



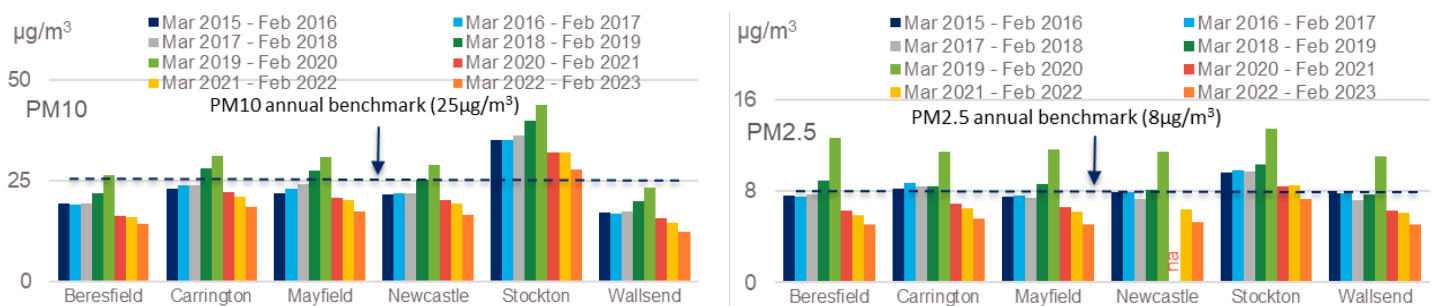
## Air quality in Newcastle: Summer 2022-23

Air quality in the Newcastle region was generally good during summer 2022-23. Daily particle levels were within national benchmarks from 87% of the time at Stockton to 100% of the time at all other stations. Hourly particle levels were in the good to fair air quality categories from 98% at Stockton to 100% of the time at all other stations in the region.

- Levels of nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>) and ammonia (NH<sub>3</sub>) were good, all remaining within national benchmarks and assessment goals.
- Daily average levels of fine particulate matter PM<sub>2.5</sub> (particles less than or equal to 2.5 microns in diameter) remained within the 25 micrograms per cubic metre (µg/m<sup>3</sup>) benchmark.
- Daily average levels of particulate matter PM<sub>10</sub> (particles less than or equal to 10 microns in diameter) were above the 50 µg/m<sup>3</sup> benchmark on 12 days during January and February at Stockton. Maximum daily PM<sub>10</sub> levels on these days ranged from 50.6 to 83.7 µg/m<sup>3</sup>.
  - At Stockton, elevated hourly PM<sub>10</sub> levels predominantly occurred under onshore north-easterly to south-easterly winds. Stockton particle levels are influenced by sea salt spray transported by onshore winds<sup>1</sup>, which prevail during the warmer months. See Stockton section for further details.
- The Newcastle region recorded below average rainfall and slightly below average maximum temperatures during the season.

## Annual air quality trends

The national annual average benchmarks are 25 µg/m<sup>3</sup> for PM<sub>10</sub> and 8 µg/m<sup>3</sup> for PM<sub>2.5</sub>, based on a calendar year. Long-term trends in annual average PM<sub>10</sub> and PM<sub>2.5</sub> levels are compared in Figure 1.



na = annual average unavailable due to insufficient data availability

**Figure 1 PM<sub>10</sub> and PM<sub>2.5</sub> annual averages – 2015-16 to 2022-23**

The comparison in Figure 1 shows that particle levels continued to decrease at most stations by the end of summer 2022–23. Annual average PM<sub>10</sub> and PM<sub>2.5</sub> levels were within the benchmarks in the 12 months to 28 February 2023, at all stations except Stockton, where PM<sub>10</sub> exceeded the annual benchmark (28.4 µg/m<sup>3</sup>). Levels were the lowest recorded since the establishment of the Newcastle local network.

Despite below average rainfall during summer 2022–23, lower particle levels were observed throughout the season.

<sup>1</sup> Lower Hunter Particle Characterisation Study

At the end of summer 2022–23, no areas in New South Wales were drought affected (Figure 2), compared to 3% at the end of summer 2021–22<sup>2</sup> and 6% at the end of summer 2020–21<sup>3</sup>.

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 than Mayfield, and 40% more PM2.5 at Stockton than Mayfield, Beresfield and Newcastle. This is primarily due to sea salt that is carried in from onshore winds.

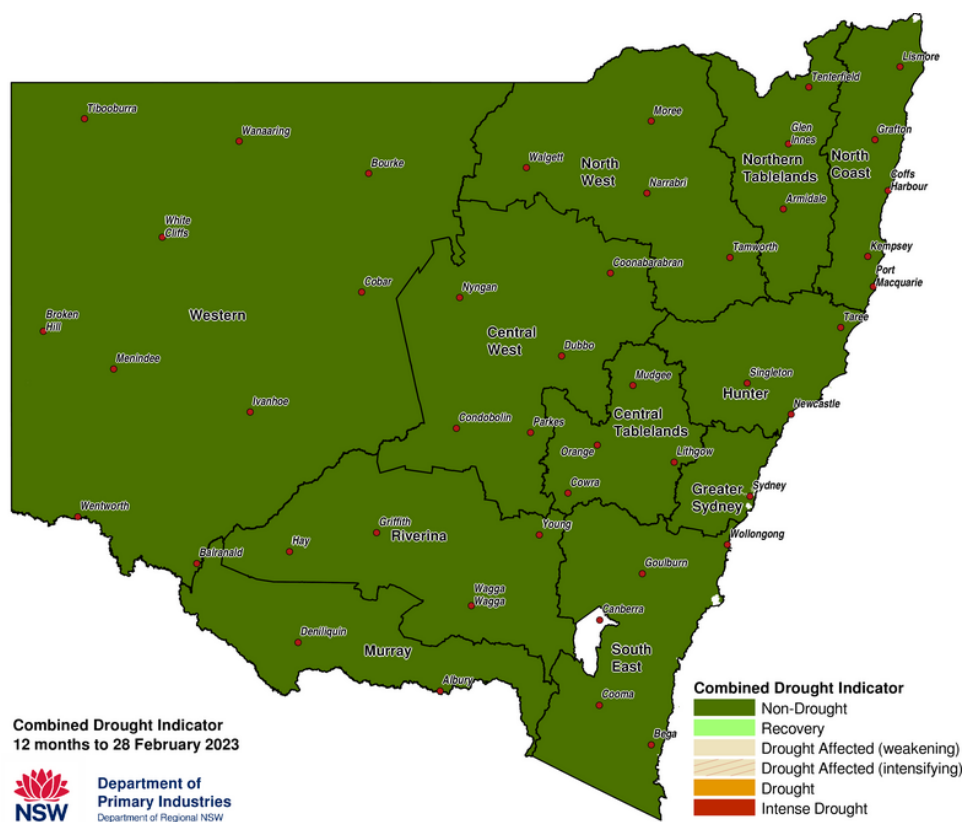


Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 28 February 2023<sup>4</sup>

## Days above benchmark concentrations

There were 12 days over the PM10 benchmark in summer 2022–23 at Stockton. Levels of PM2.5, SO<sub>2</sub>, and NO<sub>2</sub> remained within relevant benchmarks at all sites during the season.

Table 1 Number of days above the relevant benchmarks – summer 2022–23

Station	PM10 daily [50 µg/m <sup>3</sup> benchmark]	PM2.5 daily [25 µg/m <sup>3</sup> benchmark]	SO <sub>2</sub> hourly [10 pphm benchmark]	SO <sub>2</sub> daily [2 pphm benchmark]	NO <sub>2</sub> hourly [8 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	12	0	0	0	0
Wallsend	0	0	0	0	0

µg/m<sup>3</sup> = micrograms per cubic metre.

pphm = parts per hundred million by volume (i.e. parts of pollutant per hundred million parts of air).

- = not monitored.

<sup>2</sup> Sourced from Department of Primary Industries NSW State seasonal update – February 2022 (accessed July 2023).

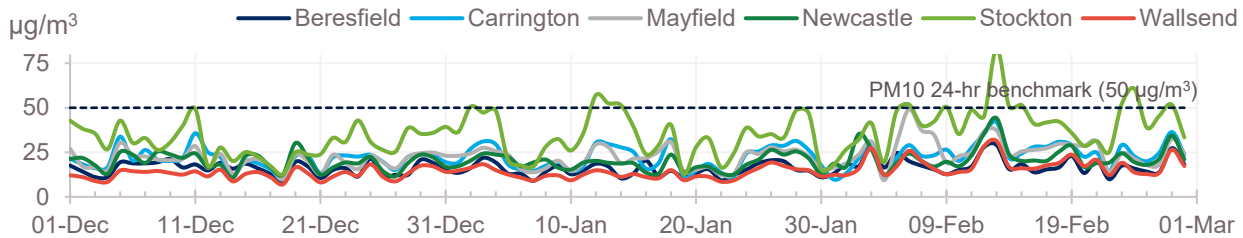
<sup>3</sup> Sourced from Department of Primary Industries NSW State seasonal update – February 2021 (accessed July 2023).

<sup>4</sup> Sourced from Department of Primary Industries NSW State seasonal update – February 2023 (accessed July 2023).

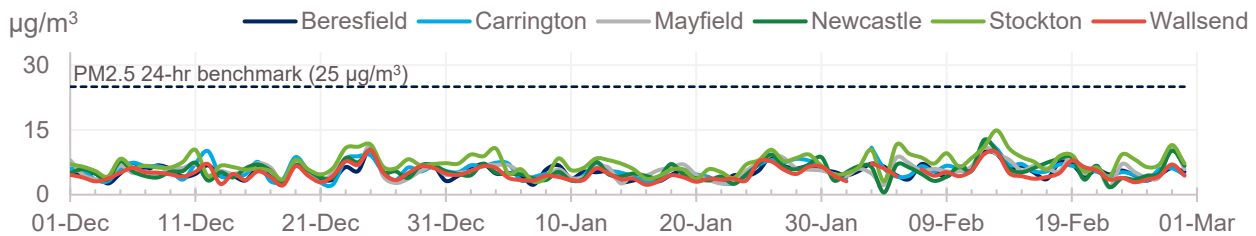
# Daily time series plots

Daily average time series plots for PM10 and PM2.5 and daily 1-hour maximum plots for NO<sub>2</sub>, SO<sub>2</sub> and NH<sub>3</sub> show the concentrations throughout the summer season (Figure 3 to Figure 7).

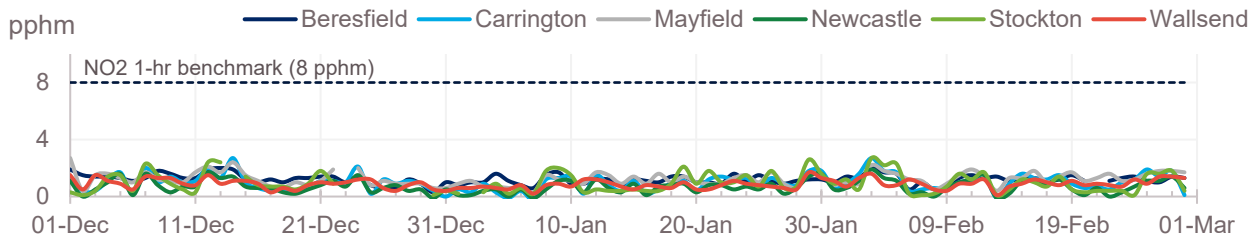
All parameters remained within the benchmarks and assessment criteria throughout the season, except for Stockton PM10 on 12 days. Stockton PM10 levels were likely affected by sea salt these days due to its proximity to the coast. See [Stockton](#) section for further details.



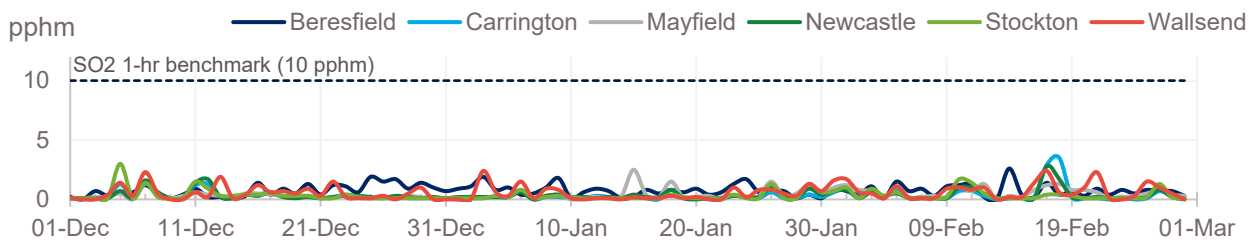
**Figure 3 Daily average PM10 during summer 2022-23**



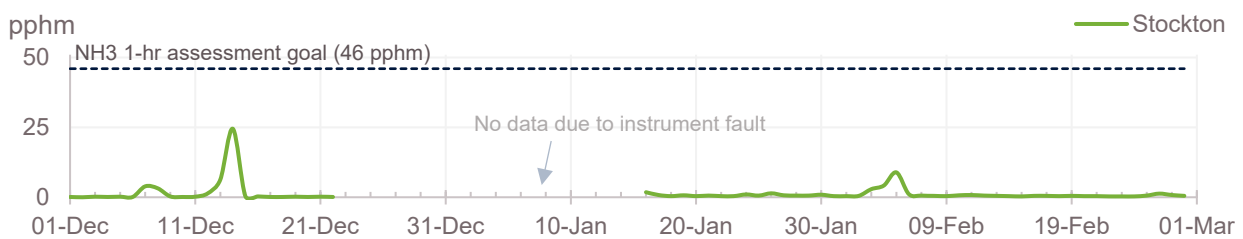
**Figure 4 Daily average PM2.5 during summer 2022-23**



**Figure 5 Daily maximum 1-hr NO<sub>2</sub> during summer 2022-23**



**Figure 6 Daily maximum 1-hr SO<sub>2</sub> during summer 2022-23**



**Figure 7 Daily maximum 1-hr NH<sub>3</sub> during summer 2022-23**



# Pollution rises from hourly particle data

The seasonal pollution rose maps<sup>5</sup> (Figure 8 and Figure 9) show that hourly<sup>6</sup> PM10 and PM2.5 levels generally remained low during the season. Noting that there are no benchmarks for hourly particle levels, PM10 below 50  $\mu\text{g}/\text{m}^3$  and PM2.5 below 25  $\mu\text{g}/\text{m}^3$  is considered as good air quality. All sites recorded occasional elevated hourly PM10 levels primarily under north-east to south-east winds, likely due to sea salt.



**Figure 8** Hourly PM10 pollution roses for the Newcastle region for summer 2022-23



**Figure 9** Hourly PM2.5 pollution roses for the Newcastle region for summer 2022-23

<sup>5</sup> 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.

<sup>6</sup> There are no standards for hourly PM10 or PM2.5 in the National Environment Protection (Ambient Air Quality) Measure (Air NEPM).

# Seasonal trends

This section compares air quality levels in summer 2022–23 with previous summer seasons, where data were available<sup>7</sup>.

All days were within benchmark concentrations for NO<sub>2</sub> and SO<sub>2</sub> in summer during the past 10 years at Beresfield, Newcastle, Stockton and Wallsend and since monitoring began at Carrington and Mayfield. For NH<sub>3</sub> at Stockton, there were no days over the assessment criterion in summer during the past 10 years. There were 12 days over the PM10 daily benchmark during summer 2022–23. This is lower than the previous year, with 28 days over the benchmark in summer 2021–22. From 2014 to 2021, the region recorded between 9 days (summer 2013–14) and 43 days (summer 2019–20) over the PM10 daily benchmark.

There were no days over the PM2.5 daily benchmark during summer 2022–23. This is the same as summer 2021–22. From summer 2012–13 to 2022–23, the region recorded between zero days and 20 days (summer 2019–20) over the PM2.5 daily benchmark.



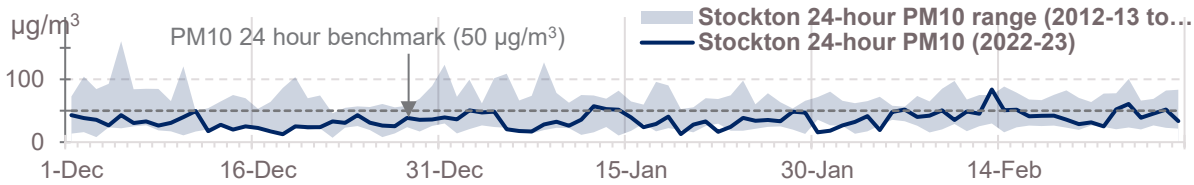
**Figure 10 Number of days above the PM10 and PM2.5 daily benchmarks: summer 2013–14 to 2022–23**

<sup>7</sup> 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.

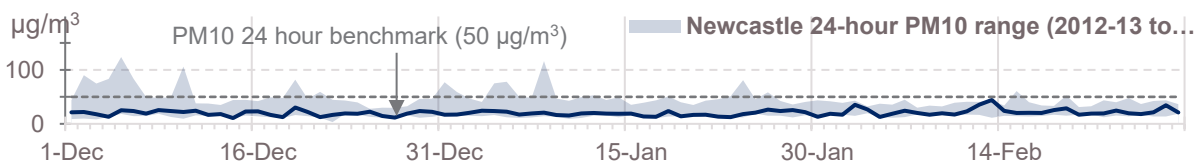
# Particle air quality trends

Figure 11 and Figure 12 show daily average PM10 during summer 2022–23, compared to the daily maximum and minimum PM10 levels (shaded range) from 2012–13 to 2022–23, at Stockton and Newcastle. Daily PM10 levels were generally within the historical range throughout the season, and often at the lower levels during summer 2022-23.

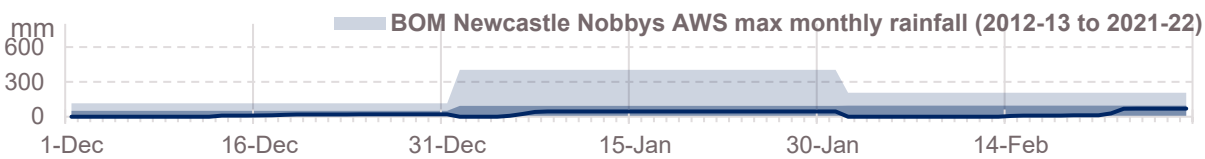
Rainfall in Newcastle was average to below-average during summer 2022–23 (Figure 13), with wettest conditions during January and late February.



**Figure 11 Stockton daily average PM10 during summer 2022–23 plotted against the daily maximum and minimum PM10 levels from 2012–13 to 2021–22**

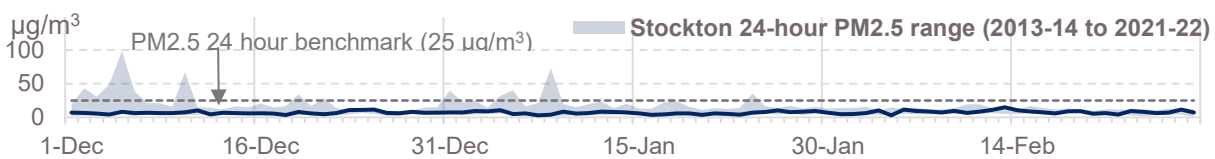


**Figure 12 Newcastle daily average PM10 during summer 2022–23 plotted against the daily maximum and minimum PM10 levels from 2012–13 to 2021–22**

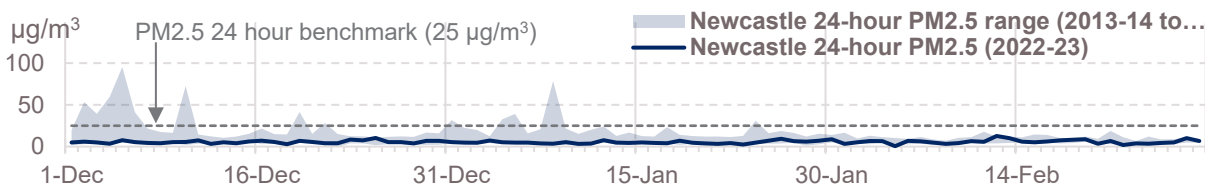


**Figure 13 Bureau of Meteorology Newcastle Nobbys Signal Station AWS<sup>8</sup> cumulative rainfall during summer 2022–23 plotted against maximum and average rainfall from 2012–13 to 2022–23**

Figure 14 and Figure 15 show daily average PM2.5 during summer 2022–23, compared to the daily maximum and minimum PM2.5 levels (shaded range) from 2013-14 to 2022–23, at Stockton and Newcastle. Daily PM2.5 levels were within the historical range throughout the season, and often at the lower levels.



**Figure 14 Stockton daily average PM2.5 during summer 2022–23 plotted against the daily maximum and minimum PM2.5 levels from 2013–14 to 2021–22**



**Figure 15 Newcastle daily average PM2.5 during summer 2022–23 plotted against the daily maximum and minimum PM2.5 levels from 2013–14 to 2021–22**

<sup>8</sup> Data from Bureau of Meteorology [Newcastle Nobbys Signal Station AWS monthly rainfall](#) page (accessed February 2023).

# Meteorological summary

## Rainfall<sup>9</sup>

The Newcastle region experienced below average rainfall during summer 2022–23 with 136 mm, compared to the long-term (1862-2023) average of 273.8 mm (Figure 16). Summer 2022–23 was also drier than summer 2021–22 with 114 millimetres less rain.

New South Wales rainfall deciles 1 December 2022 to 28 February 2023

Australian Gridded Climate Data

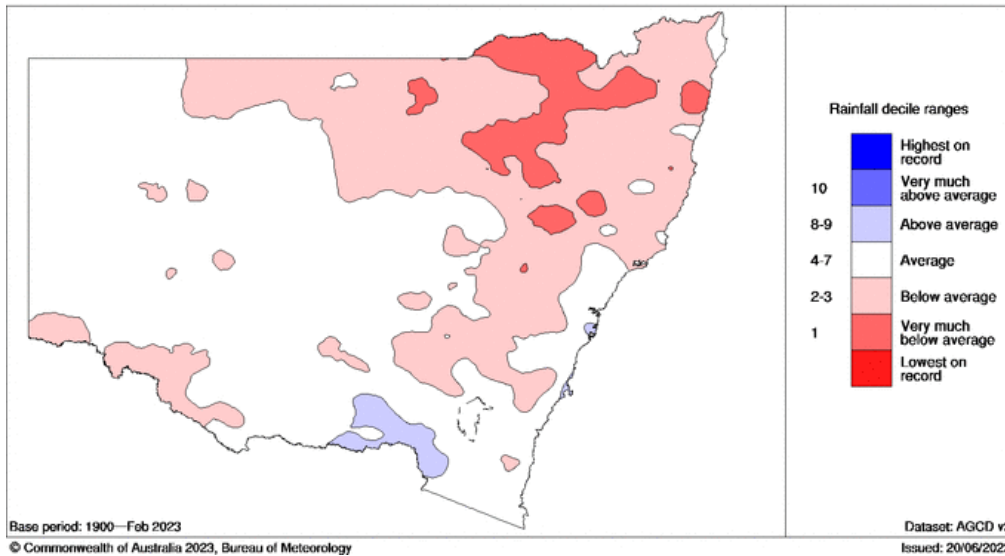


Figure 16 NSW rainfall deciles – summer 2022–23

## Temperatures<sup>9</sup>

Maximum temperatures were average during the season (Figure 17), while minimum temperatures were below average.

Maximum Temperature Deciles 1 December 2022 to 28 February 2023

Distribution Based on Gridded Data  
 Australian Bureau of Meteorology

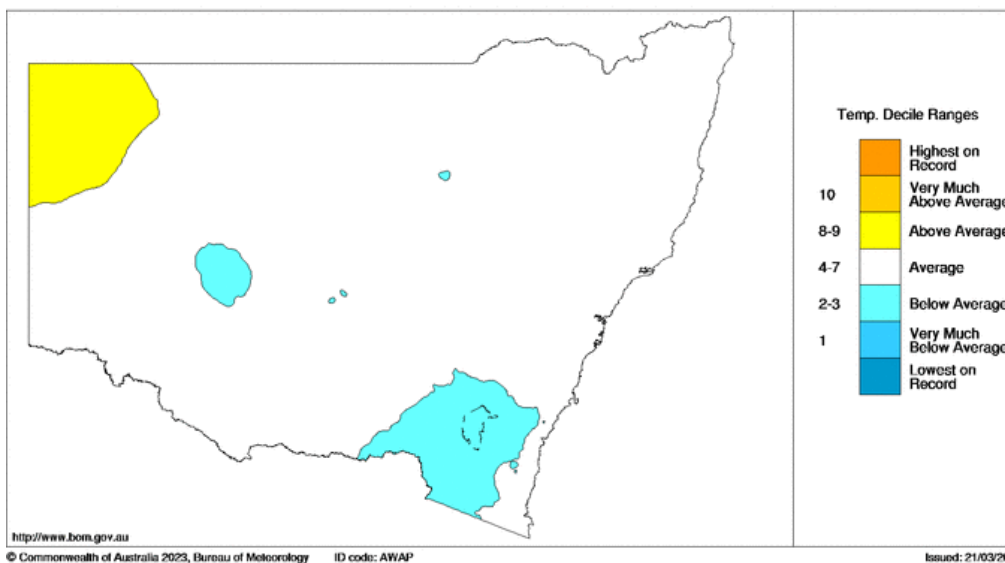


Figure 17 NSW maximum temperature deciles – summer 2022–23

<sup>9</sup> Rainfall and temperature information is from the Bureau of Meteorology [New South Wales summer 2022-23 climate statement](#) (accessed July 2023) and [climate maps](#) (accessed July 2023).



# Winds

Winds were predominantly from the north-east to south-east across the region during summer 2022–23, which was typical for summer. Slightly more inland sites recorded more directional variability than coastal sites during the season, as shown in Figure 18 below.



Figure 18 Wind rose map<sup>10</sup> for the Newcastle region for summer 2022–23

<sup>10</sup> 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.



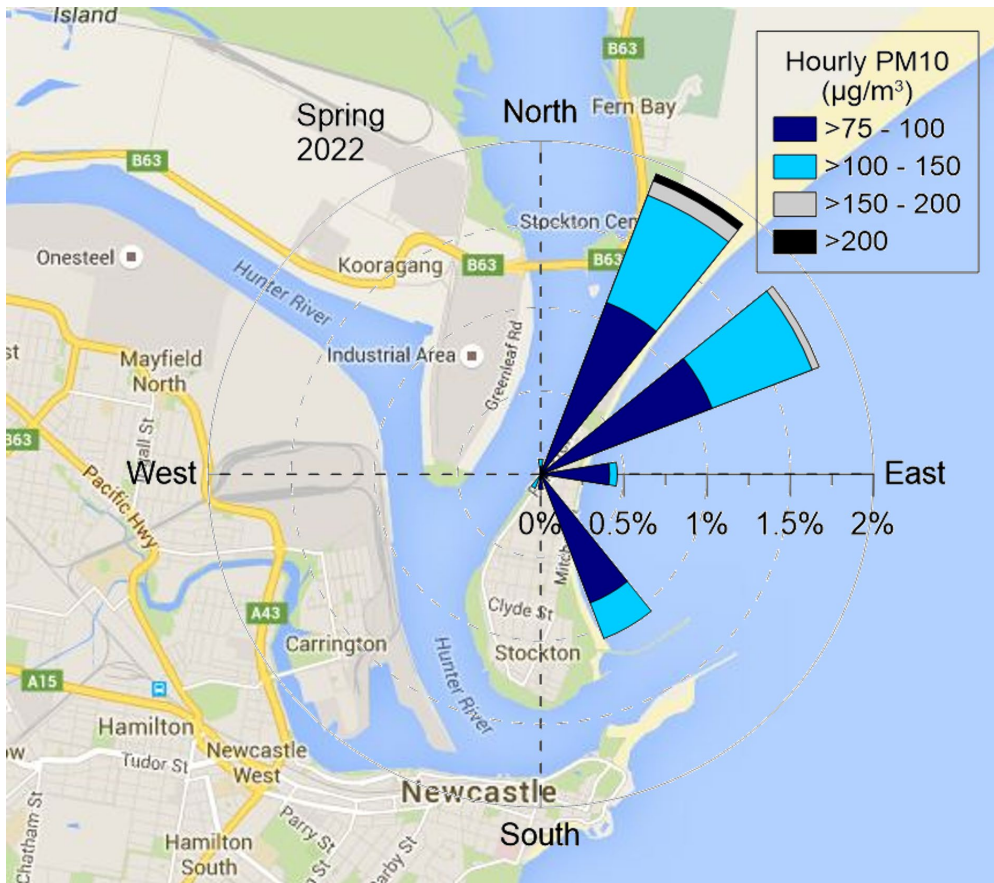
# Stockton

## Particles at Stockton in summer 2022-23

The Stockton monitoring station recorded 12 days over the PM10 daily benchmark during summer 2022–23 (2, 12, 13, and 14 January, and 6, 9, 13, 14, 15, 23, 24, and 27 February). This is the third lowest number of days over the PM10 benchmark during summer since Orica began monitoring in October 2012. By comparison, there were 28 days over the PM10 benchmark in summer 2021–22. From 2012–13 to 2020–21, Stockton recorded between 9 days (summer 2013-14) and 43 days (summer 2019-20) over the PM10 daily benchmark (Figure 10).

In summer 2022–23, elevated hourly PM10 levels ( $>100 \mu\text{g}/\text{m}^3$ )<sup>11</sup> were recorded at Stockton 1.9% of the time (Figure 19). These occurred under onshore (north north-easterly to south south-easterly) winds 69% of the time. There were no hours with elevated hourly PM10 under north-westerly winds.

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



**Figure 19 Stockton summer 2022–23 PM10 pollution rose – proportion of hourly averaged PM10 levels  $>75 \mu\text{g}/\text{m}^3$  by wind direction**

The Stockton monitoring station did not record any days over the PM2.5 daily benchmark during summer 2022–23. From 2012–13 to 2021–22, every summer recorded zero days over the PM2.5 daily benchmark except for summer 2019–20, which recorded 13 days (summer 2019–20) over the benchmark (Figure 10). There were no hours with elevated hourly PM2.5 levels ( $>50 \mu\text{g}/\text{m}^3$ )<sup>11</sup> during summer 2022–23. The maximum hourly PM2.5 level was  $27.7 \mu\text{g}/\text{m}^3$ .

<sup>11</sup> There are no standards for hourly PM10 or PM2.5 in the National Environment Protection (Ambient Air Quality) Measure.

# Network performance

The target network performance is at least 95% available data for all parameters. For NO<sub>2</sub>, SO<sub>2</sub> and NH<sub>3</sub>, the maximum online time that can be attained is 96% due to calibrations.

**Table 2 Online performance (%) during summer 2022–23**

Station	Particles PM10 daily	Particles PM2.5 daily	Gases SO <sub>2</sub> hourly	Gases NO <sub>2</sub> hourly	Gases NH <sub>3</sub> hourly	Meteorology Wind hourly
<b>Beresfield</b>	100	99	95	94	-	100
<b>Carrington</b>	99	99	95	83	-	89
<b>Mayfield</b>	100	99	95	91	-	100
<b>Newcastle</b>	100	99	95	91	-	95
<b>Stockton</b>	100	99	95	85	70	100
<b>Wallsend</b>	100	99	95	95	-	100

- = not monitored

The reduced online times were mainly due to:

- Beresfield NO<sub>2</sub> – instrument and server faults
- Carrington NO<sub>2</sub> and wind – instrument and server faults
- Mayfield NO<sub>2</sub> – server fault, instrument fault, and scheduled maintenance
- Newcastle NO<sub>2</sub> – server and instrument faults, and calibration checks
- Stockton NO<sub>2</sub> and NH<sub>3</sub> – instrument faults and calibration checks.

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