Air Quality Monitoring Network

Newcastle spring 2024

Air quality in the Newcastle region[1] was mostly good[2] during spring 2024.

- Levels of nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and ammonia (NH_3) remained below national benchmarks and assessment goals[3].
- Daily average particle benchmarks were met 87% of the time at Stockton, 99% at Beresfield, Carrington and Mayfield, and 100% of the time at the other stations.
  - Daily average levels of PM2.5[4] fine particles were above the 25 µg/m^3 benchmark on one day (25 September) at Beresfield.
  - Daily average PM10 levels were above the 50 µg/m^3 benchmark on 12 days (24, 25, 29 September; 23, 29 October; 20, 22–27 November). Stockton was over the benchmark on all 12 days, and Carrington and Mayfield also exceeded on one of these 12 days.
  - Stockton exceeded the PM10 daily benchmark most often in November (7 days). Elevated PM10 levels at Stockton are influenced by sea salt spray transported under prevailing onshore winds typical in the warmer months[5]. See Stockton section for details.
- Hourly particle levels were in the 'good' to 'fair' air quality categories[2] for 97% of hours at Stockton, and ranged from 99.9% to 100% at the other stations.
- The region had average rainfall, higher than usual daytime temperatures, and much warmer nighttime temperatures.

Annual air quality trends

Long-term trends in annual average PM10 and PM2.5 levels are shown in Figure 1 and Figure 2.

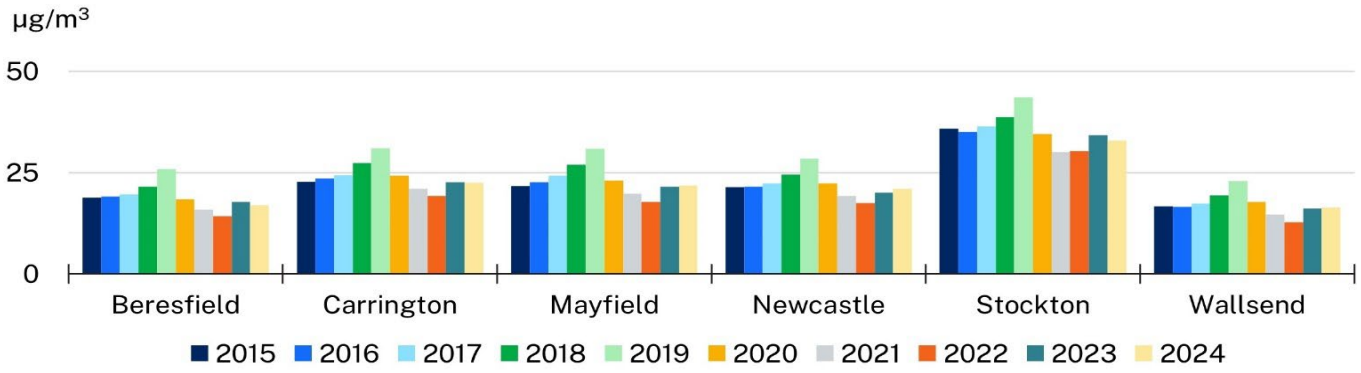

Figure 1 Annual averages for PM10 – 2015 to 2024

Note: data in this figure are listed in Table 3, Appendix A: Annual averages.

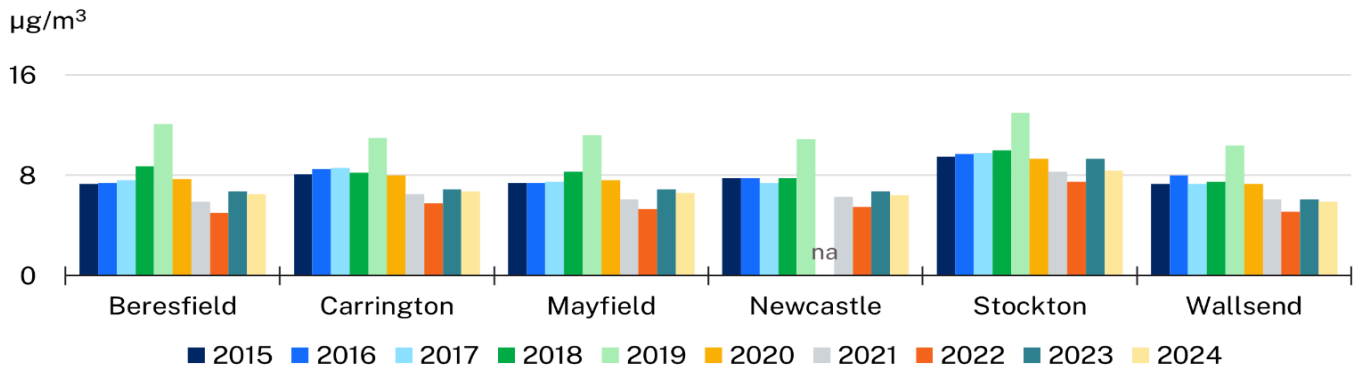

Figure 2 Annual averages for PM2.5 – 2015 to 2024

na = rolling annual average unavailable due to insufficient data availability
Note: data in this figure are listed in Table 4, Appendix A: Annual averages.

The annual averages of PM10 and PM2.5 for 2024 were slightly lower at most sites compared to the previous year (Figure 1 and Figure 2). This trend is likely due to more rainfall and better groundcover in the 12 months leading up to the end of 2024, compared to the same period the previous year.

The higher annual averages of PM10 and PM2.5 at Stockton were consistent with the Lower Hunter Particle Characterisation Study[4]. This study found PM10 at Stockton was 2.5 times higher than 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).

In the 12-months to the end of November 2024, 14% of New South Wales was in one of the 4 drought categories (Figure 3)[6]. The Newcastle region was in non-drought category by that time, a marked improvement on spring 2023 when 65% of New South Wales, including the Newcastle region was in one of 4 drought categories[7].

The lower particle annual averages in the 2024 spring season relative to spring 2023 (Figure 1 and Figure 2) reflect easing drought conditions combined with higher rainfall during spring 2024. The lowest rolling annual averages across the network were recorded in 2022, when no areas of New South Wales were drought affected at the end of spring 2022[8].

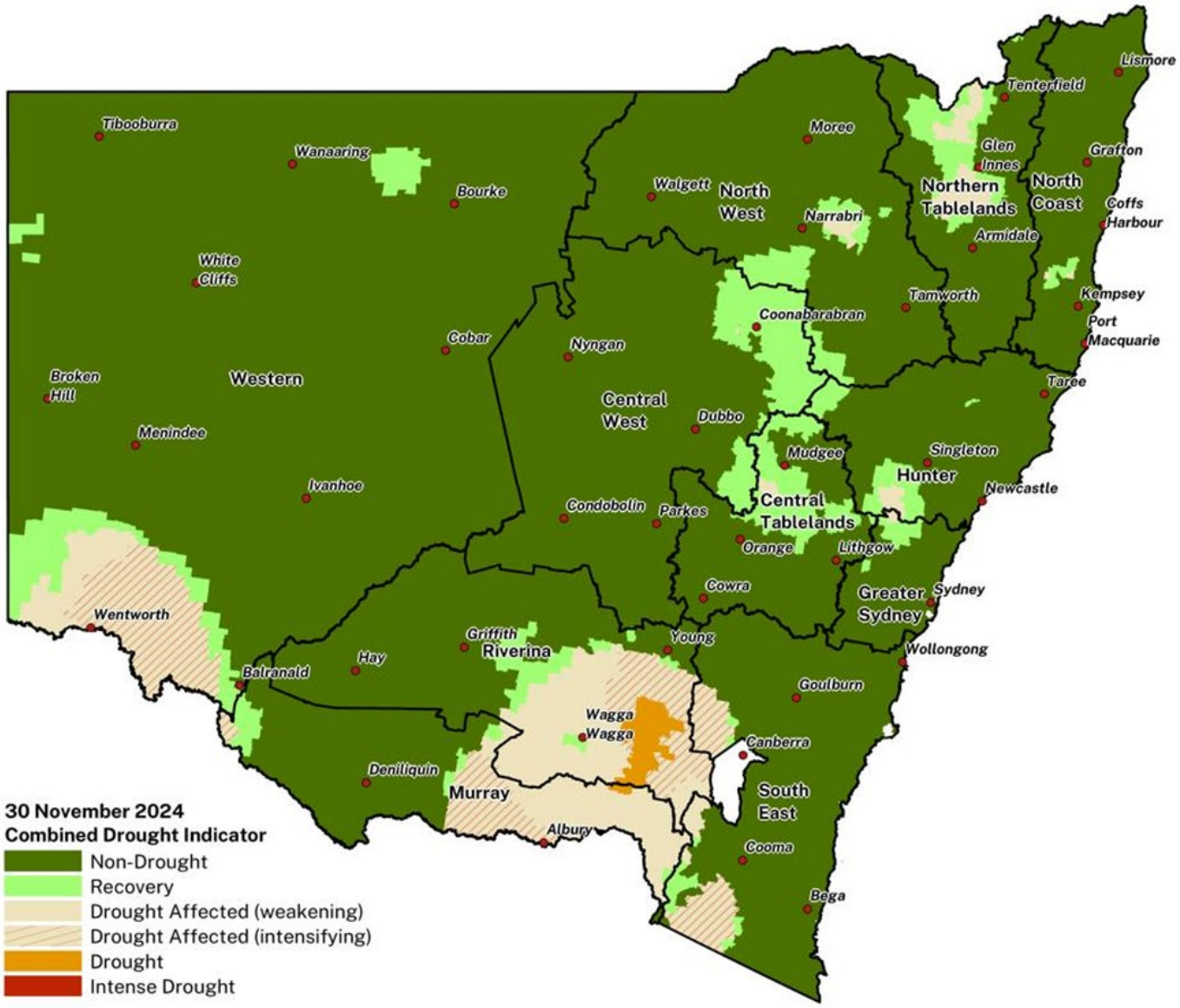

Figure 3 NSW combined drought indicator map for the 12 months to 30 November 2024[6]

Credit: NSW Department of Primary Industries and Regional Development © State of New South Wales EDIS v2.2

Days above benchmark concentrations

In spring 2024, there were 12 days over the PM10 daily benchmark across the region (Table 1). The benchmark was exceeded on 24, 25, 29 September; 23, 29 October; and 20, 22–27 November. Stockton exceeded the benchmark on all 12 days, during onshore winds when sea salt is the primary contributor to elevated PM10 levels. On one of these 12 days, 25 September, 2 additional stations (Carrington and Mayfield) were also over the benchmark. On that day, the Beresfield station also recorded PM2.5 levels above the daily benchmark because of smoke from hazard reduction burning.

Levels of SO_2, NO_2 and NH_3 remained below relevant benchmarks during the season.

Table 1 **Number of days above the relevant national benchmarks spring 2024**

Station	**PM10** daily [50 µg/m^3 benchmark]	**PM2.5** daily [25 µg/m^3 benchmark]	**SO_2** hourly [10 pphm benchmark]	**SO_2** daily [2 pphm benchmark]	**NO_2** hourly [8 pphm benchmark]	NH_3 hourly [46 pphm benchmark]
Beresfield	0	1	0	0	0	–
Carrington	1	0	0	0	0	–
Mayfield	1	0	0	0	0	–
Newcastle	0	0	0	0	0	–
Stockton	12	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 (that is, parts of pollutant per hundred million parts of air)
'–' = not monitored

Seasonal trends

There were no days above NO_2 and SO_2 benchmarks in spring during the past 12 years at Beresfield, Newcastle, Stockton, and Wallsend, or since monitoring began in 2014 at Carrington and Mayfield.

At Stockton, there were no days over the NH_3 assessment criterion in spring during the past 12 years.

Figure 4 to Figure 7 compare particle trends in spring 2024 with previous spring seasons where data were available[9].

In spring 2024, the region had 12 days over the PM10 daily benchmark (Figure 4), nearly half the number of days over the benchmark in spring 2023 (23 days). The region had the fewest days with high PM10 levels during spring 2020 to 2022. In contrast, spring 2019 had the most days with high PM10 levels (42 days).

Figure 5 shows that in spring 2024, Stockton recorded 12 days over the PM10 benchmark, an improvement compared to 23 days in 2023. High PM10 levels at Stockton are due to sea salt because it's close to the coast.

There was one day in spring 2024 when PM2.5 levels at Beresfield went over the daily benchmark. This was similar to what happened in spring 2014, 2016, 2017, and 2018 (Figure 6). Historically, there were zero days over the benchmark during spring 2015, 2020–2023 and up to 20 days in spring 2021.

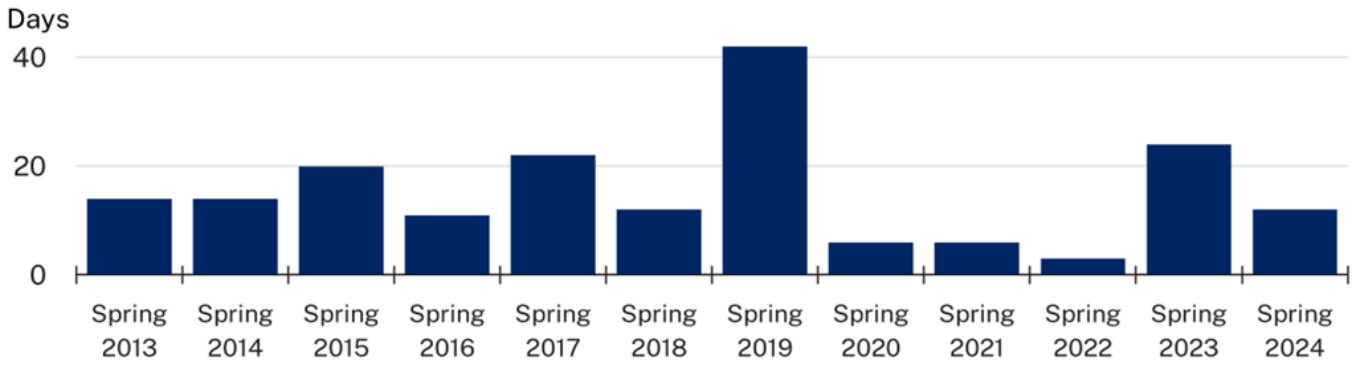

Figure 4 **Number of days above the PM10 daily benchmark in the Newcastle region spring 2013 to 2024**

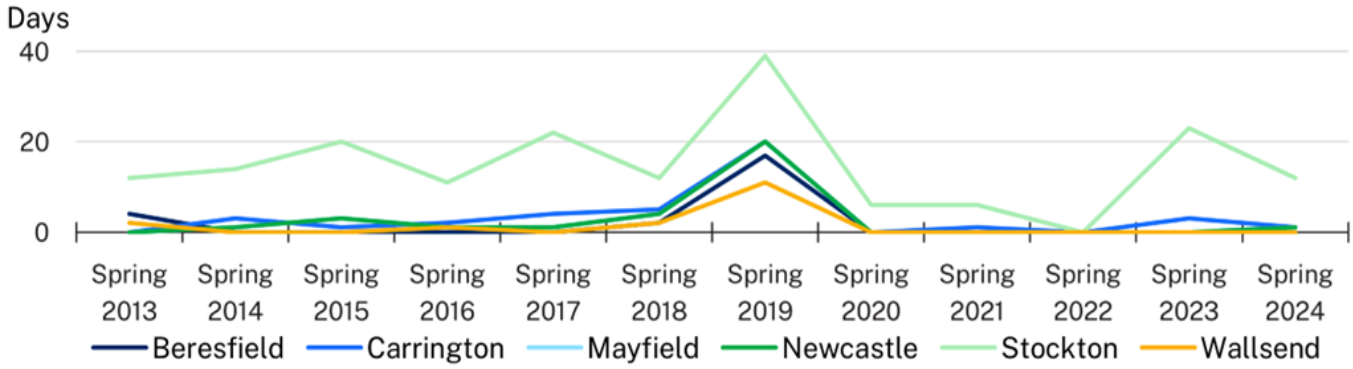

Figure 5 **Number of days above the PM10 daily benchmark at each station spring 2013 to 2024**

Note: There are no PM10 data for Carrington and Mayfield before August 2014. Stockton data before 14 October 2014 came from Orica[9]

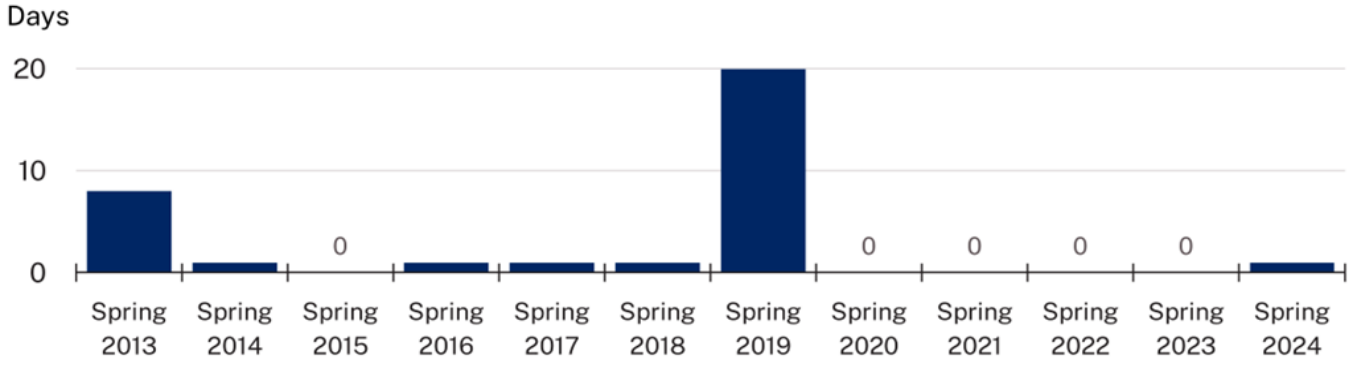

Figure 6 **Number of days above the PM2.5 daily benchmark in Newcastle region spring 2013 to 2024**

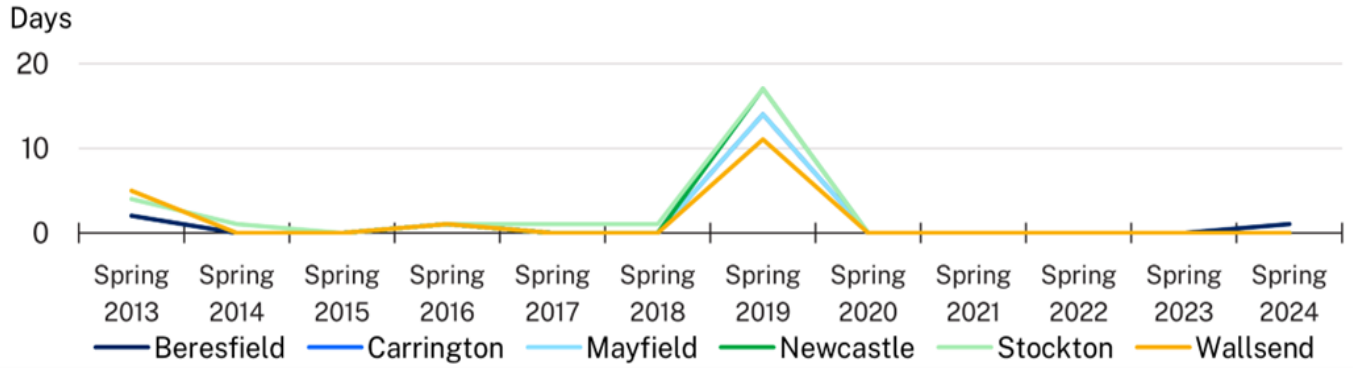

Figure 7 **Number of days above the PM2.5 daily benchmark at each station spring 2013 to 2024**

Note: there are no PM2.5 data for Carrington and Mayfield before August 2014, or Newcastle before December 2013. Data from Stockton before 14 October 2014 came from Orica[9].

Daily time series plots

Daily average time series plots for PM10 and PM2.5 and daily 1–hour maximum plots for NO_2, SO_2 and NH_3 are shown from Figure 8 to Figure 12 for spring 2024.

All parameters except PM10 and PM2.5 remained below the benchmarks and assessment criteria. Stockton exceeded the PM10 daily benchmark on 12 days and Mayfield and Carrington on one day. Beresfield PM2.5 exceeded on one day during the season. Stockton was predominantly affected by sea salt on these days due to onshore winds impacting the station, which is close to the Tasman Sea. See Stockton section for further details.

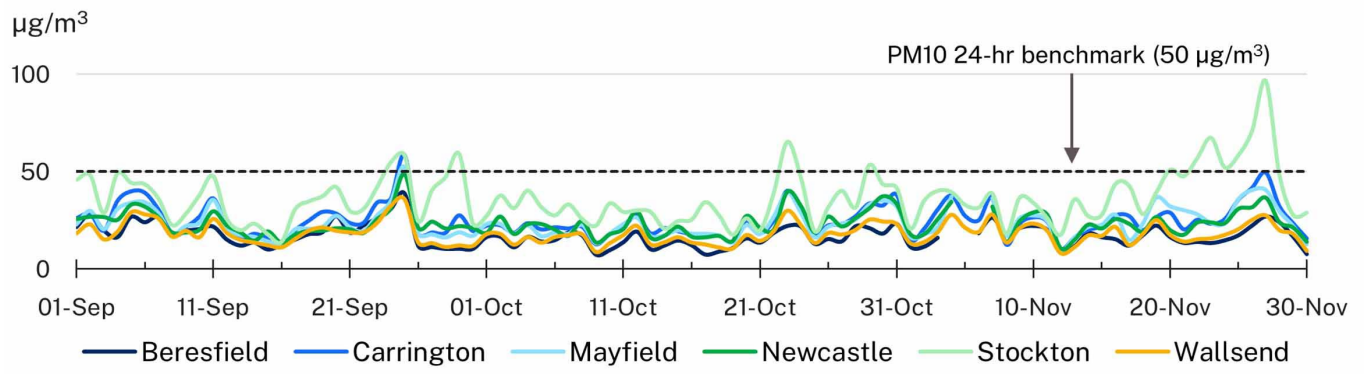

Figure 8 **Daily PM10 averages during spring 2024[10]**

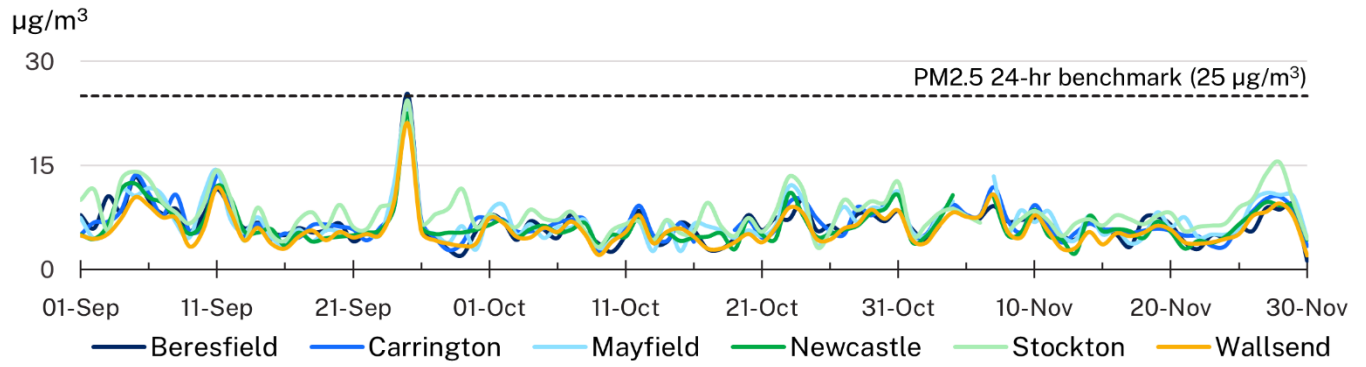

Figure 9 **Daily PM2.5 averages during spring 2024[10]**

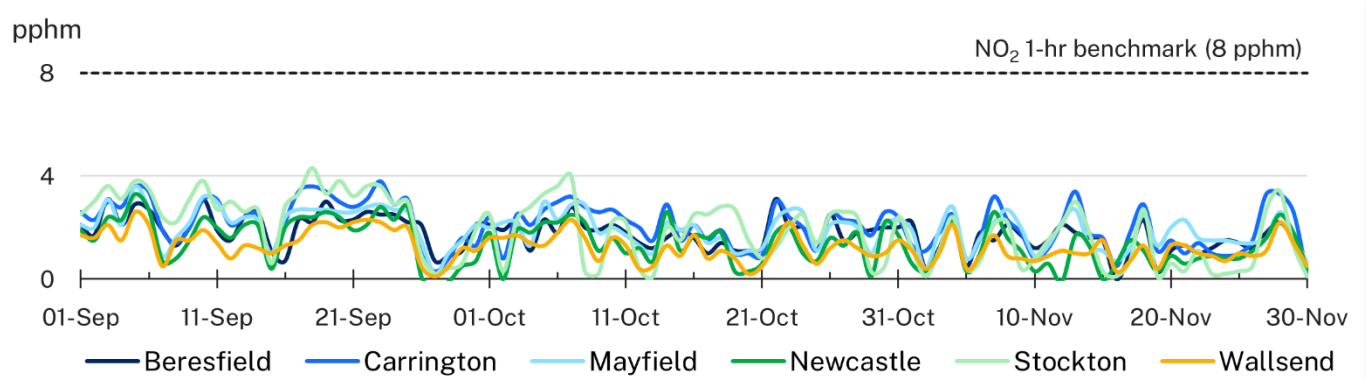

Figure 10 **Daily maximum 1-hr NO_2 during spring 2024[10]**

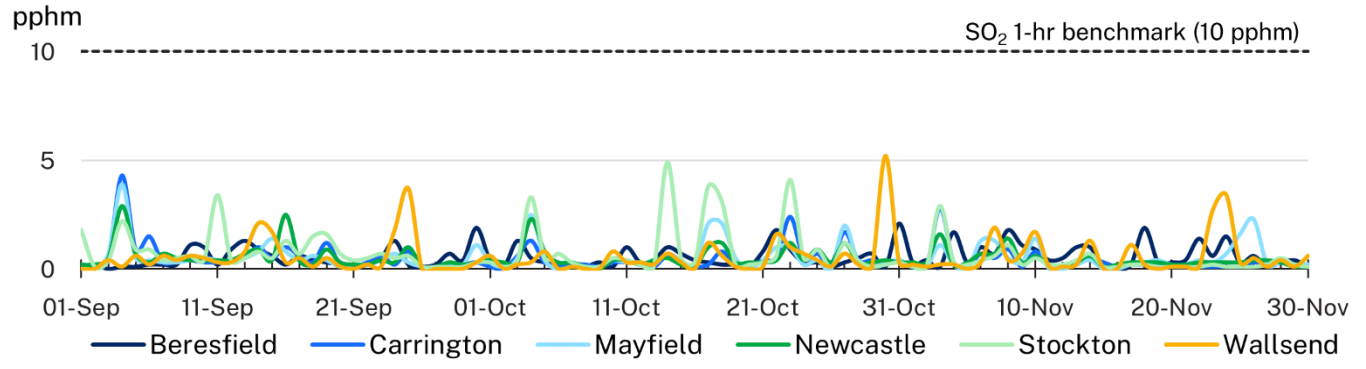

Figure 11 **Daily maximum 1-hr SO_2 during spring 2024[10]**

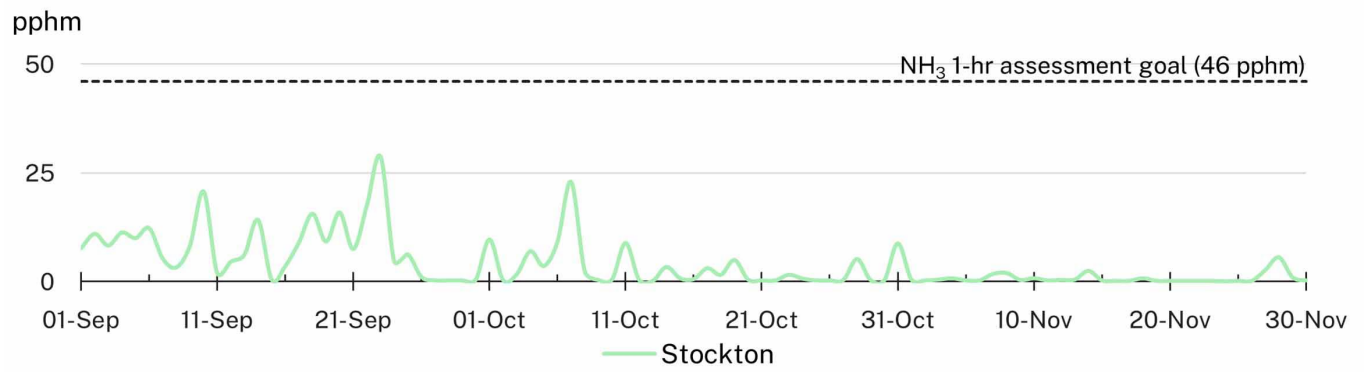

Figure 12 **Daily maximum 1-hr NH_3 during spring 2024**[10]

Pollution roses from hourly particle data

The seasonal pollution rose map[11] for PM10 particles (Figure 13) shows that hourly PM10 levels were in the 'good' to 'fair' categories[12] (< 100 µg/m^3) for 97% of hours at Stockton, 99.9% of hours at Carrington, Mayfield and Newcastle, and 100% of hours at the other stations. Elevated PM10 at Stockton was predominantly recorded during onshore easterly winds (north-east to south-east), indicative of sea salt influence (see Stockton section).

Levels of PM2.5 particles generally remained low during the season, with 100% of hours at most stations in the 'good' to 'fair' categories, except for one hour at Beresfield (99.95%) (Figure 14).

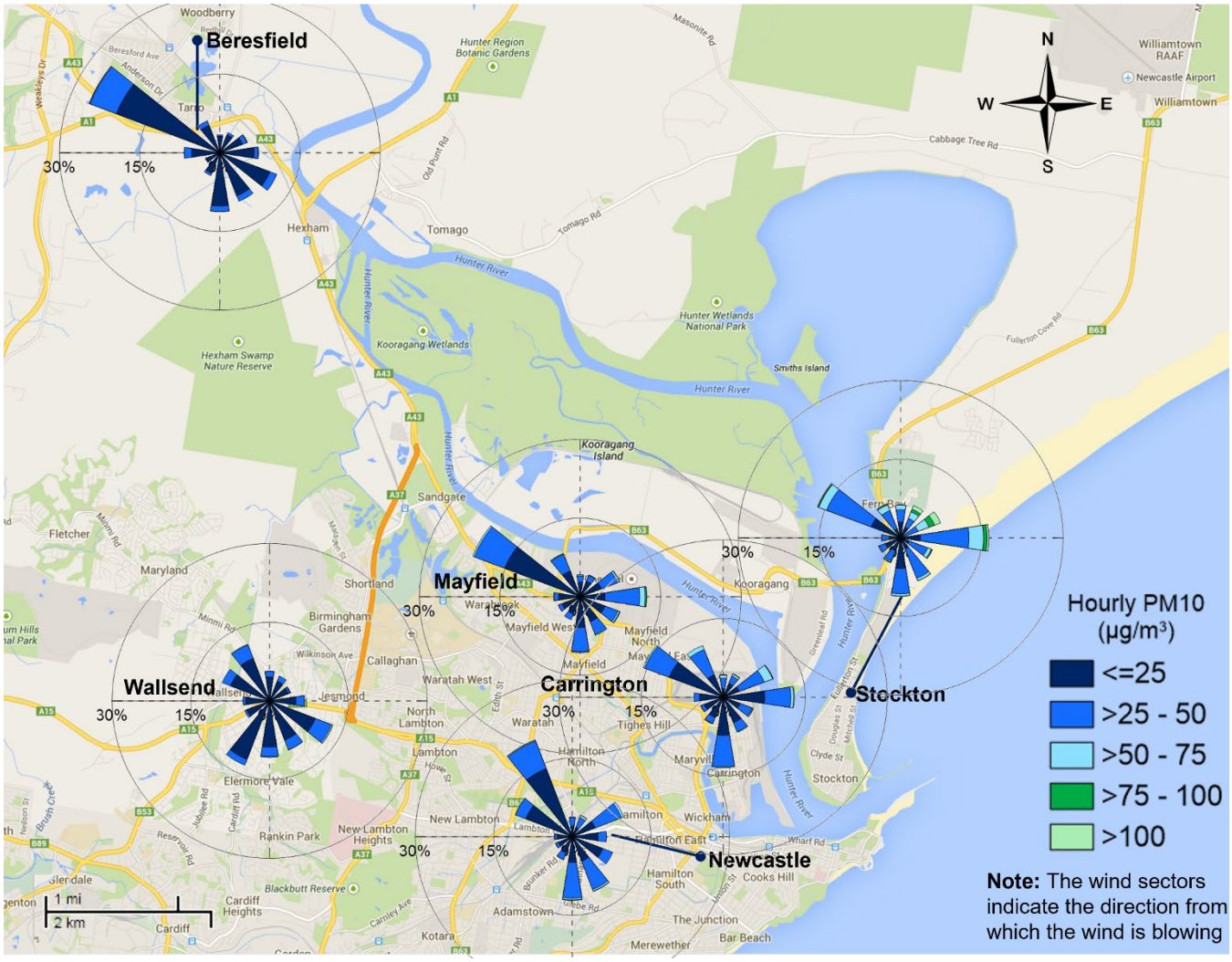

Figure 13 **Hourly PM10 pollution roses for the Newcastle region spring 2024**

Figure 14 **Hourly PM2.5 pollution roses for the Newcastle region spring 2024**

Particle air quality trends

Figure 15 and Figure 16 show the daily average PM10 during spring 2024, compared to the daily maximum and minimum PM10 levels (shaded range) from spring 2013 to 2023, at Stockton and Newcastle. Daily PM10 levels were generally within the historical range throughout the season. Exceptions include peaks in late September, October and November when sea salt is carried by onshore breezes.

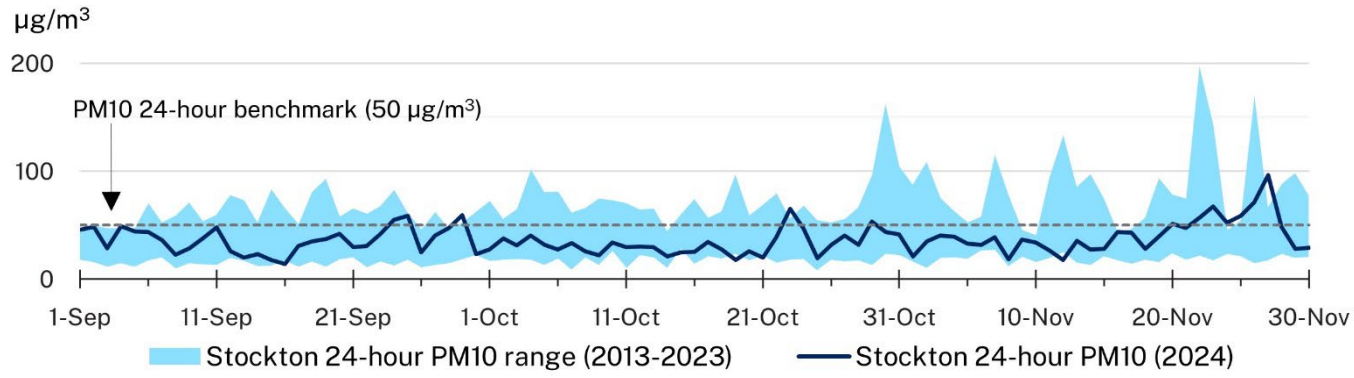

Figure 15 **Stockton daily average PM10 during spring 2024 plotted against the daily maximum and minimum PM10 levels from 2013 to 2023**

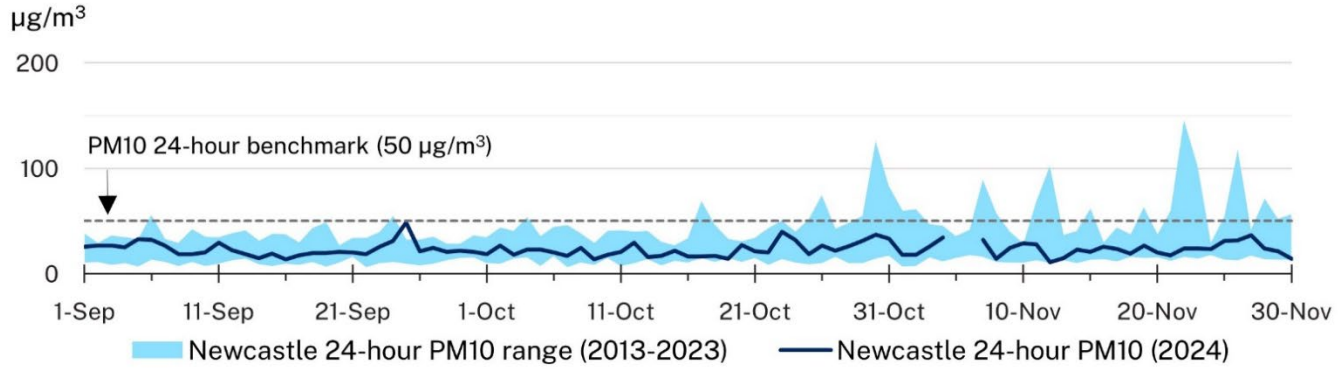

Figure 16 **Newcastle daily average PM10 during spring 2024 plotted against the daily maximum and minimum PM10 levels from 2013 to 2023** [10]

Rainfall in Newcastle was generally average during spring 2024 (Figure 17), with average rainfall across all 3 months.

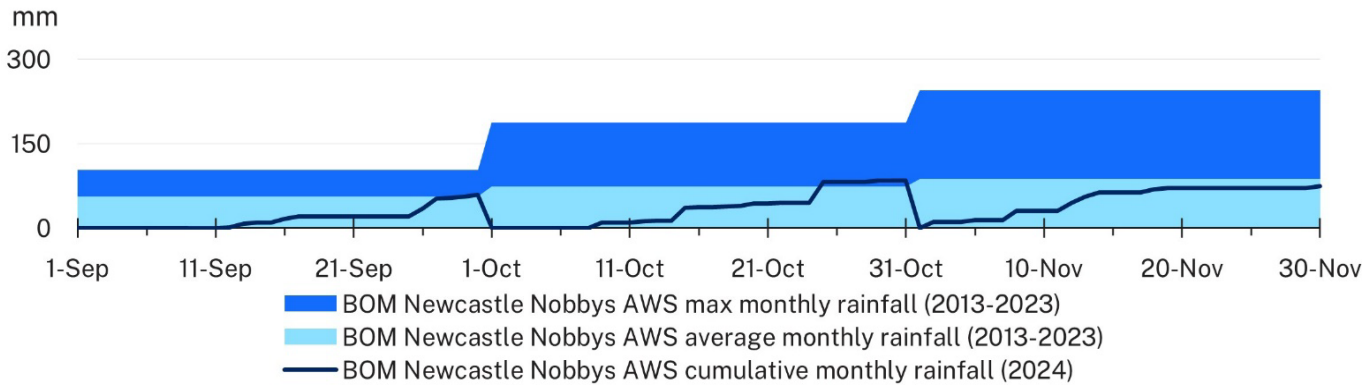

Figure 17 **Bureau of Meteorology (BoM) Newcastle Nobbys Signal Station automatic weather station (AWS)[13] cumulative rainfall during spring 2024 plotted against maximum and average rainfall from 2013 to 2023**

Figure 18 and Figure 19 show daily average PM2.5 during spring 2024, compared to the daily maximum and minimum PM2.5 levels (shaded range) from 2014 to 2022, at Stockton and Newcastle. Daily PM2.5 levels were generally within the historical range throughout the season except on 25 September, due to hazard reduction burning.

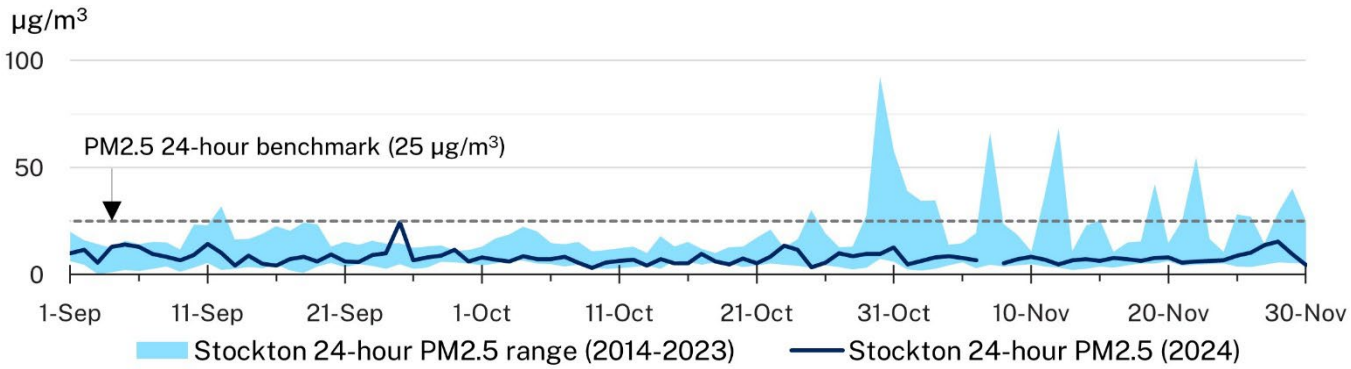

Figure 18 **Stockton daily average PM2.5 during spring 2024 plotted against the daily maximum and minimum PM10 levels from 2013 to 2023**[10]

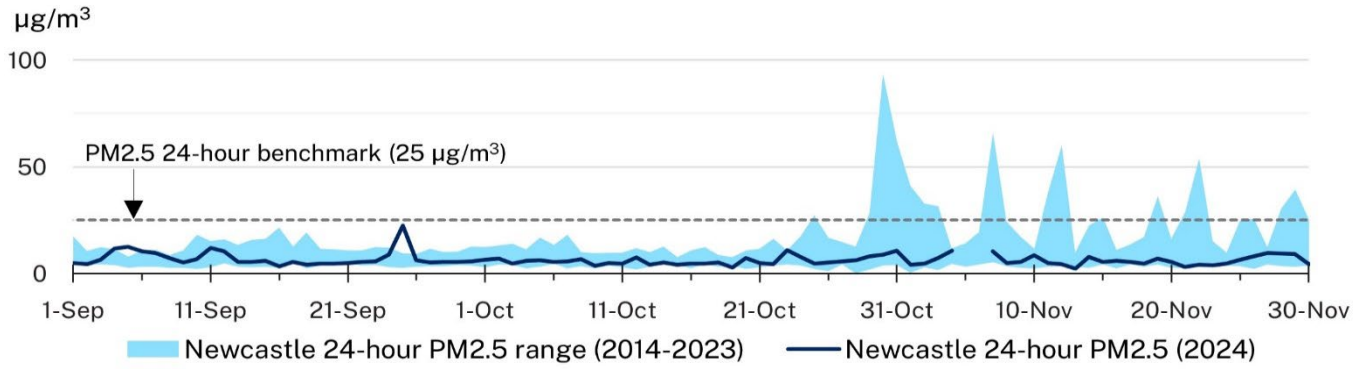

Figure 19 **Newcastle daily average PM2.5 during spring 2024 plotted against the daily maximum and minimum PM10 levels from 2013 to 2023**[10]

Meteorological summary

Rainfall and temperature[14]

The Newcastle region experienced average rainfall during spring 2024 compared to long-term records (Figure 20). Spring 2024 had the most rain in the last 3 years, with 217 mm of rainfall. In comparison, spring 2022 had 181 mm, and spring 2023 had 176 mm.

The Newcastle region had higher-than-usual temperatures this season, with both daytime highs (Figure 21) and very high nighttime lows[14] (not shown).

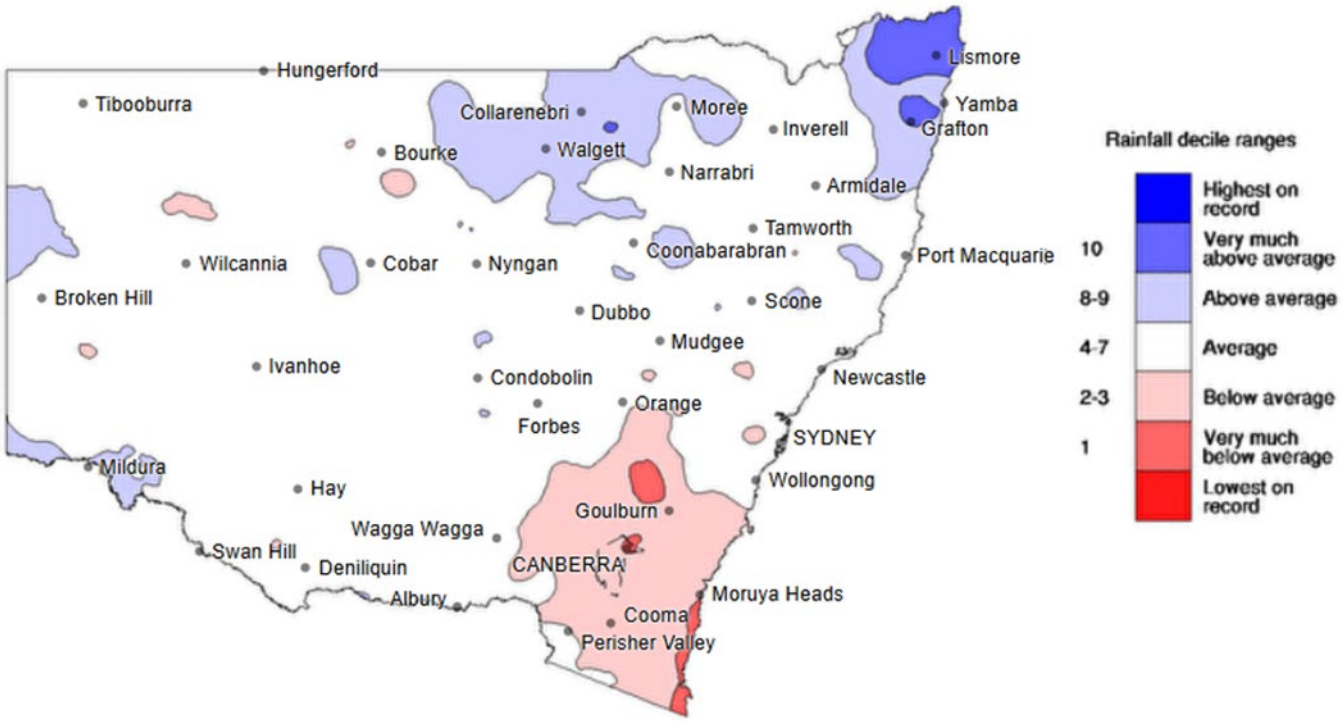

Figure 20 **NSW rainfall deciles spring 2024**[14]

Credit: ©Commonwealth of Australia 2024, Bureau of Meteorology. Base period: 1900-Nov 2024. Dataset: AGCD v2. Issued 20/05/2025

Figure 21 NSW maximum temperature deciles spring 2024[14]

Credit: ©Commonwealth of Australia 2024, Bureau of Meteorology. ID code: AWAP. Issued 28/05/2025

Winds

Figure 22 shows the wind direction and speed at each monitoring station during spring 2024[15]. Winds across the region were variable, with a prevailing north-westerly tendency. This pattern is characteristic of the transitional period between seasons, during which the dominant flow gradually shifts from north-westerly in winter to south-easterly in summer.

North-west winds prevailed 16% of the time at Stockton, with these moderate or stronger (above 5 metres per second) 51% of the time during the season.

Figure 22 **Wind rose map for the Newcastle region spring 2024**

Stockton

The Stockton monitoring station recorded 12 days over the PM10 daily benchmark during spring 2024. This is down from 23 days in spring 2023, a decrease of 11 days. From 2013 to 2024, Stockton recorded from 3 days (spring 2022) up to 39 days (spring 2019) over the PM10 daily benchmark (Figure 5).

In spring 2024, Stockton recorded 62 hours (3%) when hourly PM10 levels were elevated (>100 µg/m^3)[9]. These occurred under onshore north-easterly to south-easterly winds 89% of the time (55 hours) (Figure 23). There were 6 hours with elevated hourly PM10 under north-westerly winds, likely from local sources.

Elevated PM10 levels under predominant onshore winds at Stockton indicate the likely contribution of sea salt. The Lower Hunter Particle Characterisation Study[5] found sea salt was a major contributor of particles at the station under onshore winds.

Figure 23 Stockton pollution rose for hourly PM10 levels >75 µg/m^3 spring 2024

The Stockton monitoring station did not record any days over the PM2.5 daily benchmark during spring 2024. From 2013 to 2023, the number of days with PM2.5 levels above the daily benchmark ranged from zero days (spring 2015, 2020–2023) to 17 days (spring 2019) (Figure 7).

There were no elevated hourly PM2.5 levels (>50 µg/m^3)[12] at Stockton during spring 2024 (pollution rose not shown).

There were no days with elevated NH_3 during spring 2024 (pollution rose not shown).

Network performance

The target network performance is at least 95% available data. Due to daily calibrations for the gaseous parameters NO_2, SO_2 and NH_3, the maximum online time that can be attained is 96%. The reduced online times were due to instrument faults and scheduled maintenance (Table 2).

Table 2 Network performance (%) during spring 2024

Station	Particles daily PM10	Particles daily PM2.5	Gases hourly SO_2	Gases hourly NO_2	Gases hourly NH_3	Meteorology hourly
Beresfield	98	98	94	93	–	100
Carrington	98	98	95	94	–	100
Mayfield	98	98	95	93	–	98
Newcastle	98	98	95	89	–	100
Stockton	100	99	94	95	95	100
Wallsend	100	100	95	95	–	100

= not monitored

The overall reduced online times (Newcastle NO_2) were mainly due to scheduled maintenance and a faulty gas diluter.

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Appendix A: Annual averages

Table 3 **PM10 annual averages (µg/m^3)**

Station	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Beresfield	18.8	19.1	19.6	21.6	25.9	18.5	15.9	14.3	17.8	16.9
Carrington	22.8	23.6	24.4	27.3	31.0	24.2	21.0	19.3	22.6	22.5
Mayfield	21.7	22.6	24.2	26.9	30.8	23.0	19.8	17.7	21.6	21.8
Newcastle	21.4	21.6	22.4	24.5	28.4	22.4	19.2	17.5	20.1	21.0
Stockton	35.8	35.1	36.4	38.7	43.6	34.5	30.1	30.3	34.2	32.9
Wallsend	16.7	16.6	17.4	19.4	22.9	17.7	14.7	12.7	16.1	16.4

Table 4 **PM2.5 annual averages (µg/m^3)**

Station	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Beresfield	7.3	7.4	7.6	8.7	12.1	7.7	5.9	5.0	6.7	6.5
Carrington	8.1	8.5	8.6	8.2	11.0	8.0	6.5	5.8	6.9	6.7
Mayfield	7.4	7.4	7.5	8.3	11.2	7.6	6.1	5.3	6.9	6.6
Newcastle	7.8	7.8	7.4	7.8	10.9	na	6.3	5.5	6.7	6.4
Stockton	9.5	9.7	9.8	10.0	13.0	9.3	8.3	7.5	9.3	8.4
Wallsend	7.3	8.0	7.3	7.5	10.4	7.3	6.1	5.1	6.1	5.9

na = annual average unavailable due to insufficient data availability

[1] 'Newcastle region' includes the 3 Lower Hunter air quality region stations (Beresfield, Newcastle, Wallsend), and 3 stations in the Newcastle Local air quality region (Carrington, Mayfield, Stockton) located nearby the Port of Newcastle.

[2] Air quality categories.

[3] The national benchmarks can be found at National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) standards. There are no hourly standards for PM10 or PM2.5, nor is there a NEPM standard for ammonia (NH_3). A 1-hour assessment goal of 46 pphm is used for ammonia (NSW EPA 2022). Data from Stockton, Mayfield and Carrington are presented for comparison purposes and not for the purposes of assessing compliance against the AAQ NEPM and relevant assessment goal.

[4] PM2.5 and PM10 refer to airborne particles, less than or equal to 2.5 and 10 micrometres in diameter respectively, measured in micrograms per cubic metre ($\mu g/m^3$). NO_2 refers to nitrogen dioxide, O_3 refers to ozone, SO_2 refers to sulfur dioxide and NH_3 refers to ammonia, all of which are measured in parts per hundred million by volume, or parts of pollutant per hundred million parts of air (pphm).

[5] Lower Hunter Particle Characterisation Study found sea salt contributes significantly to PM10 levels at Stockton station during the warmer months.

[6] Sourced from Department of Primary Industries and Regional Development NSW State seasonal update – November 2024 (accessed January 2025).

[7] Sourced from Department of Primary Industries and Regional Development NSW State seasonal update – November 2023 (accessed January 2024).

[8] Sourced from Department of Primary Industries and Regional Development NSW State seasonal update – November 2022 (accessed February 2023).

[9] Monitoring at Stockton began in October 2012 and at Mayfield and Carrington in August 2014. Monitoring of PM2.5 at Newcastle began 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.

[10] Data gaps at Newcastle region stations this season were predominantly due to data logger and power issues, on top of maintenance checks.

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

[12] There are no national standards for hourly PM10 or PM2.5 in the National Environment Protection (Ambient Air Quality) Measure (Air NEPM). The Department of Climate Change, Energy, the Environment and Water defines air quality categories for web reporting purposes.

[13] Data from Bureau of Meteorology Newcastle Nobbys Signal Station AWS monthly rainfall page (accessed January 2025).

[14] Rainfall and temperature information is from the Bureau of Meteorology New South Wales spring 2024 climate statement (accessed November 2024) and climate maps (accessed November 2024).

[15] 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.