Air Quality Monitoring Network

Newcastle winter 2024

Air quality in the Newcastle region[1] was good[2] throughout winter 2024.

- Daily average levels of PM10[3] and PM2.5 remained below the 50 µg/m^3 and 25 µg/m^3 benchmarks at all stations[4].
- Levels of nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and ammonia (NH_3) remained below national benchmarks and assessment goals.
- Hourly particle levels were in the 'good' to 'fair' air quality categories for 99.6% of hours at Stockton, 99.9% at Carrington, and 100% at Beresfield, Mayfield, Newcastle and Wallsend.
- The region recorded average rainfall and above-average maximum temperatures during the season.

Annual air quality trends

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

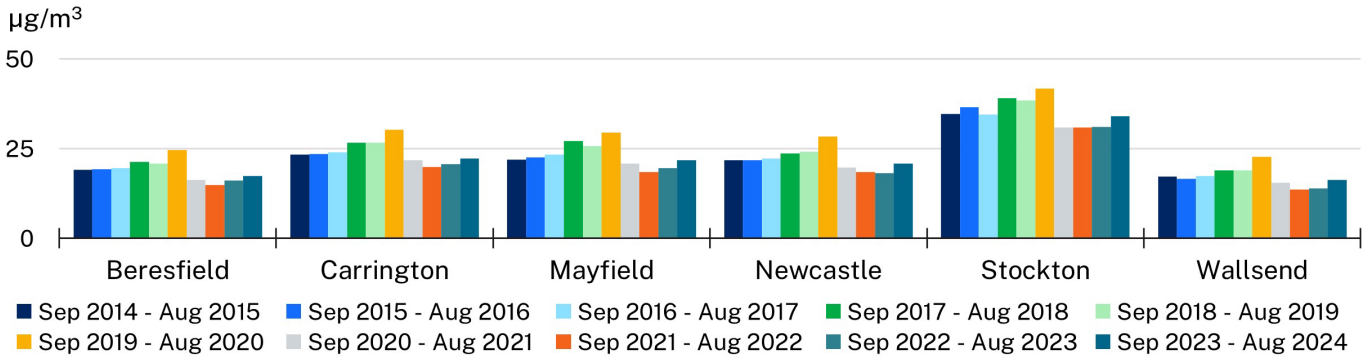

Figure 1 Rolling annual averages[5] to the end of winters 2015 to 2024 for PM10

Note: data in this figure are listed in Table 3, Appendix A: Rolling annual averages

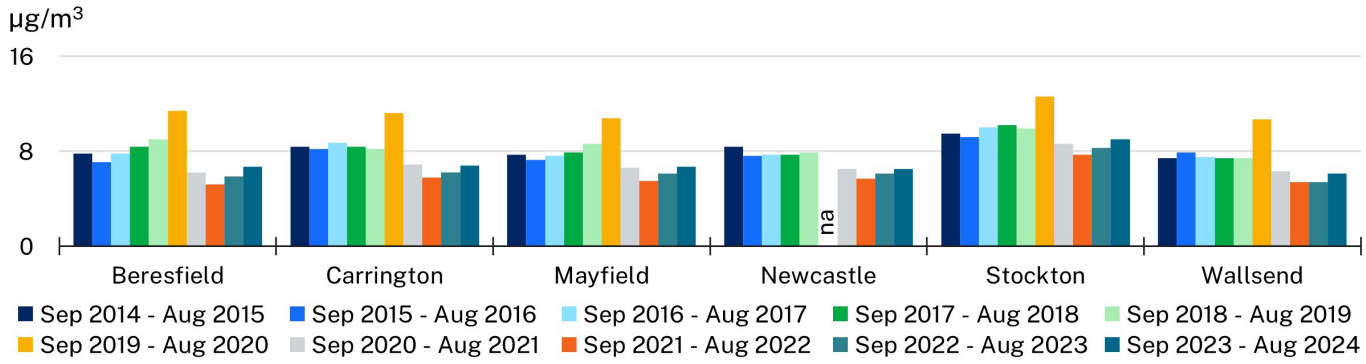

Figure 2 Rolling annual averages[5] to the end of winters 2015 to 2024 for PM2.5

na = rolling annual average unavailable due to insufficient data availability

Note: data in this figure are listed in Table 4, Appendix A: Rolling annual averages

The PM10 and PM2.5 rolling annual averages for the 12-month period from September 2023 to August 2024 are shown in Figure 1 and Figure 2. These show that particle levels increased at all stations during the 12-month period to the end of winter 2024, when compared to the previous 12 months. Despite the increase at the end of winter 2024, the PM10 and PM2.5 rolling annual averages remained below the benchmark at all stations except Stockton.

The higher PM10 and PM2.5 annual averages at Stockton were consistent with the Lower Hunter Particle Characterisation Study[6]. This study found PM10 levels at Stockton were 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).

At the end of winter 2024, approximately 12% of New South Wales was in a drought category[7], including the Hunter Region (Figure 3), compared to 9% at the end of winter 2023[8] and 7% at the end of winter 2022[9].

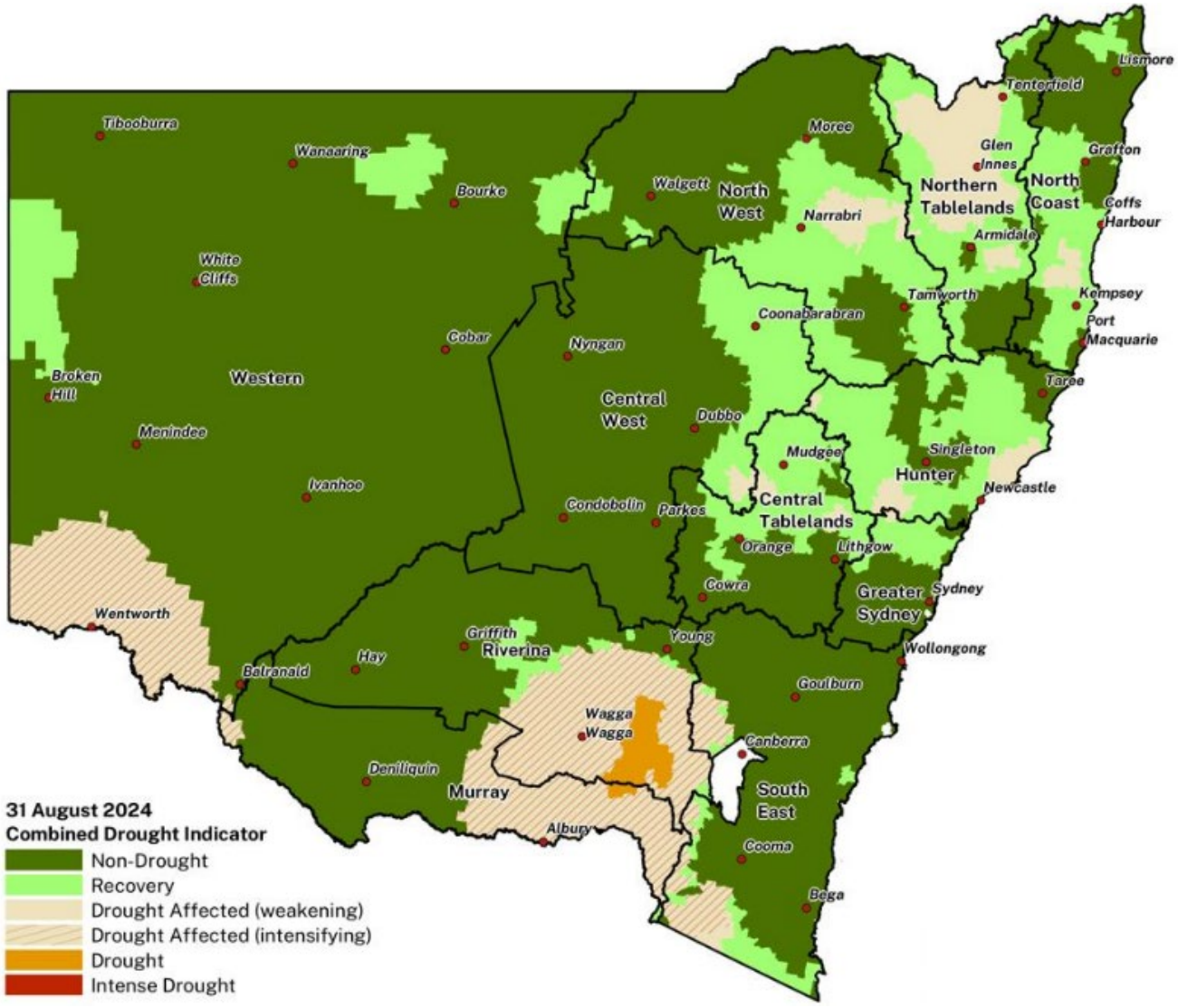

Figure 3 NSW combined drought indicator map for the 12 months to 31 August 2024[7]

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

Days above benchmark concentrations

Concentrations of PM10 particles, PM2.5 particles, SO_2, NO_2 and NH_3 were below benchmark at all stations (Table 1) during the season.

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

Station	PM10 daily [50 µg/m^3 benchmark]	PM2.5 daily [25 µg/m^3 benchmark]	SO_2 hourly [10 pphm benchmark][3]	SO_2 daily [2 pphm benchmark][3]	NO_2 hourly [8 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	0	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 winter 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 winter during the past 10 years.

Figure 4 to Figure 7 compare particle trends in winter 2024 with previous winter seasons where data were available[10].

In winter 2024, the region had no days over the PM10 daily benchmark (Figure 4). This is less than the previous year (winter 2023), which had 2 days over the benchmark, and equal to winter 2022. From 2013 to 2020, the region had between zero days (winters of 2013, 2014, 2016, and 2017) and 8 days (winter of 2018) where the PM10 levels were above the daily limit.

Figure 5 shows that historically, the highest number of days over the PM10 daily benchmark were recorded during winter 2018, with 8 days at Stockton and 3 days at all remaining stations except Wallsend (zero days). While Stockton station was influenced by sea salt due to its proximity to the coast, the wider region was affected during winter 2018 by the long-range transport of dust from severely drought-affected areas.

There were no days over the PM2.5 daily benchmark during winter 2024, same as the previous 2 winter seasons (Figure 6). Historically, the region recorded only 4 winter seasons with days over the PM2.5 daily benchmark; the peak number of days were recorded in winter 2015 (5 days), with the highest number of days at Stockton (Figure 7).

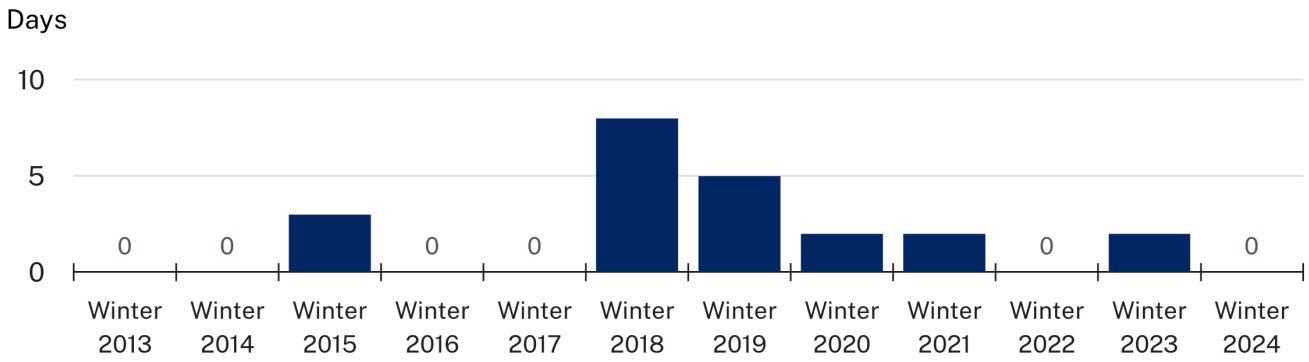

Figure 4 **Number of days above the PM10 daily benchmark in the Newcastle region: winter 2013 to 2024**

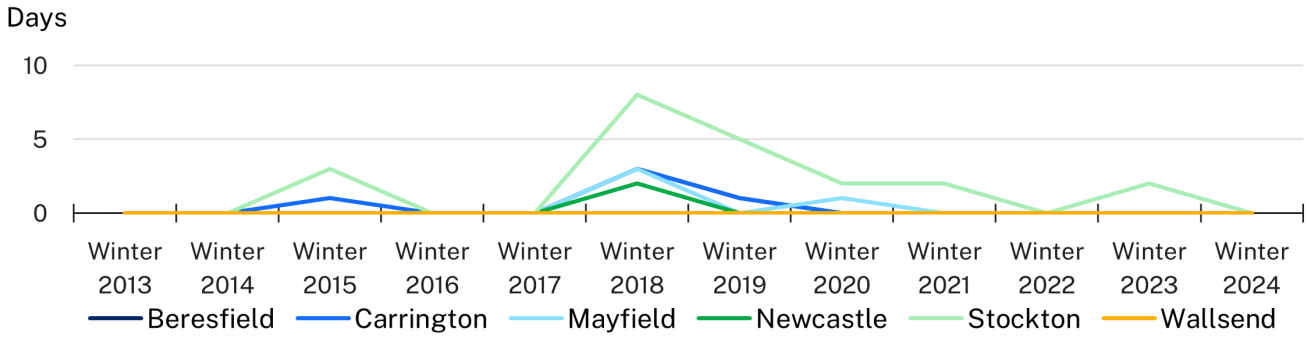

Figure 5 **Number of days above the PM10 daily benchmark at each station: winter 2013 to 2024**

Note: There are no PM10 data for Carrington and Mayfield before August 2014. Stockton data before 14 October 2014 came from Orica[10]

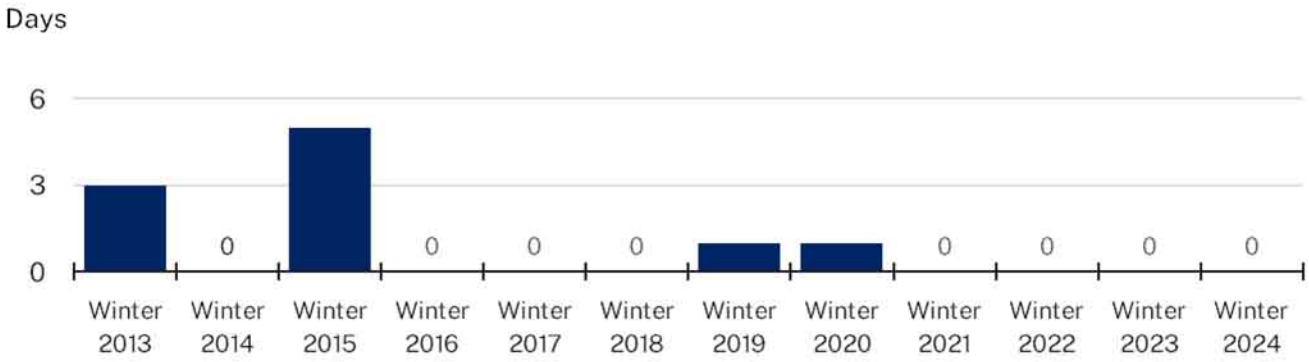

Figure 6 **Number of days above the PM2.5 daily benchmark in the Newcastle region: winter 2013 to 2024**

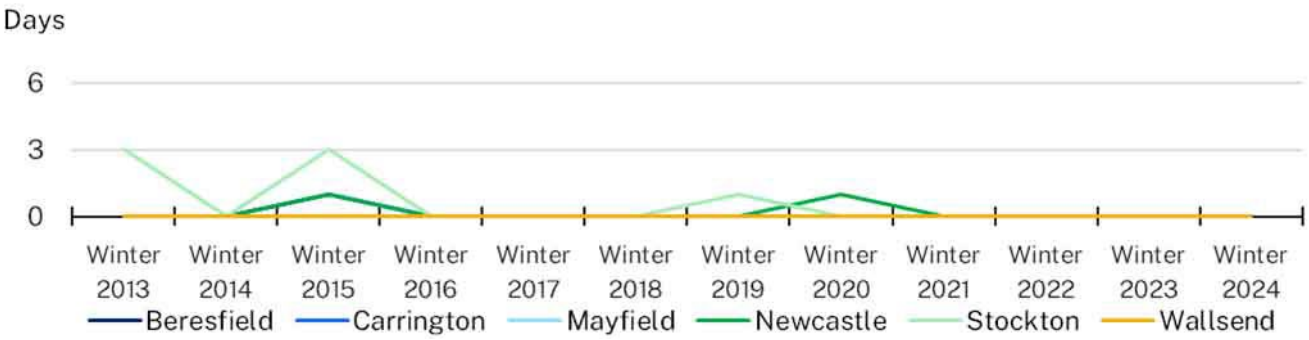

Figure 7 **Number of days above the PM2.5 daily benchmark at each station: winter 2013 to 2024**

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[10]

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 in Figure 8 to Figure 12 for winter 2024. All parameters remained below the benchmarks and assessment criteria.

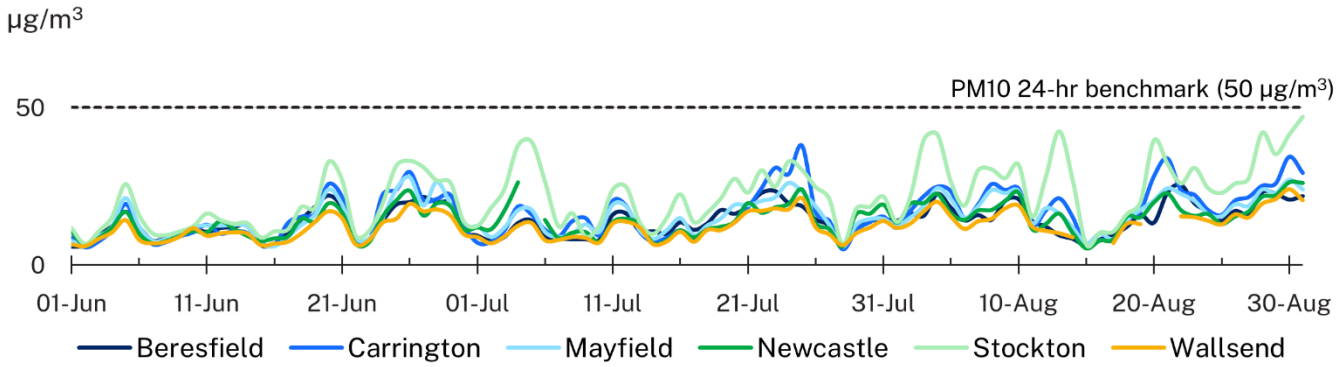

Figure 8 **Daily PM10 averages during winter 2024**[11]

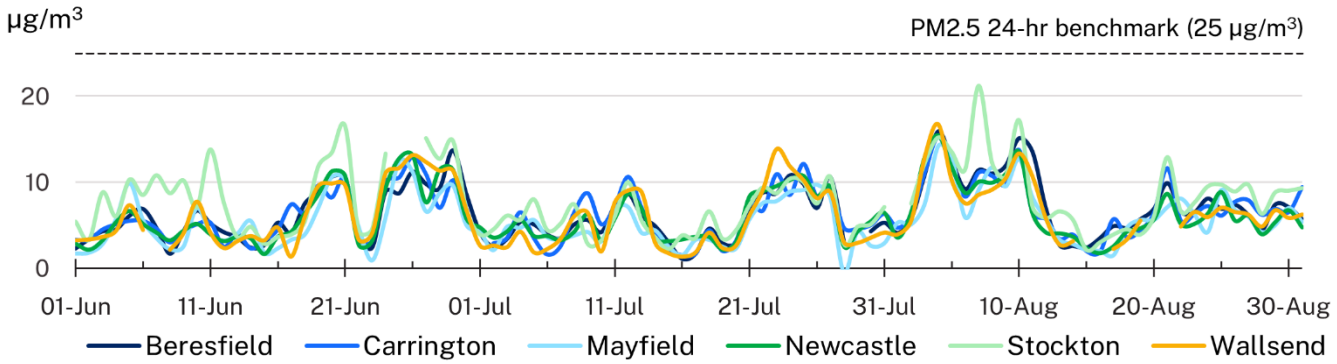

Figure 9 **Daily PM2.5 averages during winter 2024**[11]

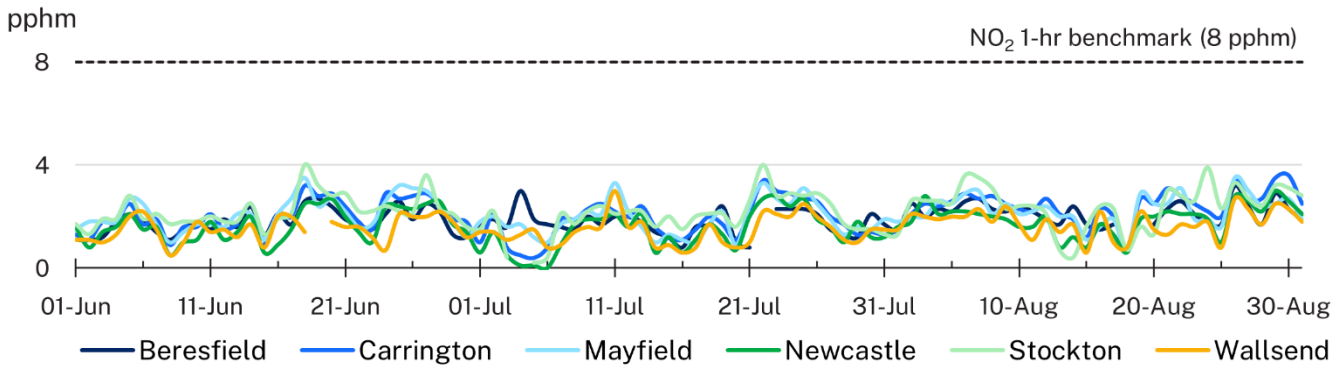

Figure 10 **Daily maximum 1-hr NO_2 during winter 2024**[11]

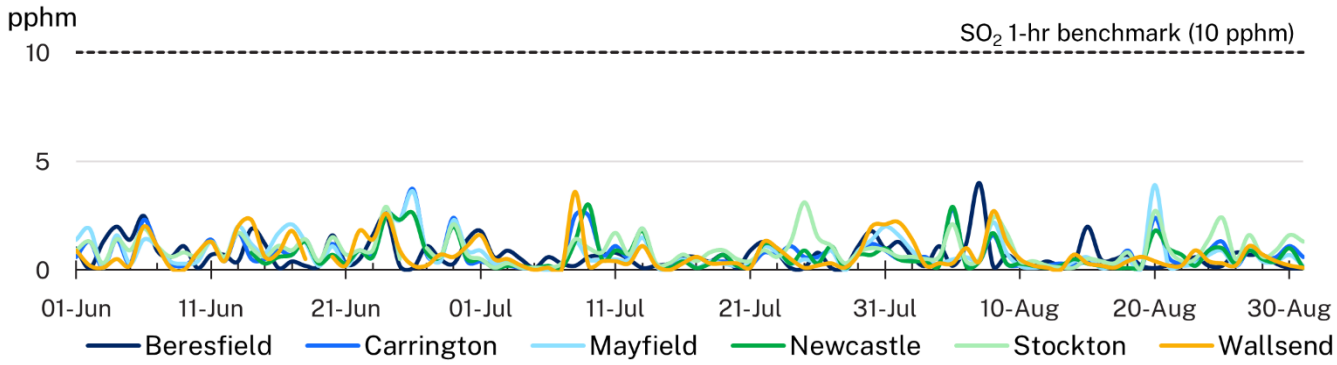

Figure 11 **Daily maximum 1-hr SO_2 during winter 2024**[11]

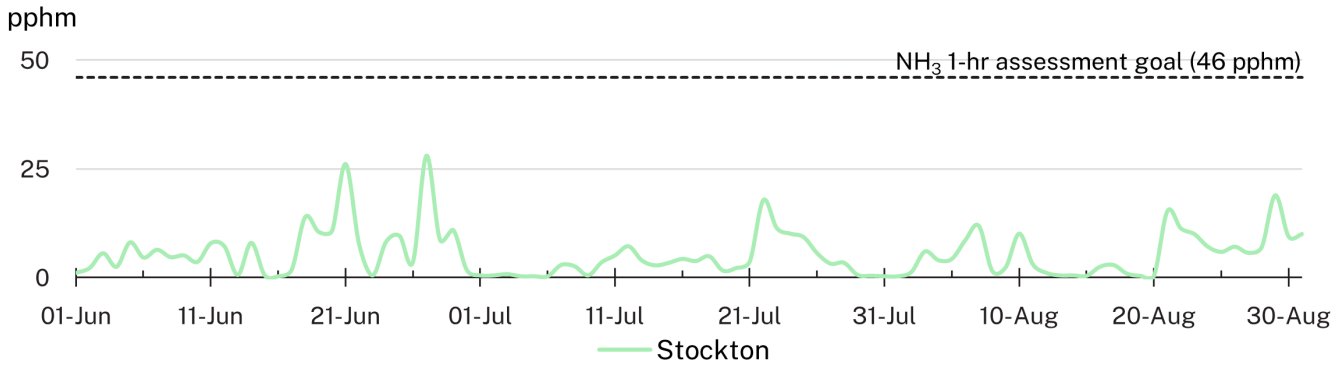

Figure 12 **Daily maximum 1-hr NH_3 during winter 2024**[11]

Pollution roses from hourly particle data

The seasonal pollution rose maps[12] (Figure 13 and Figure 14) show hourly PM10 and PM2.5 levels for the region's stations during winter 2024, and the associated wind directions when these concentrations were observed.

Hourly PM10 levels were in the 'good' to 'fair' categories (<100 µg/m^3) for 99.7% of hours at Stockton, 99.9% of hours at Carrington, and 100% of hours at all other stations (Figure 13).

Hourly PM2.5 levels were in the 'good' to 'fair' categories (<50 µg/m^3) at all stations 100% of the time. (Figure 14).

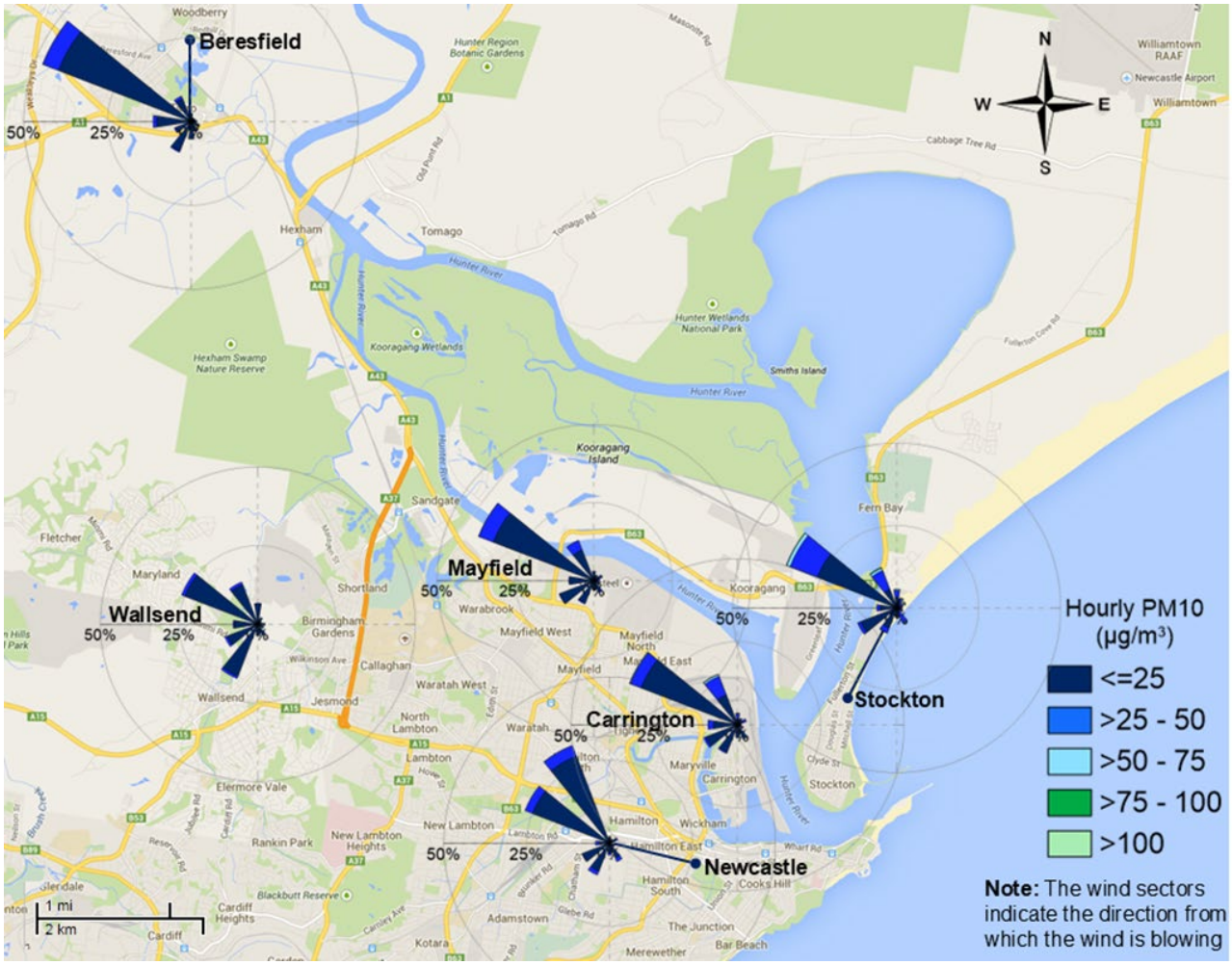

Figure 13 **Hourly PM10 pollution roses for the Newcastle region winter 2024**

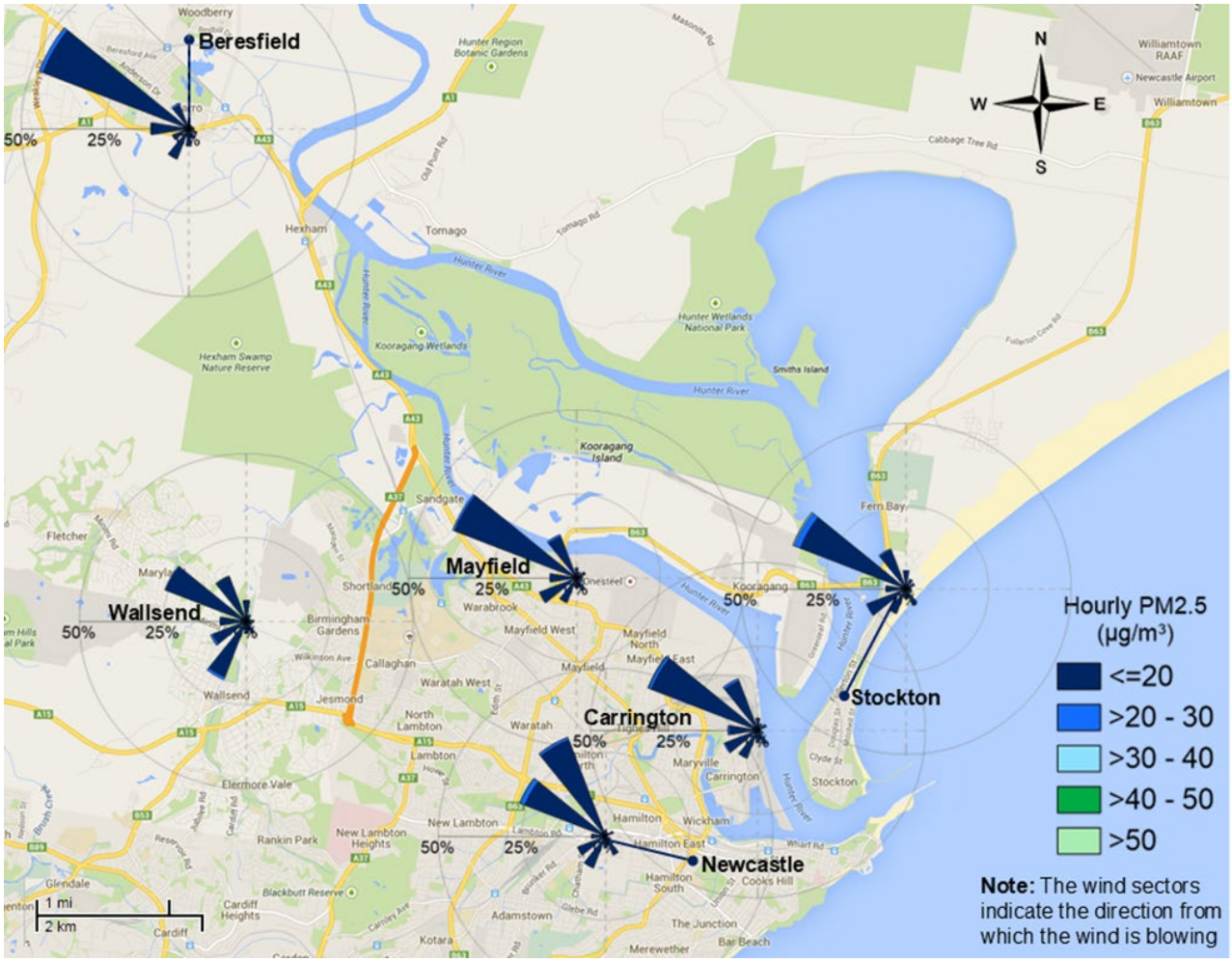

Figure 14 **Hourly PM2.5 pollution roses for the Newcastle region winter 2024**

Particle air quality trends

Figure 15 and Figure 16 show daily average PM10 during winter 2024, compared to the daily maximum and minimum PM10 levels (shaded range) from winter 2013 to 2023, at Stockton and Newcastle. Daily PM10 levels were generally within the historical range throughout the season. At Stockton, there were higher levels of sea salt in the air during June and July because of the onshore breezes.

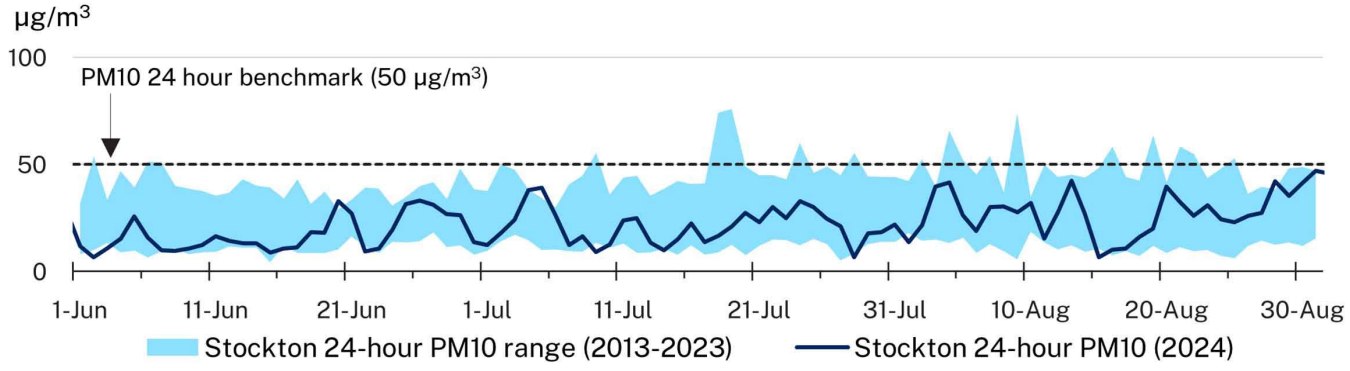

Figure 15 **Stockton daily average PM10 during winter 2024 plotted against the daily maximum and minimum PM10 levels from 2013 to 2023**

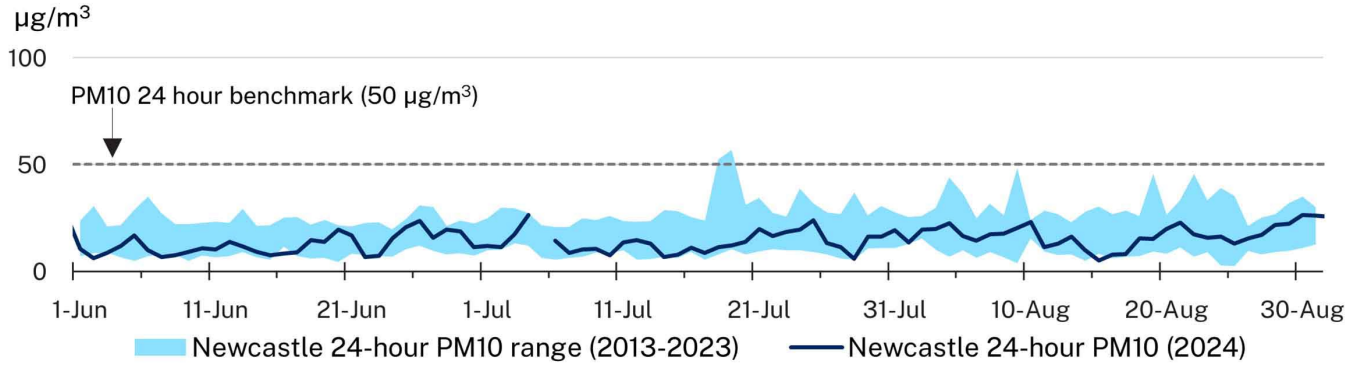

Figure 16 **Newcastle daily average PM10 during winter 2024 plotted against the daily maximum and minimum PM10 levels from 2013 to 2023**

Rainfall in Newcastle was generally average during winter (Figure 17), with above average levels in June and average levels in July and August.

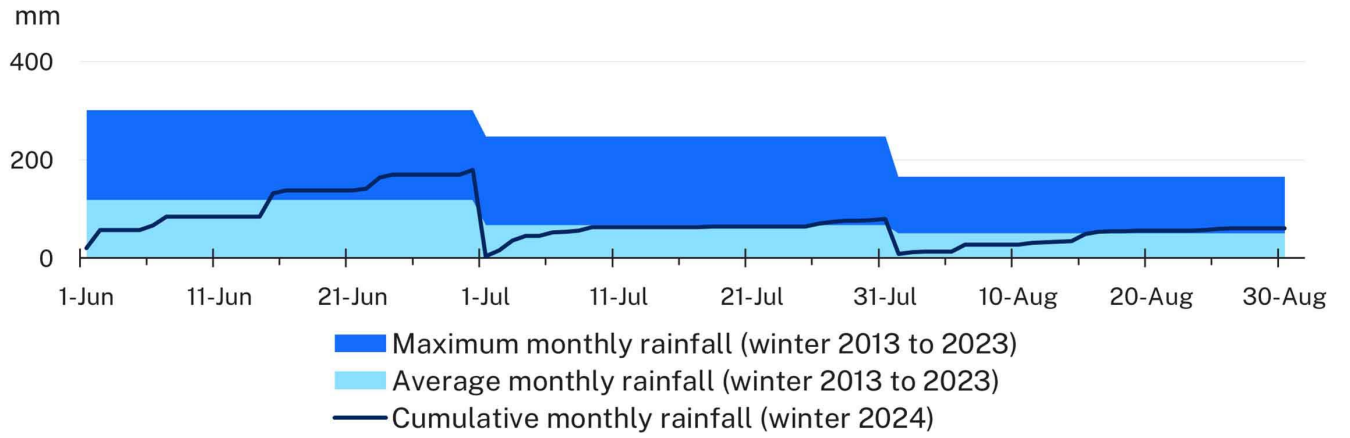

Figure 17 **Bureau of Meteorology Newcastle Nobbys Signal Station AWS[13] cumulative rainfall during winter 2024 plotted against maximum and average rainfall from 2013 to 2023**

Figure 18 and Figure 19 show daily average PM2.5 during winter 2024, compared to the daily maximum and minimum PM2.5 levels (shaded range) from 2013 to 2023, at Stockton and Newcastle.

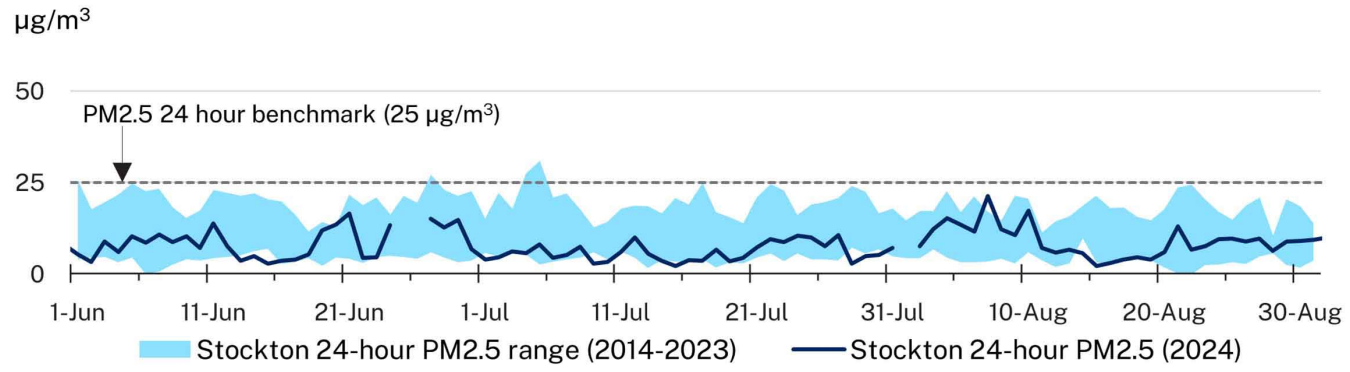

Figure 18 **Stockton daily average PM2.5 during winter 2024 plotted against the daily maximum and minimum PM10 levels from 2013 to 2023**

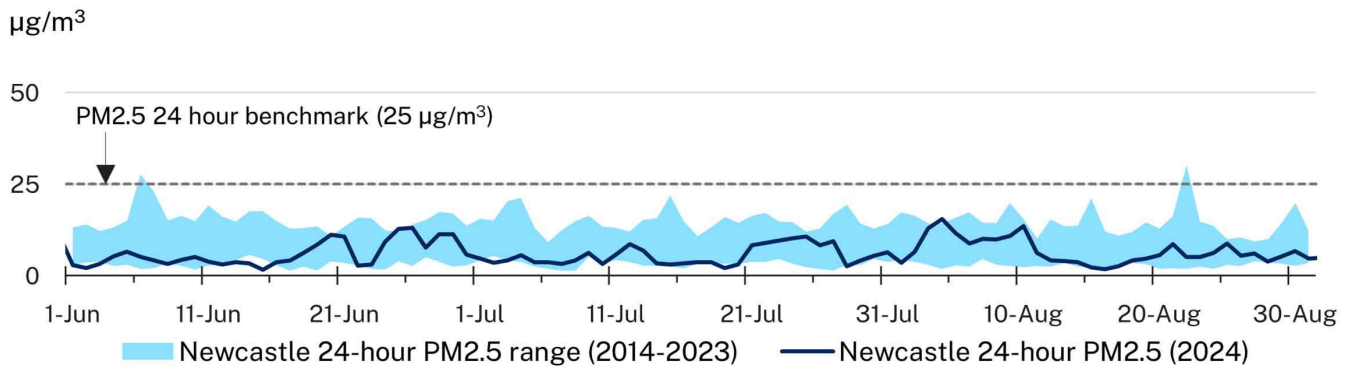

Figure 19 **Newcastle daily average PM2.5 during winter 2024 plotted against the daily maximum and minimum PM10 levels from 2013 to 2023**

Meteorological summary

Rainfall and temperature[14]

The Newcastle region experienced average rainfall during winter 2024 compared to long-term records (Figure 20). Monthly rainfall levels were average during the season.

Maximum temperatures in the region were above average and minimum temperatures were very much above average during the season (Figure 21).

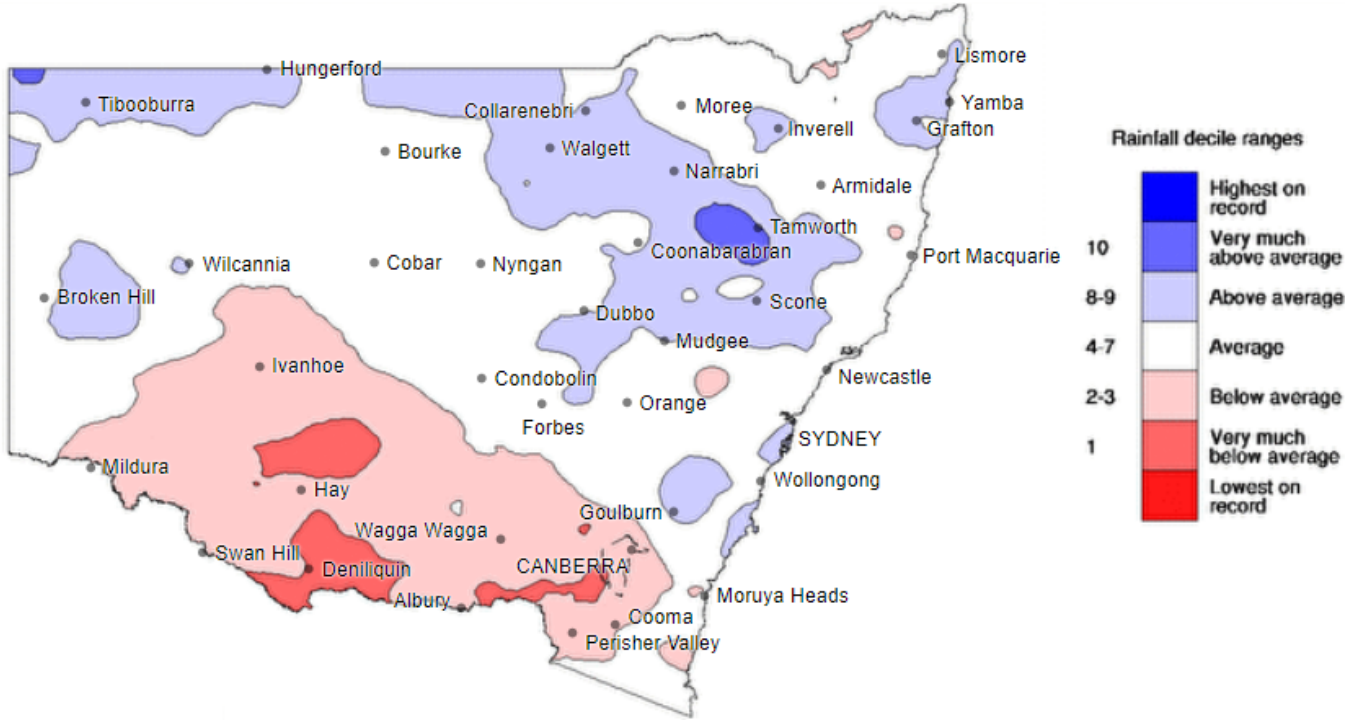

Figure 20 **NSW rainfall deciles winter 2024[14]**

Credit: ©Commonwealth of Australia 2024, Bureau of Meteorology. Base period: 1900-Nov 2023.
Dataset: AGCD v2. Issued 20/09/2024

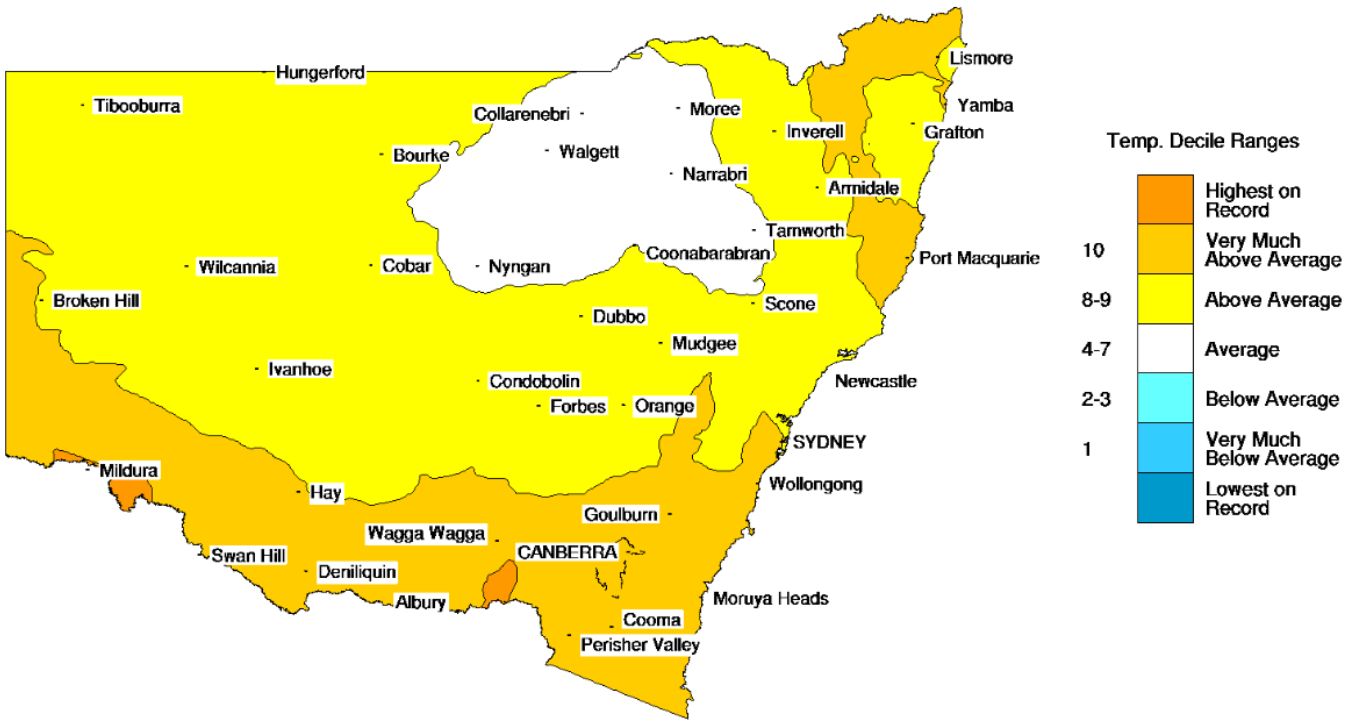

Figure 21 NSW maximum temperature deciles winter 2024[14]

Credit: ©Commonwealth of Australia 2024, Bureau of Meteorology. ID code: AWAP. Issued 29/05/2024

Winds

Figure 22 shows the wind direction and speed at each monitoring station during winter 2024[15]. Winds across the region were predominantly from the north-west across the region, as is typical for this time of year.

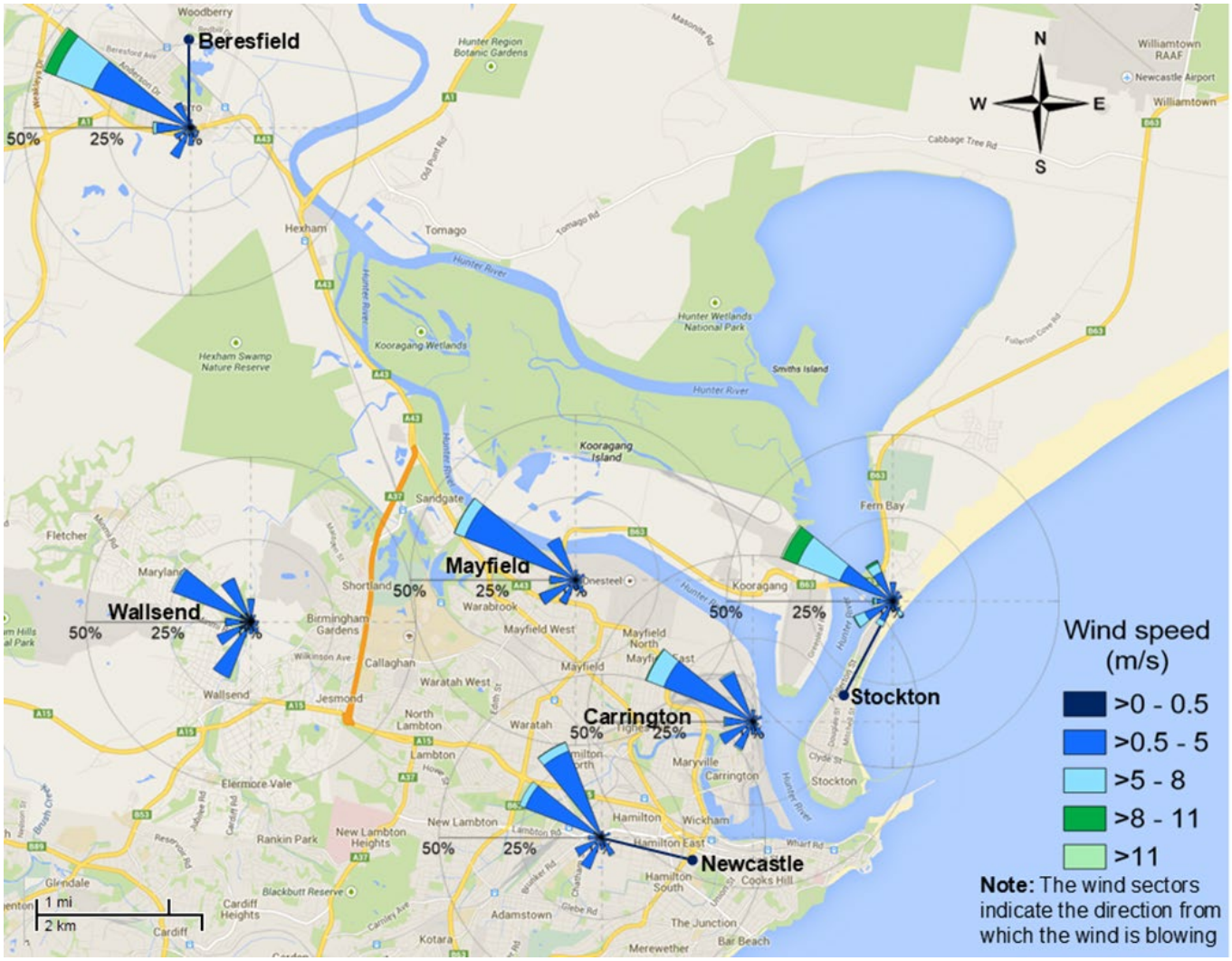

Figure 22 **Wind rose map for the Newcastle region winter 2024**[15]

Stockton

The Stockton monitoring station recorded no days over the PM10 daily benchmark during winter 2024. This is 2 days less than winter 2023. From 2013 to 2023, Stockton recorded between zero days (winters 2013, 2014, 2016, 2017, and 2022) up to 8 days (winter 2018) over the benchmark (Figure 5).

In winter 2024, elevated hourly PM10 levels (>100 µg/m^3) were recorded at Stockton 0.4% of the time (8 hours) (Figure 23). Seven of these hours occurred under onshore north-easterly winds.

Elevated PM10 levels under predominant onshore winds at Stockton indicate the likely contribution of sea salt. The Lower Hunter Particle Characterisation Study[6] 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/m³ winter 2024

The Stockton monitoring station did not record any days over the PM2.5 daily benchmark during winter 2024. From 2013 to 2023, there were 3 days over the PM2.5 daily benchmark in the winters 2013 and 2015 and one day in winter 2019 (Figure 7).

There were no elevated hourly PM2.5 levels (>50 µg/m³)[4] at Stockton in winter 2024 (Figure 24).

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

Figure 24 **Stockton pollution rose for hourly PM2.5 levels over 30 µg/m^3 winter 2024**

Ammonia at Stockton in autumn and winter 2024

There were no days over the hourly NH_3 assessment goal of 46 pphm at Stockton during autumn and winter 2024 (Figure 25).

Figure 25 shows the daily maximum 1-hour average NH_3 concentrations, plotted against the daily minimum and maximum levels from 2013 to 2023. This shows that levels were mostly within the range of the same seasons in earlier years.

Figure 26 shows the maximum 1-hour average NH_3 concentrations from 2013 to 2024 were highest in 2013. It shows daily average 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). The primary ammonia source at Stockton is Orica's ammonium nitrate manufacturing facility on Kooragang Island, located north-west of the station.

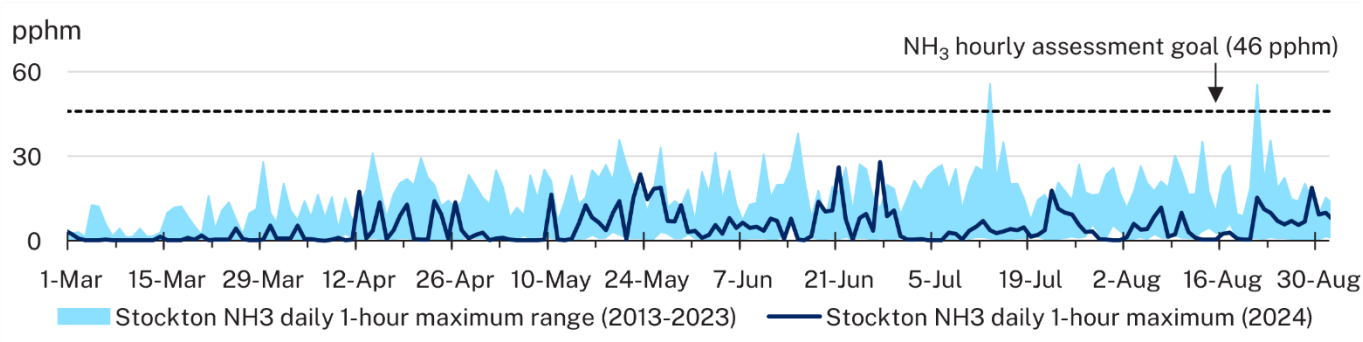

Figure 25 **Stockton daily 1-hour maximum NH_3 for autumn and winter 2024 compared to daily minimum and maximum levels from autumn and winter 2013 to 2023**

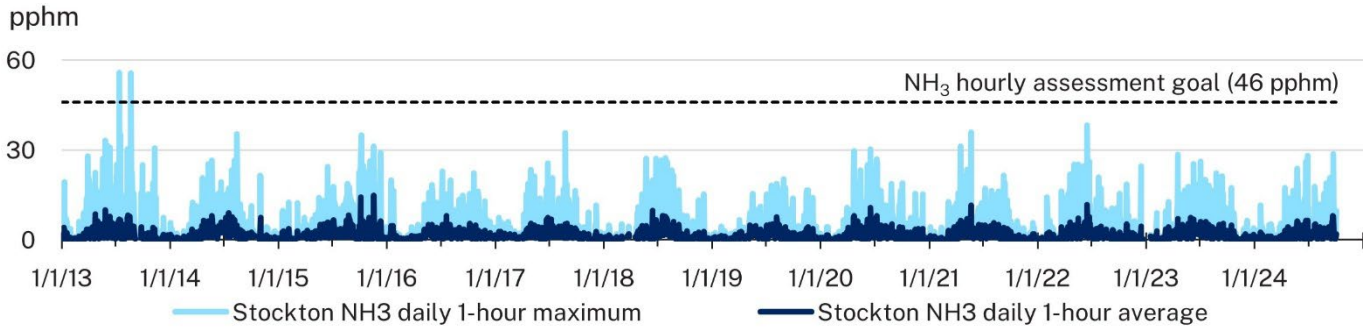

Figure 26 **Stockton daily 1-hour maximum and average NH_3 from 2013 to 2024**

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 time for Carrington, Newcastle, Stockton, Wallsend NO_2 and SO_2 was due to instrument faults and scheduled maintenance (Table 2).

Table 2 **Network performance (%) during winter 2024**

Station	Particles daily PM10	Particles daily PM2.5	Gases hourly SO_2	Gases hourly NO_2	Gases hourly NH_3	Meteorology hourly
Beresfield	100	99	95	91	–	100
Carrington	100	99	95	94	–	100
Mayfield	100	100	96	96	–	100
Newcastle	99	100	82	94	–	99
Stockton	100	97	94	94	95	99
Wallsend	96	95	92	91	–	98

'– ' = not monitored

The overall reduced online times were mainly due to:

- Beresfield NO_2 – scheduled maintenance, and power supply failure
- Newcastle SO_2 – scheduled maintenance, faulty gas diluter, and faulty instrument
- Wallsend SO_2 and NO_2 – scheduled maintenance, and power supply failure.

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Web: www.environment.nsw.gov.au.

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Appendix A: Rolling annual averages

Table 3 **PM10 rolling annual averages (µg/m^3) from the end of winter 2015 to the end of winter 2024**

Station	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	2023–24
Beresfield	19.1	19.2	19.6	21.3	20.8	24.6	16.3	14.9	16.1	17.4
Carrington	23.3	23.5	23.9	26.6	26.7	30.3	21.7	19.9	20.6	22.3
Mayfield	21.9	22.6	23.3	27.1	25.7	29.4	20.9	18.5	19.6	21.7
Newcastle	21.8	21.8	22.2	23.7	24.1	28.3	19.8	18.4	18.1	20.8
Stockton	34.6	36.6	34.5	39.1	38.4	41.8	30.9	30.9	31.0	34.0
Wallsend	17.2	16.6	17.3	19.0	18.9	22.7	15.5	13.6	13.9	16.2

Note: The rolling annual averages are calculated from 1 September to 31 August each year.

Table 4 **PM2.5 rolling annual averages (µg/m^3) from the end of winter 2015 to the end of winter 2024**

Station	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	2023–24
Beresfield	7.8	7.1	7.8	8.4	9.0	11.4	6.2	5.2	5.9	6.7
Carrington	8.4	8.2	8.7	8.4	8.2	11.2	6.9	5.8	6.2	6.8
Mayfield	7.7	7.3	7.6	7.9	8.6	10.8	6.6	5.5	6.1	6.7
Newcastle	8.4	7.6	7.7	7.7	7.9	na	6.5	5.7	6.1	6.5
Stockton	9.5	9.2	10.0	10.2	9.9	12.6	8.6	7.7	8.3	9.0
Wallsend	7.4	7.9	7.5	7.4	7.4	10.7	6.3	5.4	5.4	6.1

Note: the rolling annual averages are calculated from 1 September to 31 August each year
na = rolling 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] 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).

[4] Most benchmarks can be found at National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) standards. Data from Stockton, Mayfield and Carrington are presented for comparison purposes and not for the purposes of assessing compliance against the AAQ NEPM. There are no hourly standards for PM10 or PM2.5, nor is there a NEPM standard for ammonia (NH_3), whose assessment goal is given as an hourly average of 46 pphm.

[5] Rolling annual averages use 12 months of data to the end of the season. These are used indicatively to assess long-term trends using the most up-to-date monitoring data and are not intended for comparison to the calendar year annual benchmarks of 25 $\mu g/m^3$ for PM10 and 8 $\mu g/m^3$ for PM2.5.

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

[7] Sourced from Department of Primary Industries and Regional DevelopmentNSW State seasonal update - August 2024 (accessed November 2024).

[8] Sourced from Department of Primary Industries and Regional DevelopmentNSW State seasonal update – August 2023 (accessed November 2023).

[9] Sourced from Department of Primary Industries and Regional DevelopmentNSW State seasonal update – August 2022 (accessed October 2022).

[10] 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.

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

[12] 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.

[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 winter 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.