overall during autumn 2021 compared to long-term records (Figure 15). Monthly rainfall varied throughout the season, with highest on record rainfall during March and below average rainfall in April.

Autumn 2021 was much wetter than the 3 previous autumns, with between 200 to 400 millimetres more rain in autumn 2021 compared to each of the previous 3 autumns.

Maximum and minimum temperatures were average during the season (Figure 16).

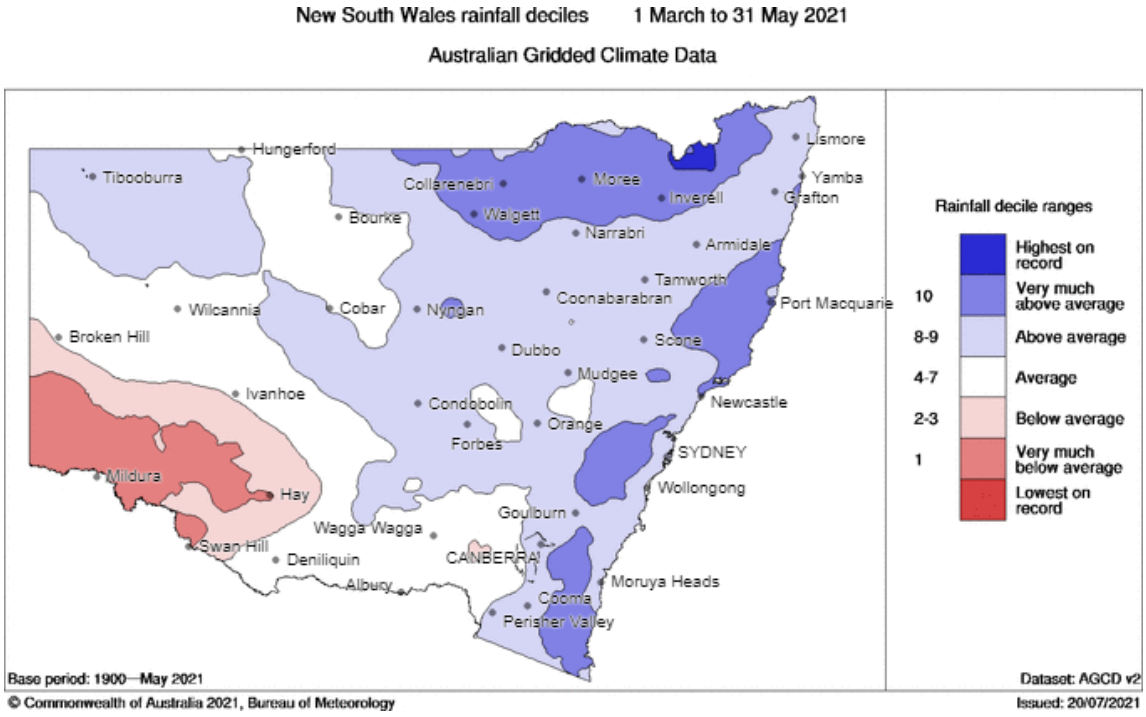

Figure 15 NSW rainfall deciles – autumn 2021

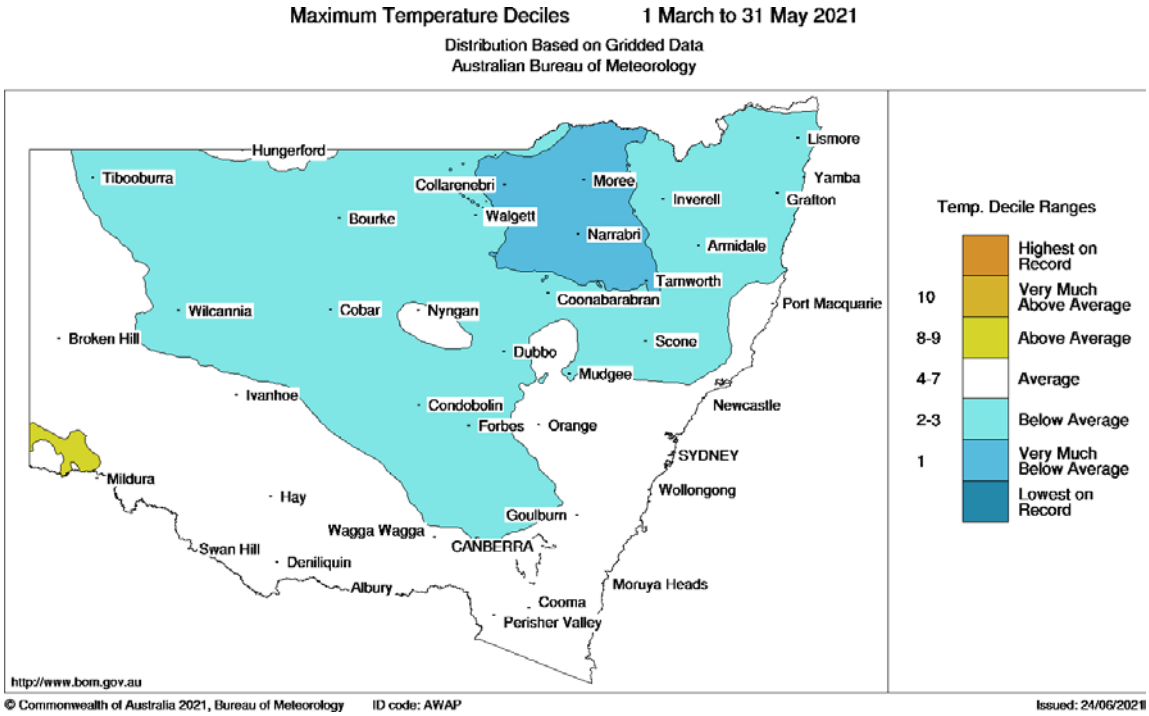

Figure 16 NSW maximum temperature deciles – autumn 2021

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

Wind

The winds were variable in the region during autumn 2020, with an increasing percentage of north-westerly winds. Winds typically change from onshore easterly flows during the warmer months to offshore westerly flows as conditions cool.

As an example, Figure 17 shows that north-west winds prevailed 26% of the time at Stockton, with these moderate or stronger winds (above 5 metres per second) 7% of the time.

Figure 17 Wind rose map[11] for the Newcastle region for autumn 2021

[11] 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 autumn 2021

The Stockton monitoring station recorded 3 days over the PM10 daily benchmark during autumn 2021 (7 and 19 March, and 14 April 2021). There were fewer days over the PM10 daily benchmark in autumn 2021 compared to most earlier years (Figure 10). From 2015 to 2020, there were between 10 days (autumn 2015) and 20 days (autumn 2016) over the PM10 benchmark. In autumns 2013 and 2014, there were one and two days over the PM10 benchmark, respectively.

In autumn 2021, elevated hourly PM10 levels (>75 µg/m^3)[12] were recorded at Stockton 2.3% of the time (Figure 18). These occurred under:

- onshore north-easterly to south-easterly winds 58% of the time (29 hours, 1.3% total for autumn)
- north-westerly winds 20% of the time (10 hours, 0.5% total for autumn).

Elevated PM10 levels under predominant onshore winds at Stockton indicate the potential contribution of sea salt, as was observed during the 7 and 19 March events. The Lower Hunter Particle Characterisation Study found sea salt was a major contributor of particles at the station under onshore winds.

Elevated PM10 levels under light north-westerly winds occurred late on 14 April. These elevated levels were due to an undetermined upwind source, with levels remaining good to fair at other stations in the region.

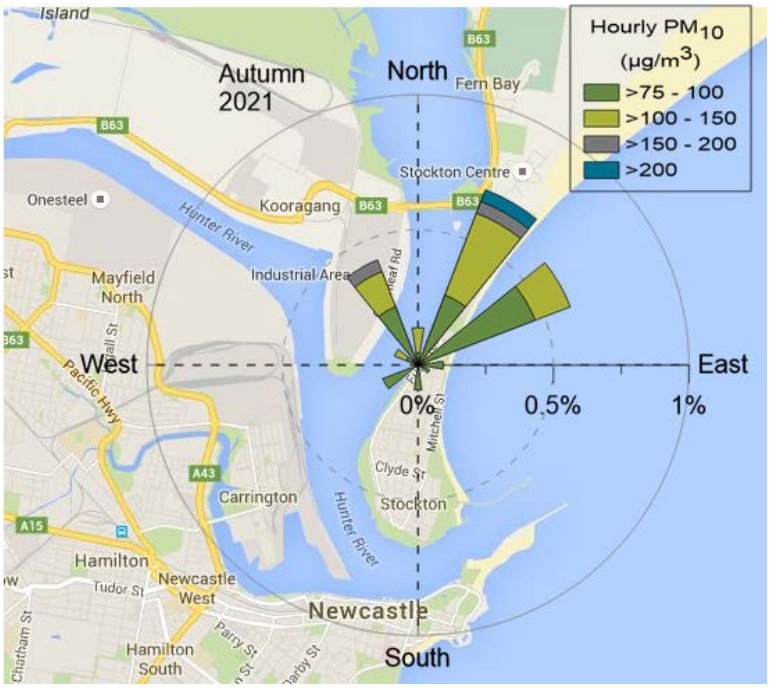

Figure 18 Stockton autumn 2021 PM10 pollution rose – proportion of hourly averaged PM10 levels >75 µg/m^3 by wind direction

The Stockton monitoring station did not record any days over the PM2.5 daily benchmark during autumn 2021. This was the same as all previous years (Figure 10). Elevated levels of hourly PM2.5 (>40 µg/m^3)[12] were observed at Stockton for only one hour during the season.

[12] There are no standards for hourly PM10 or PM2.5 in the Air NEPM.

Network performance

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

Table 2 Online performance (%) during autumn 2021

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	95	-	100
Carrington	97	98	94	93	-	100
Mayfield	98	95	93	93	-	99
Newcastle	100	98	91	93	-	100
Stockton	97	97	93	94	95	99
Wallsend	100	100	93	96	-	100

- = not monitored

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