

Portola End of Season Report | Nov 2022 - Apr 2023

Sonoma Technology forecasts wintertime fine particle (PM_{2.5}) Air Quality Index (AQI) levels for the city of Portola to support the Northern Sierra Air Quality Management District's (NSAQMD) wood stove curtailment (WSC) program. Each weekday from November to April, Sonoma Technology issues same-day and next-day forecasts of 24-hour average PM_{2.5} concentrations with a 5-day outlook.

PM_{2.5} concentrations are typically higher during winter months because colder temperatures can lead to strong overnight temperature inversions, trapping pollutants near the surface. In addition, increased residential wood burning during winter months can contribute to higher levels of PM_{2.5} locally and regionally. As a significant fraction of wintertime PM_{2.5} pollution can be attributed to residential wood smoke, the WSC program aims to reduce burning on days when meteorological conditions are conducive to pollutant accumulation in the Portola region. The forecast threshold for 24-hour average PM_{2.5} concentrations for NSAQMD to issue a WSC day for November through March was at or above 30 µg/m³ (89 AQI value), and above 20 µg/m³ (68 AQI value) for April.

This report summarizes the meteorological and air quality conditions in Portola during the period from November 1, 2022, through April 31, 2023, and provides an analysis of air quality forecast accuracy. Air quality data are sourced from the U.S. Environmental Protection Agency's (EPA) AirNow-Tech platform.

Summary

- Observed air quality in the Portola region during the 2022-23 WSC season was in the Good AQI category on 31% of days, the Moderate category on 65% of days, and the Unhealthy for Sensitive Groups (USG) category on 4% of days.
- The highest AQI levels of the season typically occurred when upper-level high pressure over the Portola region limited vertical mixing and cold temperatures at the surface produced strong temperature inversions, trapping pollutants near the surface. Particle levels were further increased by periods of calm winds, which allowed pollutants to accumulate in the region.
- High AQI levels were also observed on a few days toward the end of December 2022 with calm winds and above-normal temperatures. On these days, excess moisture from snowmelt increased relative humidity levels, promoting particle formation.
- A total of 42 WSC day forecasts were issued during the 2022-23 WSC season. The average observed daily PM_{2.5} concentration on WSC days was 27.0 µg/m³. Further details are provided on page 6.
- The Percent Correct next-day forecast score was 80%. Percent Correct and other forecast statistics are defined on page 6 of this report.



Highest AQI Days
Nov. 2022-Apr. 2023

142 February 2
Portola
PM_{2.5}

114 December 20
Portola
PM_{2.5}

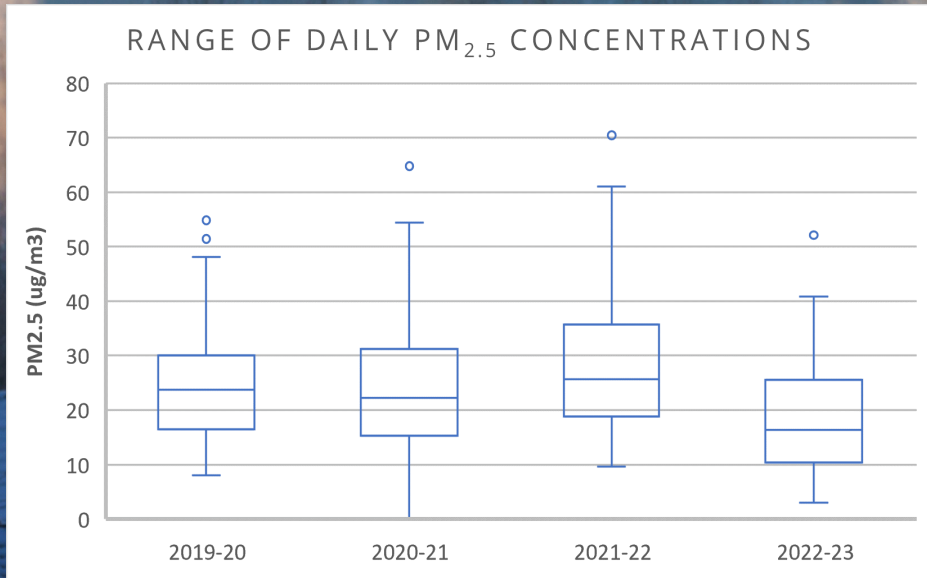
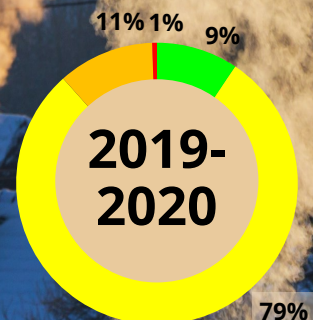
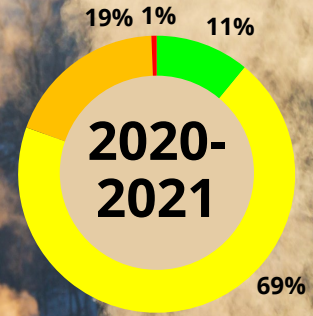
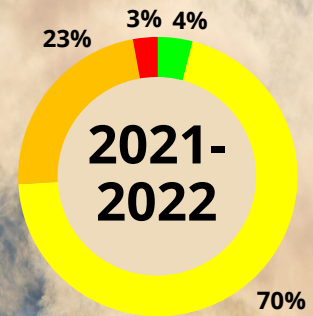
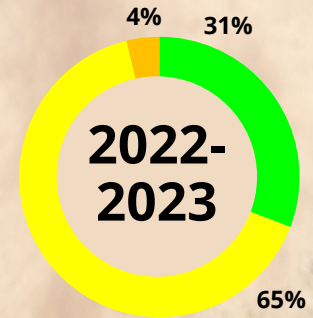
111 December 21
Portola
PM_{2.5}

106 December 23
Portola
PM_{2.5}

Yearly AQI Comparison | November - April (2019-2023)

Air quality in Portola during the 2022-23 WSC season was better than the previous three seasons, partially due to an active weather pattern enhancing mixing and dispersion across the northern Sierra. The pie charts show the percentage breakdown of observations in each AQI category for each season. These charts show a substantial increase in Good AQI levels, and a substantial decrease in USG AQI levels in Portola this season.

In addition to an active weather pattern improving air quality in Portola this season, the WSC program also appeared to be effective in improving AQI levels. As shown in the box and whisker plot below, the top whisker this season was 8-20 $\mu\text{g}/\text{m}^3$ lower than the previous three seasons, indicating the potential effectiveness of curtailments at reducing the highest concentrations.



Missing | Good | Moderate | Unhealthy For Sensitive Groups | Unhealthy | Very Unhealthy | Hazardous

Seasonal Weather Summary

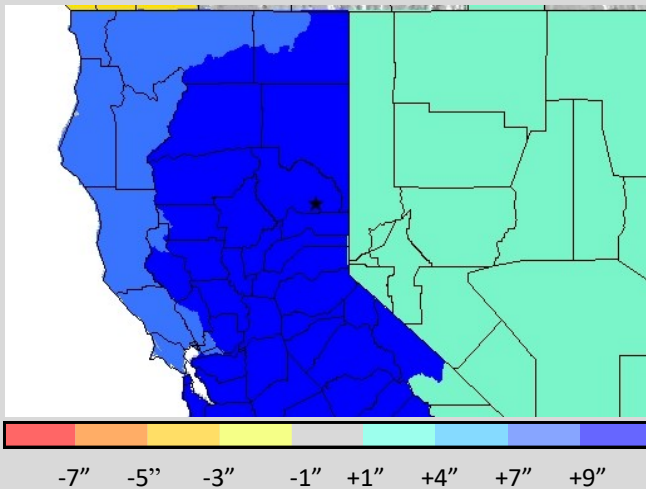
Outside of wildfire season, PM_{2.5} concentrations in the Portola region are typically higher during the winter months because strong overnight temperature inversions limit vertical mixing as emissions of PM_{2.5} increase due to residential wood burning. These inversions are strengthened by the high terrain surrounding Portola, which acts as a barrier to wind and allows inversions to become more stable as cold air flows downslope into the valley, trapping pollutants near the surface. Temperature inversions were common in Portola throughout winter and into spring, with below-normal temperatures observed from November through April. Temperatures on days with PM_{2.5} concentrations above the WSC threshold averaged 7°F below normal, with average lows below 15°F.

Thankfully, the cold temperatures this season were accompanied by a very active weather pattern, with significant precipitation and snowfall across the northern Sierra. Liquid precipitation was 13.97" above normal in Portola from November 2022 through April 2023, as numerous low-pressure systems traversed the region. Moderate-to-heavy precipitation and periods of gusty winds associated with the frequent storm systems enhanced dispersion and shortened the potential duration of high AQI levels. Just one exceedance of the WSC threshold was observed during the wettest months of the season, January and March. The majority of WSC threshold exceedances occurred in November and December before the extended stormy pattern developed. A few additional exceedances occurred in February as a break in the active weather pattern allowed pollutants to accumulate in Portola.

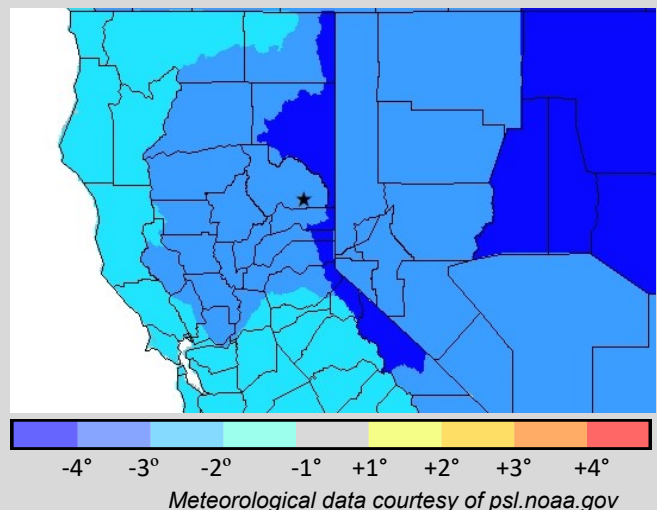
Month	Portola temperature departure from normal (°F)	Portola precipitation departure from normal (inches)	Curtailments Issued	Days with 24-hour PM _{2.5} above WSC threshold
November	-6.2	-0.07	14	6
December	-6.2	2.82	13	7
January	-5	6.37	4	1
February	-6.8	-1.03	9	3
March	-8.9	6.81	1	0
April	-0.2	-0.93	1	0

Source: Weather data - xmacis.rcc-acis.org. Air quality data - www.airnowtech.org

Precipitation Anomalies (inches)
November 2022-April 2023
Versus 1991-2020 Average



Temperature Anomalies (°F)
November 2022-April 2023
Versus 1991-2020 Average



Highest Observed and Forecasted AQI Days

Observed AQI levels in the Portola region met or exceeded the WSC threshold (89 AQI value) on 17 days this season. WSC days—when PM_{2.5} AQI levels were forecast to meet or exceed 89 (30 µg/m³ in Nov. - Mar.) or 68 (20 µg/m³ in Apr.)—were issued on 42 days. The table below shows the dates when AQI levels met or exceeded the WSC threshold in the Portola region. Days are ranked from highest to lowest by observed AQI levels, and forecast WSC days are bold. A meteorological summary of the high-AQI-level events on February 2, 2023, and December 20-23, 2022, is included on page 5.

Date	Monitoring Site	Observed AQI	Next-Day Forecast	Same-Day Forecast
2/2/2023	Portola (061131003)	142	89	99
12/20/2022	Portola (061131003)	114	82	87
12/21/2022	Portola (061131003)	111	89	102
12/23/2022	Portola (061131003)	106	89	91
11/26/2022	Portola (061131003)	101	89	89
12/22/2022	Portola (061131003)	101	93	93
12/13/2022	Portola (061131003)	100	91	91
12/7/2022	Portola (061131003)	99	91	91
1/28/2023	Portola (061131003)	98	78	N/A*
11/4/2022	Portola (061131003)	97	91	91
12/16/2022	Portola (061131003)	96	84	84
2/3/2023	Portola (061131003)	95	78	78
11/11/2022	Portola (061131003)	91	102	102
11/17/2022	Portola (061131003)	91	102	95
11/22/2022	Portola (061131003)	91	95	95
11/27/2022	Portola (061131003)	89	84	84
2/9/2023	Portola (061131003)	89	91	93

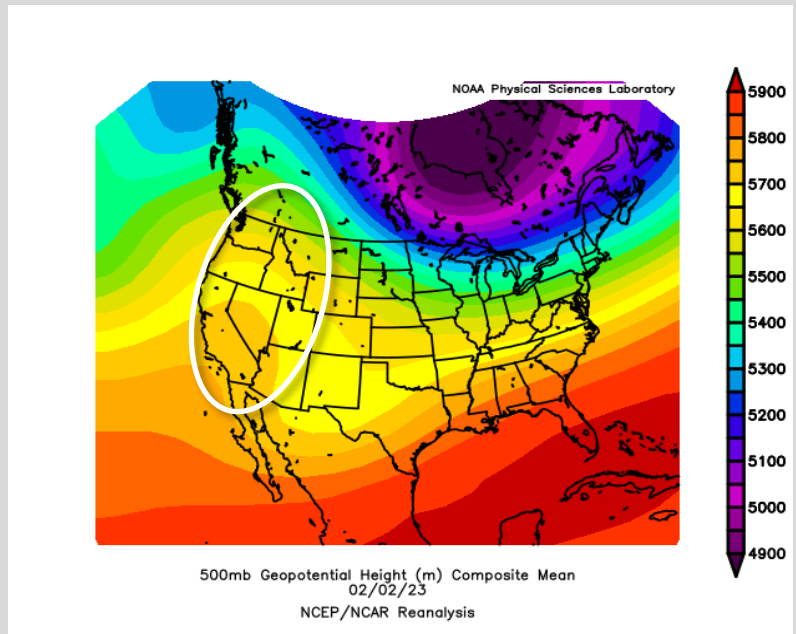
* Forecasts not issued on weekends.



Highlighted Days

February 2, 2023: **142 AQI**

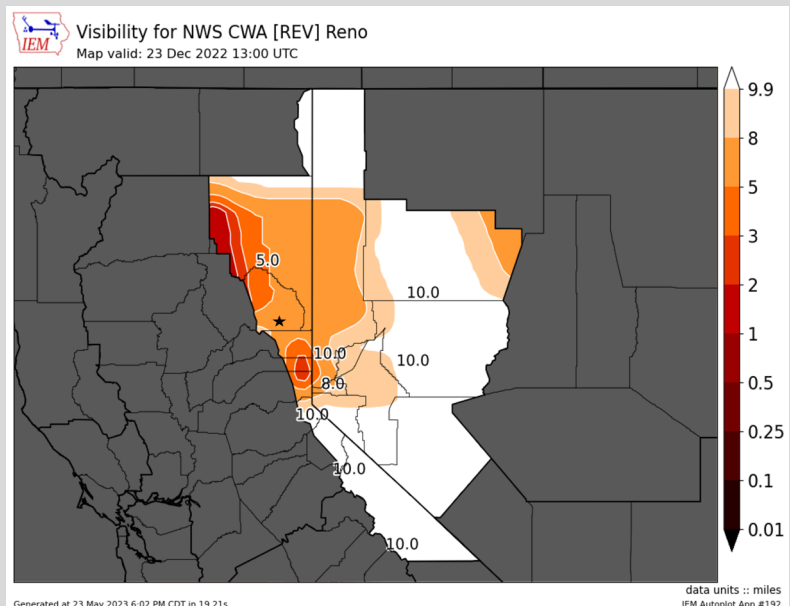
The highest AQI levels of the season were observed on February 2, 2023, as a strong ridge of high pressure moved across northern California and limited atmospheric mixing. Additionally, clear skies and calm winds overnight allowed temperatures to fall into the single-digits in Portola during the morning hours, strengthening a temperature inversion in lower elevations and trapping pollutants near the surface. Furthermore, calm-to-light southerly winds hindered dispersion throughout the day. With limited mixing and dispersion in the forecast, a WSC day was issued on February 1. However, even with the curtailment in place, the AQI value reached 142 at the Portola PM_{2.5} monitor.



February 2: 500 mb heights from February 2, 2023. A strong upper-level high pressure ridge along the West Coast (circled) inhibited vertical mixing in the Portola region, contributing to USG AQI levels. *Source: NOAA Physical Sciences Laboratory*

December 20-23, 2022: **101-114 AQI**

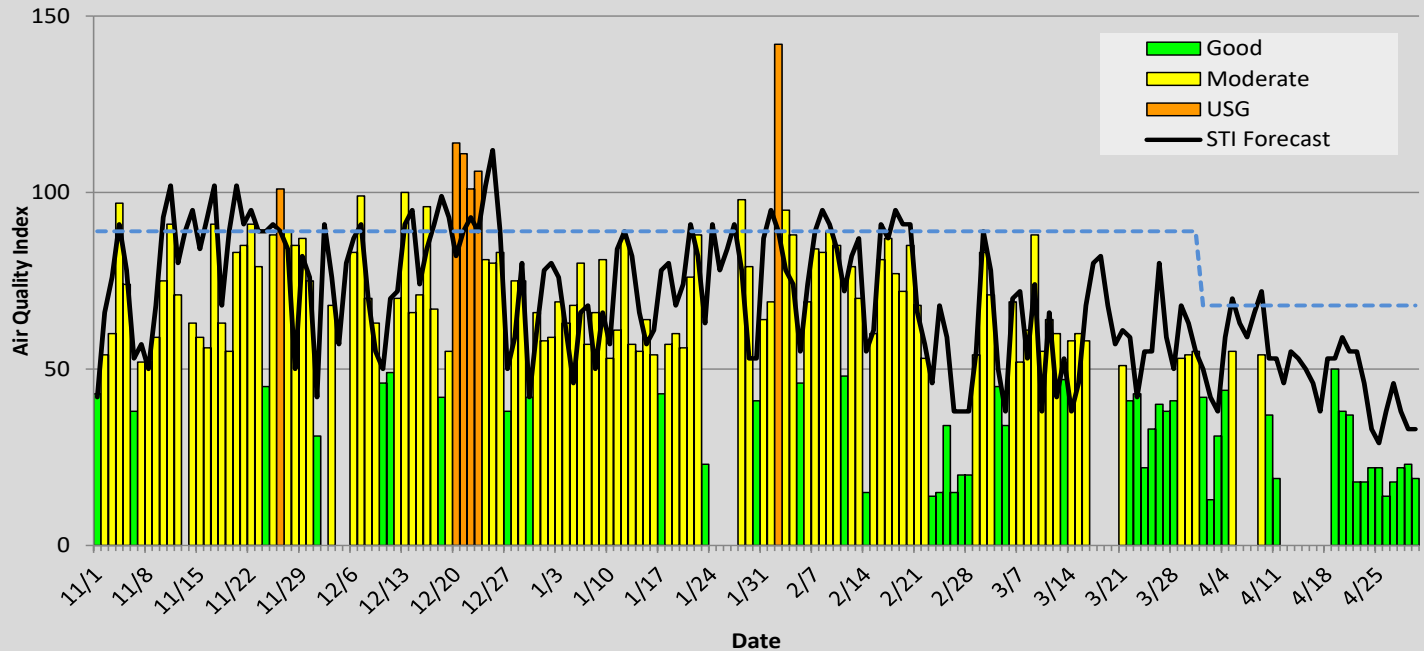
A four-day stretch of USG AQI levels occurred just before the Christmas holiday. This period started with a strong temperature inversion trapping pollutants near the surface, with a low of 5°F recorded in Portola on the morning of December 20. The weather pattern then shifted for the next few days as a ridge of high pressure aloft limited atmospheric mixing and brought warmer temperatures to the northern Sierra. High temperatures climbed above freezing from December 21-23 in Portola, which melted several inches of snow. Added humidity from the melting snow led to periods of fog and enhanced particle formation. In addition, light and variable winds through the period limited dispersion, and allowed pollutants to carryover from day-to-day. Despite WSC days issued from December 21-23, AQI levels reached the USG category each day.



December 23: Visibility (miles) at 5 a.m. Reductions to visibility due to fog, which developed after several days of melting snow and light winds. These conditions enhanced particle formation in Portola, supporting USG AQI levels. *Source: Iowa State University.*

Forecast Performance

Sonoma Technology (STI on the graph) provides same-day, next-day, and extended forecasts for the Portola region. The chart below shows daily observed AQI levels (colored bars) and Sonoma Technology forecasts (black line), along with the WSC threshold (horizontal-dotted blue line). Sonoma Technology forecasts overall track well with the general trend of observed air quality levels in Portola. Next-day and same-day forecast accuracy statistics are below the chart.



Wood-Stove Curtailment Forecast Performance Summary

- Using the WSC threshold, the percent correct was 80% for next-day forecasts and 81% for same-day forecasts.
- The probability of detection for concentrations exceeding the WSC threshold was 71% for next-day forecasts and 75% for same-day forecasts. The false alarm rate was 65% for next-day forecasts and 64% for same-day forecasts.
- The average observed PM_{2.5} concentration on days when WSC day forecasts were issued was 27.0 µg/m³.
- The average observed PM_{2.5} concentration on non-WSC days was 16.8 µg/m³.
- Next-day forecasts were biased by +1.8 µg/m³, on average, and had a mean absolute error (MAE) of 6.3 µg/m³. Same-day forecasts were biased by +1.5 µg/m³, on average, and had a MAE of 5.2 µg/m³.

Percent Correct: The percentage of forecasts that correctly predicted whether observations would be above or below the WSC threshold.

Probability of Detection: How often a WSC day forecast was issued when observed conditions exceeded the WSC threshold.

False Alarm Rate: How often a WSC day forecast was issued and observed conditions ended up below the WSC threshold.

Bias: The average difference between forecasted and observed concentrations. A positive bias indicates that the forecasted concentrations tended to be higher than observed concentrations. A negative bias indicates that the forecasted concentrations tended to be lower than observed.

Mean Absolute Error: Indicates the average absolute difference between forecast and observed concentrations. A low MAE suggests that forecasts tend to be fairly accurate.

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