Comments on the EPA Document: Policy Assessment for the Reconsideration of the National Ambient Air Quality Standards for Particulate Matter (External Review Draft), EPA-452/P-21-001, October 2021

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**Disclaimer**: Dr. Lefohn's comments contained within this document are his own; he represents only himself; no person or organization has seen these comments prior to submission to the Government Docket; and he has not been reimbursed for the time necessary to produce these comments. His comments are directed at suggesting additional material that might be included in the first draft of the EPA document: Policy Assessment for the Reconsideration of the National Ambient Air Quality Standards for Particulate Matter. His comments are submitted into the PM Docket (No. EPA-HQ-ORD-2015-0072) for the purpose of providing scientific clarification for the particulate matter (PM) rulemaking activity.

## About the Author

**Dr. Allen S. Lefohn** is currently President and Founder of A.S.L. & Associates, LLC in Helena, Montana. From 1981 until 2017, he served as President and Founder of A.S.L. & Associates, a Montana corporation. He received his Bachelor of Science degree from UCLA in 1966 and a Ph.D. in physical chemistry from the University of California at Berkeley in 1969. His advisor was Professor George C. Pimentel. During the period 1989 – 1999, he served as an Executive Editor of the internationally recognized journal *Atmospheric Environment* and is an Emeritus Editor of the Journal. Dr. Lefohn has published approximately 125 peer-reviewed publications, edited four books, presented numerous oral papers, and participated in panel presentations. For many years, he served as an Adjunct Professor of Environmental Engineering at Montana Tech in Butte, Montana. Dr. Lefohn has been involved in all the American Lung Association's annual State of the Air reports (1999-2021). These reports provide a county-by-county summary of ozone (smog) and $PM_{2.5}$ (soot) concentrations experienced across the United States. During a career spanning over 50 years, his research has focused on (1) analyzing results from the EPA's air quality databases for (a) characterizing co-occurrence patterns of criteria air pollutants under ambient conditions (e.g., ozone, sulfur dioxide, particulate matter, and nitrogen dioxide), (b) characterizing ozone trend patterns, and (c) designing research experiments that utilize realistic ambient exposures for assessing human health and vegetation effects, (2) developing exposure-response relationships and indices that describe the effects of ozone on vegetation and human health, (3) investigating biological mechanisms that influence the nonlinearity response (i.e., weighting of the higher concentrations more than the mid- and low-level values) to ozone for both human health and vegetation, and (4) understanding the relative importance of background ozone in relation to ambient concentrations and how background influences margin of safety considerations under the Clean Air Act. He served as Chairman of the Science Advisory Committee of the Center for Ecological Health Research, University of California, Davis and served as a member of the Committee until January 2002. His research results have been integrated into the EPA rulemaking activities. Between 2007 and 2015, EPA staff, CASAC, and the EPA Administrator discussed the application of an exposure metric, the W126 exposure index, as the federal secondary ozone standard to protect vegetation. Dr. Lefohn created the exposure metric in 1985 with the help of the first-generation Apple Macintosh computer and introduced the metric into the peer-review literature in 1987 and 1988. In October 2015, as well as in December 2020, the EPA Administrator announced that the 8-h ozone standard would be used to control those cumulative W126 exposures that elicit an adverse effect on vegetation; the EPA continues to use the W126 metric as an indicator of the potential risk of ambient ozone exposures to vegetation. With several research investigators, he led an international team to estimate the historical global emissions of sulfur for the period 1850-1990. The sulfur emission estimates are used in global climate change models. An important contribution of his work in the human health research area has been the designing of hour-by-hour ozone concentrations used in several of the key experiments that identified realistic ambient exposure regimes that elicited adverse $FEV_1$ responses. Over the years, several of these clinical laboratory studies of healthy volunteers have formed the scientific basis for the human health ozone NAAQS, including the current 8-h 70 ppb standard. Dr. Lefohn has lived in Montana for over 45 years and continues to perform his worldwide research from this location.

## Executive Summary

On page 2-64 of the 2021 Supplemental PM PA (EPA, 2021a), the authors discuss how episodic impacts from a large natural source can affect $PM_{2.5}$ concentrations in the U.S. by illustrating an example from a 2017 wildfire event. In summer 2017, smoke from wildfires in British Columbia, Canada led to severe air quality degradation in parts of the Pacific Northwest. Smoke from these fires was captured at the North Cascades IMPROVE monitor, where daily fine PM concentrations were increased from a typical baseline of less than 10 $\mu g/m^3$ to ~100 $\mu g/m^3$ during this period. In reviewing the hourly average $PM_{2.5}$ data in the EPA's AQS database for the period 2017-2019, much higher concentrations are observed near or within wildfires than presented in the Supplemental PM PA (EPA, 2021a).

To better place into perspective the range of magnitude and the seasonal nature of the hourly and average 24-hour $PM_{2.5}$ concentrations that populations are exposed to near and within wildfire areas in the U.S., it is important to review additional monitoring data. $PM_{2.5}$ data from three wildfire events (2018 Camp Fire (Butte County, CA), 2017 Rice Ridge Fire (Missoula County, MT), and 2017 Thomas Fire (Santa Barbara and Ventura

Counties, CA)) are provided here as examples of the degree of severity of the $PM_{2.5}$ concentrations to which populations are exposed during wildfire events. Both parameter code 88101 and 88502 monitors are used in the characterization of the additional monitoring data. Parameter code 88101 monitors (referred to as $PM_{2.5}$ local conditions) are FRM and FEM monitors. Parameter code 88502 monitors (referred to as Acceptable $PM_{2.5}$ AQI & Speciation Mass) are considered by the EPA to be acceptable for defining $PM_{2.5}$ AQI and for Speciation Mass determinations. The initials AQI refer to the EPA's Air Quality Index. The EPA considers 88502 monitors to produce valid data that reasonably match FRM monitors with or without correction. However, EPA notes that data from 88502 monitors should not be used in NAAQS decisions (https://www.epa.gov/aqs/aqs-memos-technical-note-reporting-pm25-continuous-monitoring-and-speciation-data-air-quality). Both 88101 and 88502 monitors are used by AirNow in its Interactive Map of Air Quality to describe the spatial and temporal distribution of $PM_{2.5}$ AQI and 24-h average concentrations (https://gispub.epa.gov/airnow/?mlayer=ozonepm&clayer=none&panel=0). Fig. ES-1 below illustrates the $PM_{2.5}$ AQI readings for November 16, 2018, for monitoring sites near the 2018 Camp Fire in California. The California Air Resources Board (CARB, 2021) indicates that the 2018 Camp Fire was the deadliest wildfire in California history. At least 85 people died as the wildfire burned through Butte County (CA), destroying nearly 19,000 buildings and most of the town of Paradise. The fire generated a large plume of heavy smoke that traveled thousands of miles. The smoke caused dangerously high levels of air pollution in the Sacramento Valley and Bay Area in particular, for a period of about two weeks.

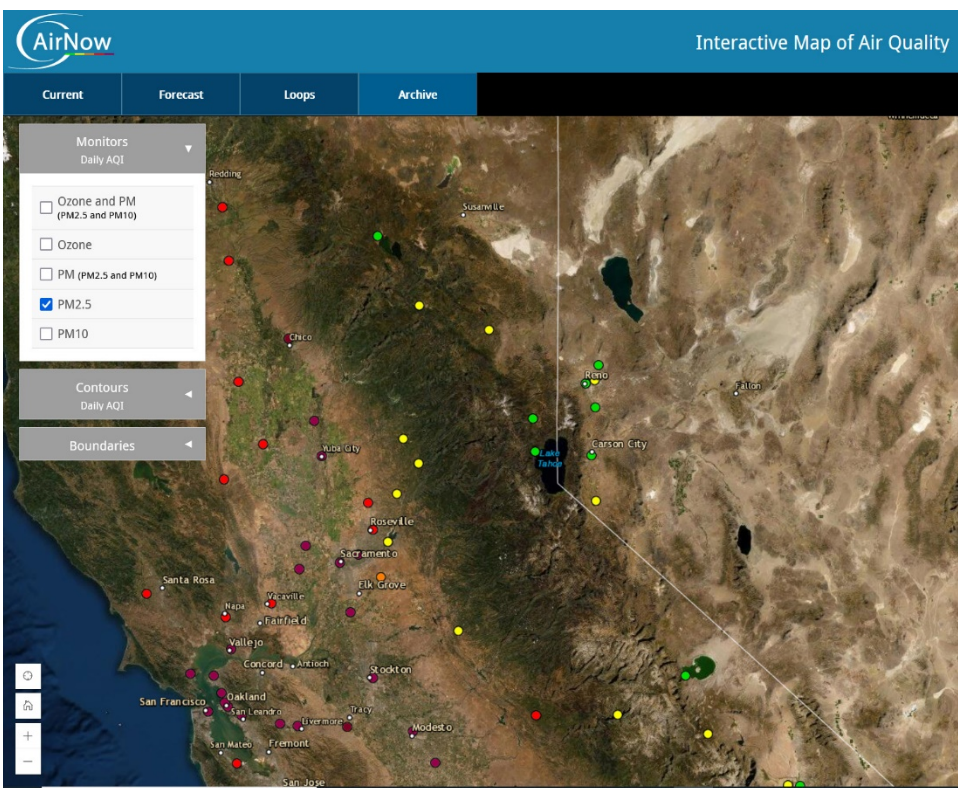


**Figure ES-1. AirNow Interactive Map of Air Quality. November 16, 2018. Monitoring sites near the Camp Fire in Butte County, California.**

The $PM_{2.5}$ data characterized from the three wildfire events discussed here provide important information about the $PM_{2.5}$ exposures that people can receive during wildfire events. It is suggested that the authors of the Supplemental PM PA document (EPA, 2021a) consider adding this material into the document to provide the reader with examples of the magnitude and frequency of episodic hourly and 24-h average $PM_{2.5}$ concentrations to which populations can be exposed during wildfire events. In the Appendix at the end of this document, Table A-1 (Hourly average $PM_{2.5}$ concentrations (Butte County, California) during the Camp Fire for the November 8 – 22, 2018 period), Table A-2 (Hourly average $PM_{2.5}$ concentrations (Missoula County, Montana) during the Rice Ridge Fire for the August 4 – September 7, 2017 period), and Table A-3 (Hourly average $PM_{2.5}$ concentrations (Ventura County, California) during the Thomas Fire for the December 5 - 17, 2017 period) provide hourly and 24-h average daily concentration information so that the reader is better able to understand the magnitude of the episodic exposures to which populations are exposed during wildfire events.

## 1. Introduction

The 2019 PM ISA (EPA, 2020a) notes that $PM_{2.5}$ can be generated from both natural and anthropogenic sources. The greatest contributors to primary $PM_{2.5}$ at the national level are agricultural dust, dust resuspended through on-road activities, and fires (i.e., wildfires, prescribed fires, and agricultural fires). Nationally, it has been estimated that wildfire smoke contributes from 10−20% of primary $PM_{2.5}$ emissions per year, and intercontinental transport contributes 0.05 to 0.15 $\mu g/m^3$ to annual average $PM_{2.5}$ concentrations in the U.S., but that this contribution varies by region and season. On average, natural sources, including soil dust and sea salt, have been estimated to account for approximately 10% of U.S. urban $PM_{2.5}$ (EPA, 2020a).

Abatzogloua and Williams (2016) have noted that widespread increases in fire activity, including area burned, number of large fires, and fire-season length, have been documented across the western United States. Increased fire activity across western US forests has coincided with climatic conditions more conducive to wildfire. Although numerous factors aided the recent rise in fire activity, observed warming and drying have significantly increased fire-season fuel aridity, fostering a more favorable fire environment across forested systems.

Page 2-26 of the Supplemental Policy Assessment (PA) (EPA, 2021a) notes that at long-term monitoring sites in the U.S., annual $PM_{2.5}$ concentrations from 2017 to 2019 averaged 8.0 $\mu g/m^3$ (with the 10th and 90th percentiles at 5.9 and 10.0 $\mu g/m^3$, respectively) and the $98^{th}$ percentiles of 24-hour concentrations averaged 21.3 $\mu g/m^3$ (with the 10th and 90th percentiles at 14.0 and 29.7 $\mu g/m^3$, respectively). The highest ambient $PM_{2.5}$ concentrations occur in the West, particularly in California and the Pacific Northwest. Much of the eastern U.S. has lower ambient concentrations, with annual average concentrations generally well below 12.0 μg/m$^3$ and 98th percentiles of 24-hour concentrations generally at or below 30 μg/m$^3$. These concentrations are distinct from design values in part because they include days with episodic events like wildfires and dust storms, which can experience elevated $PM_{2.5}$ and/or $PM_{10}$ concentrations.

In reviewing the 2019 PM ISA (EPA, 2020a), 2019 PM PA (EPA, 2020b), 2021 Supplemental PM ISA (EPA, 2021b), and the 2021 Supplemental PM PA (EPA, 2021a) documents, there is a paucity of quantitative information about the absolute $PM_{2.5}$ concentrations observed during wildfire episodes that have occurred in the Western and Rocky Mountain states over the period 2017-2019. $PM_{2.5}$ concentration levels from wildfires can be exceptionally high. Information is lacking in the 2019 PM ISA (EPA, 2020a), 2019 PM PA (EPA, 2020b), 2021 Supplemental PM ISA (EPA, 2021b), and the 2021 Supplemental PM PA (EPA, 2021a) documents about how high these $PM_{2.5}$ concentrations are. Elevated $PM_{2.5}$ concentrations from wildfires are considered by the EPA in its regulatory attainment designation process as ***exceptional events*** and are flagged as such in the AQS database. While exceptional events are excluded in the regulatory attainment designations so the EPA can assess the efficacy of control strategies implemented by the states and the tribes, it may not be clear to the public what the level is of the magnitude and duration of elevated $PM_{2.5}$ concentrations in terms of hourly, as well as 24-h average $PM_{2.5}$ concentration information during these exceptional events. In the comments which follow, I provide quantitative information about the elevated hourly and 24-hour average $PM_{2.5}$ concentration data collected over the 2017-2019 period at monitoring sites near or within three wildfire areas. I suggest this information be included in the revised Supplemental PM ISA (2021b) and/or Supplemental PM PA (2021a) documents. The period of interest in my comments is limited to 2017-2019; in the Supplemental PM PA (EPA, 2021a) document, in many instances, $PM_{2.5}$ concentration information is described for the period 2017-2019. In the West for the years 2020 and 2021, wildfires have continued to occur with populations experiencing episodic hourly and 24-h average $PM_{2.5}$ concentrations comparable, and in some cases higher, to those experienced during the 2017-2019 period. In the most recent years, many regions of the U.S. have experienced increasing occurrences of elevated AQI readings associated with $PM_{2.5}$ during the times coincident with wildfires in the West.

## 2. The Magnitude of $PM_{2.5}$ Episodic Wildfire Concentrations – 2017-2019

As described in the Introduction, Abatzogloua and Williams (2016) noted that widespread increases in fire activity, including area burned, number of large fires, and fire-season length, have been documented across the western United States. In many cases, increases in fire activity have resulted in episodic events that have led to extremely high 24-h average $PM_{2.5}$ concentrations, as well as extremely high hourly average $PM_{2.5}$ concentrations. In the previous section, it was mentioned that wildfires are considered exceptional events for the purpose of regulatory attainment designations by the Agency. The EPA's Exceptional Events Rule (81 FR 68216, October 3, 2016), most recently updated in 2016, describes the process by which these events can be excluded from the design values used for comparison to the NAAQS. Regionally concurred exceptional events are unusual or naturally occurring events, such as wildfires or high wind dust events that have 1) resulted in $PM_{2.5}$ concentrations above the level of the NAAQS, 2) been submitted by tribal, state, or local air agencies under the EPA's Exceptional Events Rule to their respective EPA Region, and 3) received concurrence. Exceptional events are unusual or naturally occurring events that can affect air quality but are not reasonably controllable using techniques that tribal, state, or local air agencies may implement in order to attain and maintain the National Ambient Air Quality Standards (NAAQS) (https://www.epa.gov/air-quality-analysis/treatment-air-quality-data-influenced-exceptional-events-homepage-exceptional). An exceptional event is not related to the frequency of occurrence of episodic events, such as wildfires and dust storms, but rather the event is related to the source associated with the event (e.g., wildfires, controlled burns, fireworks, dust storms, stratospheric ozone intrusions to the surface, and volcanic eruptions).

In September of 2016, the EPA finalized revisions to the Exceptional Events Rule to establish criteria and procedures for use in determining if air quality monitoring data has been influenced by exceptional events (https://www.epa.gov/air-quality-analysis/treatment-air-quality-data-influenced-exceptional-events-homepage-exceptional). The rule

- applies to all exceptional event types and all NAAQS,
- ensures that air quality measurements are properly evaluated and characterized with regard to their causes,
- identifies reasonable actions that state, local and tribal air quality agencies should take to address the air quality and public health impacts caused by these types of events,
- avoids imposing unreasonable planning requirements on air quality agencies related to violations of the NAAQS due to exceptional events, and
- ensures that the use of air quality data, whether afforded special treatment or not, is subject to full public disclosure and review.

In the Supplemental PM PA (EPA, 2021a), Fig. 2-19 (page 2-33) presents the frequency distribution of 2-hour average $PM_{2.5}$ mass concentrations from all FEM $PM_{2.5}$ monitors in the U.S. for 2017-2019. According to the document, at sites meeting the current primary $PM_{2.5}$ standards, these 2-hour average concentrations generally remain below 10 $\mu g/m^3$, and virtually never exceed 30 $\mu g/m^3$. Two-hour concentrations are higher at sites violating the current standards, generally remaining below 16 $\mu g/m^3$ and virtually never exceeding 80 $\mu g/m^3$ (EPA, 2021a, page 2-33).

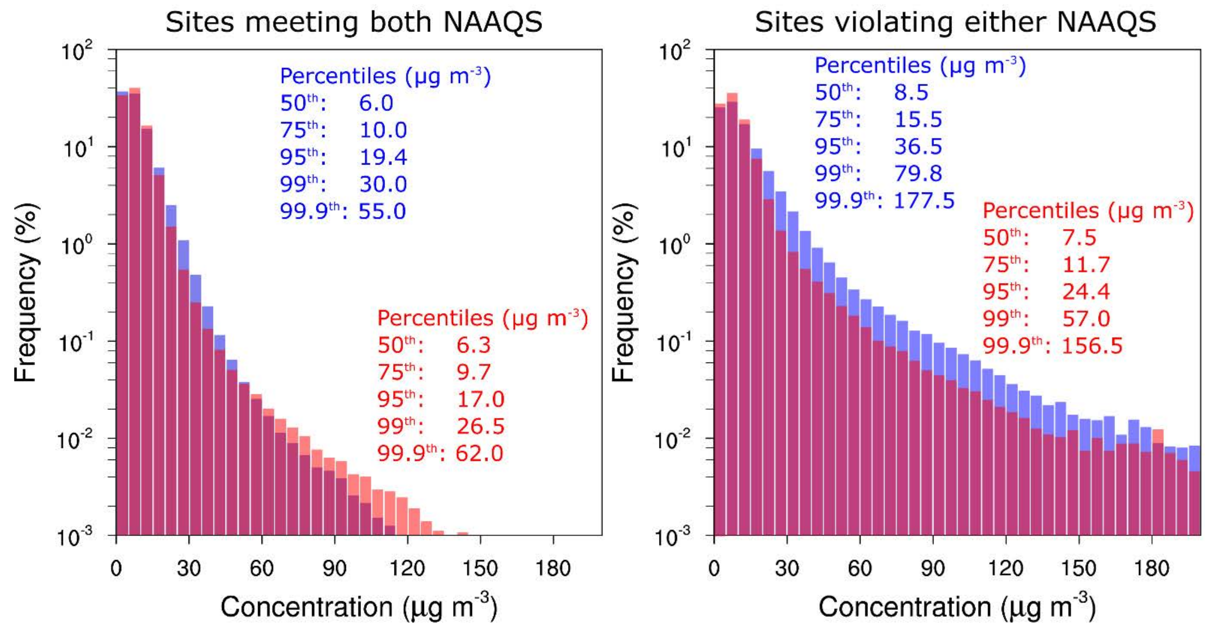



**Figure 2-19. Frequency distribution of 2017-2019 2-hour averages for sites meeting both or violating either $PM_{2.5}$ NAAQS for October to March (blue) and April to September (red). Source: EPA (2021a).**

On page 2-34 of the Supplemental PM PA document (EPA, 2021a), the document notes that the extreme upper end of the distribution of 2-hour $PM_{2.5}$ concentrations is shifted higher during the warmer months (red in Fig. 2-19), generally corresponding to the period of peak wildfire frequency (i.e., April to September) in the U.S. According to the document, at sites meeting the current primary standards, the highest 2-hour average concentrations measured virtually never occur outside of the period of peak wildfire frequency. Most of the sites measuring these very high concentrations are in the northwestern U.S. and California, where wildfires have been relatively common in recent years (see Fig. A-1 below from the Supplemental PM PA document (page A-3)).

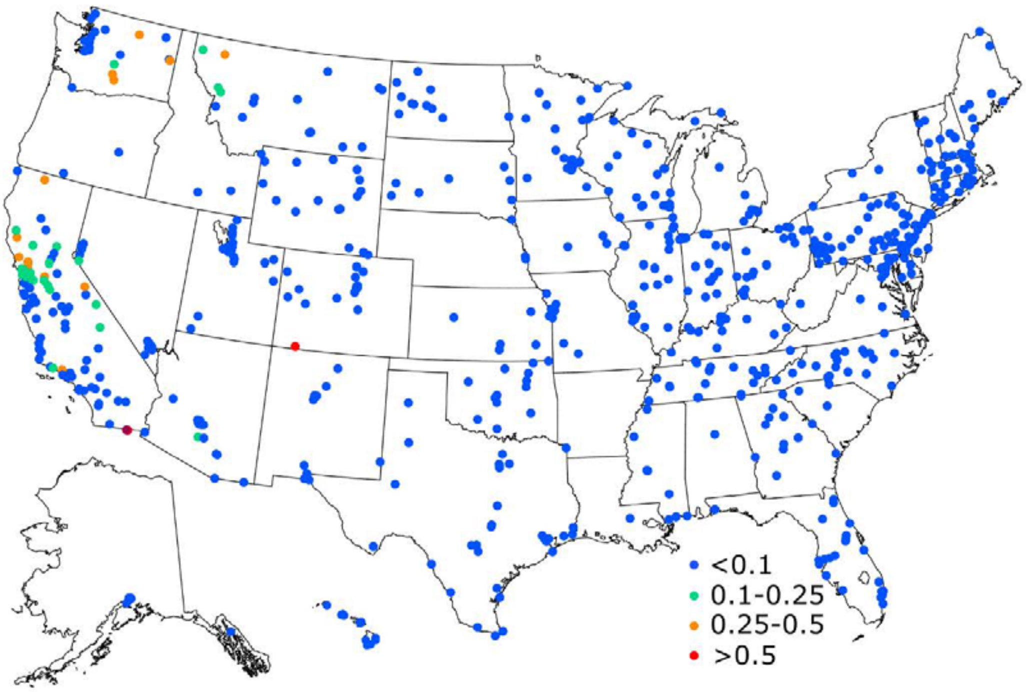



**Figure A-1. Percentages of 2017-2019 2-hour average $PM_{2.5}$ mass concentrations above 140 $\mu g/m^3$.**

**Source: EPA (2021a).**

On page 2-64 of the 2021 Supplemental PM PA (EPA, 2021a), the authors discuss how episodic impacts from a large natural source can affect $PM_{2.5}$ concentrations in the U.S. by illustrating an example from a 2017 wildfire event. In summer 2017, smoke from wildfires in British Columbia, Canada led to severe air quality degradation in parts of the Pacific Northwest. Smoke from these fires was captured at the North Cascades IMPROVE monitor, where daily fine PM concentrations were increased from a typical baseline of less than 10 $\mu g/m^3$ to ~100 $\mu g/m^3$ during this period.

In reviewing the hourly average $PM_{2.5}$ data in the EPA's AQS database for the period 2017-2019, much higher 24-h average and hourly average concentrations are observed than presented in the Supplemental PM PA (EPA, 2021a) using the IMPROVE monitor example. To better place into perspective the range of magnitude and the seasonal nature of the hourly and average 24-hour $PM_{2.5}$ concentrations that populations are exposed to near and within wildfire areas in the U.S., it is important to review additional monitoring data from the EPA's AQS database. $PM_{2.5}$ data from three wildfire events are provided as examples of the degree of severity of the $PM_{2.5}$ concentrations to which populations are exposed during wildfire events. It is suggested that the authors of the Supplemental PM PA document (EPA, 2021a) consider adding this material into the supplemental PM PA to provide the reader with examples of the magnitude and frequency of episodic hourly and 24-h $PM_{2.5}$ concentrations to which populations can be exposed during wildfire events. To place into perspective the measured $PM_{2.5}$ concentrations during the three wildfires described below, the current Federal 24-h $PM_{2.5}$ human health standard is 35 $\mu g/m^3$. There currently is no 1-h average $PM_{2.5}$ standard.

In its 2021 report about the 2018 Camp Fire (https://en.wikipedia.org/wiki/Camp_Fire_(2018)), the California Air Resources Board (CARB, 2021) indicated that the 2018 Camp Fire was the deadliest wildfire in California history. At least 85 people died as the catastrophic wildfire burned through Butte County, destroying nearly 19,000 buildings and most of the town of Paradise. According to the document, the fire generated a large plume of heavy smoke that traveled thousands of miles. The smoke caused dangerously high levels of air pollution in the Sacramento Valley and Bay Area in particular, for a period of about two weeks. With the first initial impacts recorded on November 8, the highest levels of particulate matter (PM) were recorded between November 13 and November 16, 2018, and concentrations returned to normal conditions, below current state and federal PM ambient air quality standards (standards), by November 22. According to the CARB document, the short-term episodes in particulate matter from the Camp Fire and other wildfires included in its analysis were comparable to industrial and mobile source pollution levels observed in countries such as China and India.

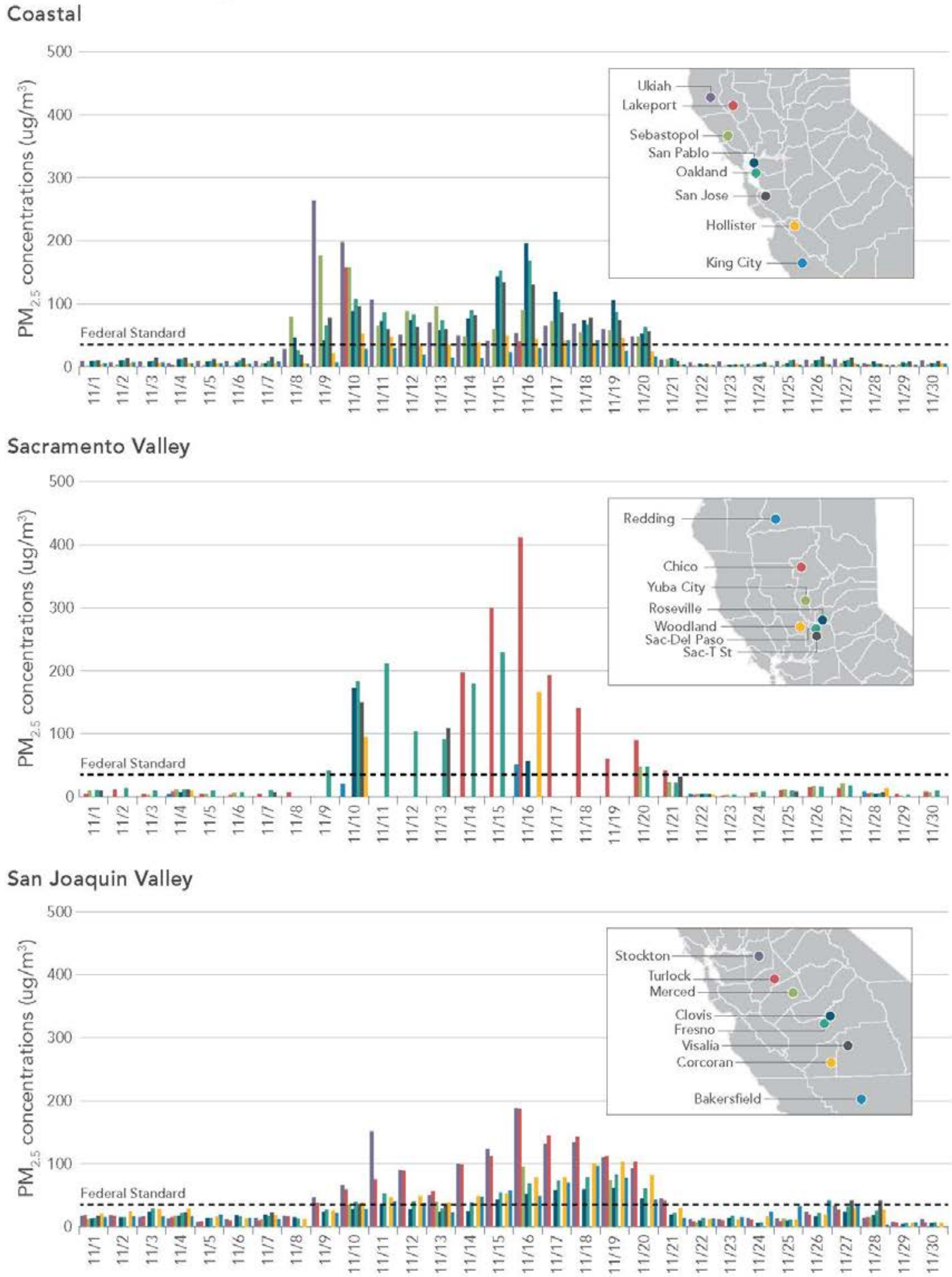
CARB (2021) notes that

> During the 2018 Camp Fire in Paradise, California, all of the Butte County ambient air monitoring sites were in operation. The California Air Resources Board (CARB) operates monitoring stations in Chico (carbon monoxide [CO], nitrogen dioxide [$NO_2$], ozone, particulate matter [$PM_{10}$ and $PM_{2.5}$], and toxics), Gridley ($PM_{2.5}$), and Paradise (ozone and $PM_{2.5}$).
>
> Two monitoring sites located in Paradise did not collect data during the Camp Fire; the ozone monitor at the Paradise- Airport site and the PM monitor at the Paradise-Theater site ceased operations when Pacific Gas and Electric Company (PG&E) cut power to the area on November 8. A filter-based monitor at the Chico site, 15 miles away from the Camp Fire, continued to operate, collecting samples on November 10, 2018, and November 16, 2018, (on an every 6th day collection schedule). The Chico site also collected data using a specialized speciation sampler, which uses filters to collect samples of particulate matter. The filters are later processed in a laboratory to determine the chemical composition of the particulate matter. Among other details, speciation helps quantify $PM_{2.5}$ mass, trace elements, wood smoke tracers, carbon, and ions.
>
> Particulate matter increased at most sites in Northern California west and south of the Camp Fire (Figure 2). The highest PM concentrations were recorded in Chico, the closest monitoring site

> to the Camp Fire and in the direct path of the smoke plumes (Figure 3). The average PM concentrations at selected monitoring sites showed significant increases when compared to both historical (2010 to 2017) November averages and to the period in which the Camp Fire occurred (Figure 3; Tables 2 and 3). From November 8 to November 22, $PM_{2.5}$ increased by more than 300 percent from historical averages.

Table 1 from CARB (2021) shows that the maximum 24-h average $PM_{2.5}$ concentration at the Chico monitoring station (06070008-1) was 412 $\mu g/m^3$ on November 16, 2018. At the Modesto, Sacramento-Del Paso, and San Jose monitoring sites, the maximum 24-h $PM_{2.5}$ average concentrations were 190 $\mu g/m^3$ (November 16), 228 $\mu g/m^3$ (November 15), and 134 $\mu g/m^3$ (November 15), respectively.

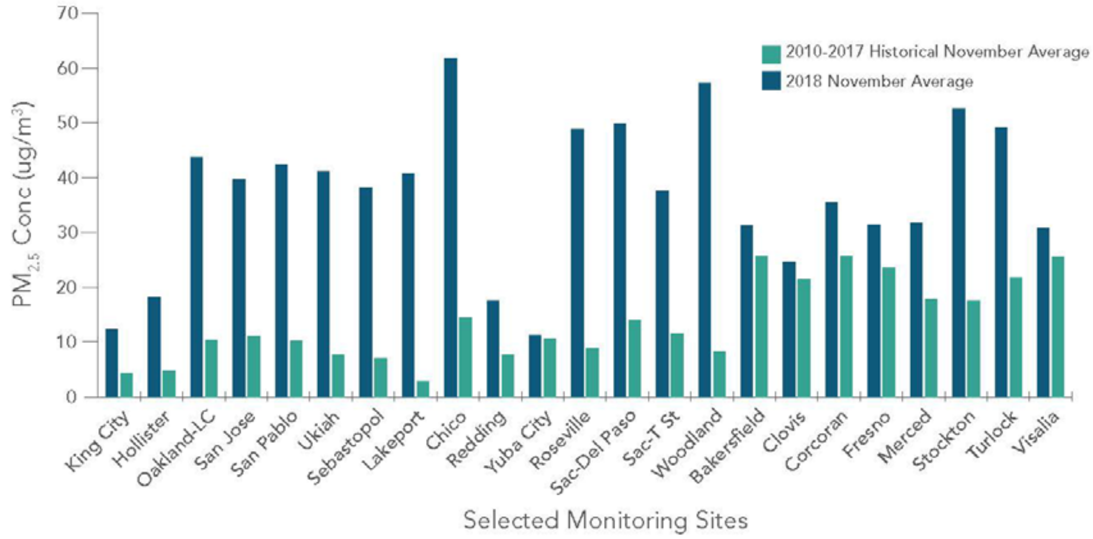
**FIGURE 2: DAILY $PM_{2.5}$ CONCENTRATIONS – NOVEMBER 2018**




4 Camp Fire Air Quality Data Analysis

**Source: CARB (2021).**

**Figure 3: November monthly average concentrations at selected sites – November 2018 compared to average of Novembers 2010-2017**




The following tables highlight the significant increase in $PM_{2.5}$ concentrations recorded at selected sites in the path of the smoke plume and compares them to average concentrations from the previous eight years (2010-2017).

**Source: CARB (2021).**

**Table 1: Maximum PM Concentrations at Four Selected Sites**

| Site | $PM_{2.5}$ | |
|---|---|---|
| | Concentration (µg/m³) | Date |
| Chico | 412 | 11/16/18 |
| Modesto | 190 | 11/16/18 |
| Sacramento-Del Paso | 228 | 11/15/18 |
| San Jose | 134 | 11/15/18 |

**Source: CARB (2021).**

Table A-1 in the Appendix shows for the Chico and Gridley monitors the hour-by-hour $PM_{2.5}$ concentrations for the period November 8 – 22, 2018 for the 88502 monitors near the Camp Fire. The hourly $PM_{2.5}$ data were downloaded from the EPA's AQS website (https://aqs.epa.gov/aqsweb/airdata/download_files.html#Raw). Parameter code 88502 monitors are considered by the EPA to be acceptable for defining $PM_{2.5}$ AQI and for Speciation Mass determinations. The EPA considers 88502 monitors to produce valid data that reasonably match FRM monitors with or without correction. However, EPA notes that data from 88502 monitors should not be used in NAAQS decisions (https://www.epa.gov/aqs/aqs-memos-technical-note-reporting-pm25-continuous-monitoring-and-speciation-data-air-quality). Hourly average $PM_{2.5}$

concentrations (shown in red in Table A-1) at Chico, California (AQS ID 060070008-3) on November 16, 2018, ranged from 255 µg/m$^3$ to 585 µg/m$^3$. The 24-h average concentration at this site on November 16, 2018, was 417 µg/m$^3$. The 88101 monitor (060070008-1), which is a bulk sampler, on that same day recorded 412 µg/m$^3$. On November 9, 2018, the Chico monitor (060070008-3) recorded 3 consecutive $PM_{2.5}$ hourly average concentrations of 995 µg/m$^3$ at 1700, 1800, and 1900 LST. The 24-h average $PM_{2.5}$ concentration was 279 µg/m$^3$ on that day. At the Chico monitor (060070008-3), for the November 8 – 22, 2018 period, there were 164 hours when the $PM_{2.5}$ hourly average concentrations that ranged from 200 to 995 µg/m$^3$.

In Montana, additional monitoring data during a 2017 wildfire provide information on $PM_{2.5}$ concentrations that populations are exposed to near and within wildfire areas. In Montana, the Rice Ridge Fire (https://en.wikipedia.org/wiki/Rice_Ridge_Fire) was started by a lightning strike on July 24, 2017. It burned northeast of Seeley Lake in the Lolo National Forest in Montana. The fire became a megafire on September 3, 2017, growing from 40,000 acres (162 km$^2$) to over 100,000 acres (405 km$^2$), at which time it became the nation's top wildfire priority. Located north and east of Seeley Lake, Montana, over 700 firefighting personnel were assigned to the blaze, primarily active in a mountainous lodgepole and mixed conifer forest. At one point, the fire threatened over 1,000 homes in Powell County and Missoula County, including the town of Seeley Lake. The hourly $PM_{2.5}$ data were downloaded from the EPA's AQS website (https://aqs.epa.gov/aqsweb/airdata/download_files.html#Raw) and summarized in Table A-2 in the Appendix. A monitor (an 88502 monitor with AQS ID 300630038-3) is in the Seeley Lake area. On August 4, 2017, a 24-h average $PM_{2.5}$ concentration of 369 µg/m$^3$ at Seeley Lake was recorded; the highest hourly $PM_{2.5}$ concentration was 994.6 µg/m$^3$, which occurred two times during the day. Between August 4 and September 7, 2017, 9 days were recorded at the Seeley Lake monitor, where the hourly average $PM_{2.5}$ concentration reached a maximum of 994.6 µg/m$^3$. During this same period, there were 30 occurrences of the 24-h average $PM_{2.5}$ concentration above 100 µg/m$^3$. On September 6, 2017, a maximum 24-h average concentration of 642 µg/m$^3$ was recorded.

A few months after the 2017 Rice Ridge fire in Montana, a massive wildfire broke out in southern California. California had already been experiencing several serious wildfires during the year. In December 2017, a massive fire in the Ojai, California area, referred to as the Thomas Fire (https://en.wikipedia.org/wiki/Thomas_Fire), affected Ventura and Santa Barbara Counties. It burned approximately 281,893 acres (440 sq mi; 114,078 ha) before being fully contained on January 12, 2018, As of August 2020, the Thomas Fire is California's tenth-most destructive wildfire. Ventura's agriculture industry suffered at least $171 million in losses due to the Thomas Fire. The hourly $PM_{2.5}$ data from a monitoring site in Ojai, California were downloaded from the EPA's AQS website (https://aqs.epa.gov/aqsweb/airdata/download_files.html#Raw) and summarized in Table A-3 in the Appendix. The monitor is an 88101 monitor with AQS ID 061111004-3). Elevated $PM_{2.5}$ hourly average concentrations were measured at the site from December 5 through December 17, 2017. On December 6, a maximum hourly average $PM_{2.5}$ concentration of 979 µg/m$^3$ was recorded. On that same day, the 24-h $PM_{2.5}$

concentration of 557 µg/m$^3$ was recorded. Over the 13-day period, there were 8 days when the 24-h average $PM_{2.5}$ concentration was above 100 µg/m$^3$.

## 3. Identifying Additional Episodic $PM_{2.5}$ Events that May be Associated with Wildfires

The $PM_{2.5}$ data characterized from the three wildfire events discussed in Section 2 provide important information about the $PM_{2.5}$ exposures that people can receive during wildfire events. It is suggested that the authors of the Supplemental PM PA document (EPA, 2021a) consider adding this material into the document to provide the reader with examples of the magnitude and frequency of episodic hourly and 24-h average $PM_{2.5}$ concentrations to which populations can be exposed during wildfire events. In the Appendix at the end of this document, Table A-1 (Hourly average $PM_{2.5}$ concentrations (Butte County, California) during the Camp Fire for the November 8 – 22, 2018 period), Table A-2 (Hourly average $PM_{2.5}$ concentrations (Missoula County, Montana) during the Rice Ridge Fire for the August 4 – September 7, 2017 period), and Table A-3 (Hourly average $PM_{2.5}$ concentrations (Ventura County, California) during the Thomas Fire for the December 5 - 17, 2017 period) provide hourly and 24-h average daily concentration information so that the reader is better able to understand the magnitude of the episodic exposures to which populations are exposed during wildfire events.

Besides the three examples provided in Section 2, additional short-term $PM_{2.5}$ exposure information from wildfires during the 2017-2019 period may be available in the EPA's AQS database. Local air quality agencies are required to report air quality using the Air Quality Index (AQI) as required in 40 CFR Part 58.50 and according to 40 CFR Appendix G to Part 58 (EPA, 2018). Metropolitan Statistical Areas (MSAs) with a population of more than 350,000 are required to report the AQI daily to the public. MSAs must report the AQI daily, which is defined as at least five days each week. In implementing its Air Quality Index reported across the U.S., EPA for $PM_{2.5}$ separates the range of 24-h average concentrations into the following color-coded ranges as described by the American Lung Association's State of the Air report (2021):

| 24-hour $PM_{2.5}$ Concentration | Air Quality Index Levels |
|---|---|
| 0.0 µg/m$^3$ to 12.0 µg/m$^3$ | Good (Green) |
| 12.1 µg/m$^3$ to 35.4 µg/m$^3$ | Moderate (Yellow) |
| 35.5 µg/m$^3$ to 55.4 µg/m$^3$ | Unhealthy for Sensitive Groups (Orange) |
| 55.5 µg/m$^3$ to 150.4 µg/m$^3$ | Unhealthy (Red) |
| 150.5 µg/m$^3$ to 250.4 µg/m$^3$ | Very Unhealthy (Purple) |
| greater than or equal to 250.5 µg/m$^3$ | Hazardous (Maroon) |

**Source: American Lung Association (2021).**

Additional examples of episodic $PM_{2.5}$ events (i.e., 24-h average values) that may be associated with wildfires during the 2017-2019 period were identified by sorting maximum 24-h average $PM_{2.5}$ concentrations using Quick Look summaries from the EPA's AQS database. As indicated in Section 2 of this document, maximum 24-h $PM_{2.5}$ concentrations experienced in or near the wildfires were equal to or greater than 250.5 $\mu g/m^3$ (i.e., AQI Hazardous reading designated by the maroon color in the table above). Table 1 below identifies those 88101 monitoring sites that met this criterion. Table 2 identifies those 88502 monitoring sites that experienced 24-h average $PM_{2.5}$ maximum concentrations $\geq 250.5\ \mu g\ m^3$. The column with the maximum $PM_{2.5}$ 24-h average concentration is identified in red. Several of the $PM_{2.5}$ monitoring sites are in Washington, Oregon, and California, where major wildfires occurred during the 2017-2019 period.

## References


Abatzoglou, J. T., Williams, A.P. 2016. Impact of anthropogenic climate change on wildfire across western US forests. Proceedings of the National Academy of Sciences of the United States of America, 113 (42), 11770–11775. doi:10.1073/pnas.1607171113.

American Lung Association. 2021. State of the Air 2021. Washington, DC. https://www.lung.org/getmedia/17c6cb6c-8a38-42a7-a3b0-6744011da370/sota-2021.pdf.

California Air Resources Board (CARB). 2021. Camp Fire Air Quality Analysis. Air Quality Planning & Science Division Monitoring & Laboratory Division Research Division. Sacramento, California. https://ww2.arb.ca.gov/sites/default/files/2021-07/Camp_Fire_report_July2021.pdf.

U.S. EPA. 2018. Technical Assistance Document for the Reporting of Daily Air Quality – the Air Quality Index (AQI). EPA 454/B-18-007. Research Triangle Park, NC: Environmental Protection Agency. Available at https://www.airnow.gov/sites/default/files/2020-05/aqi-technical-assistance-document-sept2018.pdf.

US EPA. 2020a. Integrated Science Assessment of Ozone and Related Photochemical Oxidants. EPA/600/R-20/012. April. Research Triangle Park, NC: Environmental Protection Agency. April. Available at: https://www.epa.gov/naaqs/ozone-o3-standards-integrated-science-assessments-current-review.

US EPA. 2020b. Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards. EPA-452/R-20-001. May. Available at https://www.epa.gov/naaqs/ozone-o3-standards-policy-assessments-current-review.

US EPA. 2021a. Policy Assessment for the Reconsideration of the National Ambient Air Quality Standards for Particulate Matter, External Review Draft), EPA-452/P-21-001, October 2021.

US EPA, 2021b. Supplement to the 2019 Integrated Science Assessment for Particulate Matter (External Review Draft), EPA/600/R-21/198, September 2021.

**Table 1. EPA AQS Quick Look 2017 – 2019 24-h Average $PM_{2.5}$ Maximum Concentration ≥ 250.5 µg $m^{-3}$ using 88101 Monitoring Sites. Units are µg/$m^3$.**

| AQS ID | Param. | POC | EDT | Duration | Year | Unit | Latitude | Longitude | Meas. | Max | 2nd | 3rd | 4th | Annual | Method Code |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 061111004 | 88101 | 3 | 2 | X | 2017 | 105 | 34.44806 | -119.231 | 360 | **557** | 529.4 | 186.5 | 178.8 | 13.49 | 170 |
| 410390059 | 88101 | 1 | 0 | 7 | 2017 | 105 | 44.06722 | -123.141 | 120 | **330** | 46.8 | 42.5 | 36.4 | 10.92 | 145 |
| 410391009 | 88101 | 1 | 0 | 7 | 2017 | 105 | 44.0467 | -123.018 | 59 | **286.8** | 134.1 | 41.4 | 27.9 | 13.68 | 143 |
| 060070008 | 88101 | 1 | 0 | 7 | 2018 | 105 | 39.76168 | -121.84 | 346 | **411.7** | 299.9 | 197 | 192.5 | 13.77 | 145 |
| 060450006 | 88101 | 3 | 2 | X | 2018 | 105 | 39.15047 | -123.207 | 362 | **263.2** | 198 | 106 | 70.5 | 11.35 | 170 |
| 530470013 | 88101 | 5 | 0 | X | 2018 | 105 | 48.39999 | -119.519 | 334 | **261** | 236 | 125.2 | 115.9 | 12.17 | 170 |
| 020900035 | 88101 | 1 | 2 | 7 | 2019 | 105 | 64.76297 | -147.31 | 331 | **327** | 314.5 | 278.4 | 210 | 15.21 | 145 |

**Table 2. EPA AQS Quick Look 2017 – 2019 24-h Average $PM_{2.5}$ Maximum Concentration ≥ 250.5 µg $m^{-3}$ using 88502 Monitoring Sites. Units are µg/$m^3$.**

| AQS ID | Param. | POC | EDT | Duration | Year | Unit | Latitude | Longitude | Meas. | Max | 2nd | 3rd | 4th | Annual | Method Code |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 300630038 | 88502 | 3 | 2 | X | 2017 | 105 | 47.17563 | -113.476 | 359 | **641.9** | 545.8 | 503.8 | 435.4 | 46.39 | 731 |
| 061050002 | 88502 | 1 | 2 | X | 2017 | 105 | 40.73475 | -122.941 | 184 | **498** | 358.5 | 241.5 | 212 | 22.7 | 731 |
| 410170004 | 88502 | 3 | 0 | X | 2017 | 105 | 44.2921 | -121.556 | 343 | **315.1** | 307.2 | 300.2 | 221.3 | 15.91 | 771 |
| 410290203 | 88502 | 3 | 0 | X | 2017 | 105 | 42.1941 | -122.709 | 364 | **305.7** | 257.8 | 176.9 | 140.2 | 11.76 | 771 |
| 300890007 | 88502 | 3 | 2 | X | 2017 | 105 | 47.5944 | -115.324 | 184 | **299.8** | 225 | 217.3 | 215.4 | 19.78 | 731 |
| 410330011 | 88502 | 3 | 0 | X | 2017 | 105 | 42.29009 | -123.232 | 351 | **282.9** | 246.3 | 207.5 | 192.5 | 12.53 | 771 |
| 410290133 | 88502 | 3 | 0 | X | 2017 | 105 | 42.31411 | -122.879 | 365 | **268.4** | 247.8 | 198.5 | 150.3 | 13.99 | 771 |
| 160090010 | 88502 | 3 | 0 | X | 2017 | 105 | 47.31658 | -116.571 | 356 | **256.3** | 182.9 | 120.3 | 118.2 | 15.58 | 731 |
| 060070008 | 88502 | 3 | 2 | X | 2018 | 105 | 39.76168 | -121.84 | 360 | **417** | 306.2 | 279.7 | 246.8 | 18.07 | 731 |
| 530070007 | 88502 | 4 | 0 | X | 2018 | 105 | 47.83861 | -120.023 | 355 | **389** | 237.4 | 172.2 | 171.4 | 12.25 | 771 |
| 530070011 | 88502 | 4 | 0 | X | 2018 | 105 | 47.43061 | -120.342 | 330 | **295.8** | 215.9 | 165 | 153.5 | 11.97 | 771 |
| 061010003 | 88502 | 3 | 0 | X | 2018 | 105 | 39.13877 | -121.619 | 359 | **285** | 221.6 | 190.1 | 188.5 | 18.27 | 731 |
| 060074001 | 88502 | 3 | 0 | X | 2018 | 105 | 39.32756 | -121.669 | 358 | **266.8** | 260.4 | 223.9 | 197.5 | 17.08 | 731 |
| 060670010 | 88502 | 3 | 0 | X | 2018 | 105 | 38.56844 | -121.493 | 340 | **263.3** | 225.1 | 152.2 | 149.4 | 12.78 | 731 |
| 060773005 | 88502 | 3 | 0 | X | 2018 | 105 | 37.68264 | -121.442 | 351 | **257.5** | 174.7 | 141.7 | 114.4 | 12.26 | 731 |
| 060431001 | 88502 | 3 | 0 | X | 2018 | 105 | 37.74871 | -119.587 | 274 | **251** | 225.8 | 212.7 | 185.7 | 24.06 | 731 |
| 020900035 | 88502 | 3 | 0 | X | 2019 | 105 | 64.76297 | -147.31 | 331 | **264.5** | 264.2 | 252.5 | 182 | 16.78 | 731 |

**Appendix A**

**Table A-1. Hourly average $PM_{2.5}$ concentrations (Butte County, California) during the Camp Fire for the November 8 – 22, 2018 period. Units are $\mu g/m^3$.**

| Site | AQS ID | POC | Parm. | Date (LST) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | Avg. | Max. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gridley | 060074001 | 3 | 88502 | 11/8/2018 | 9 | 7 | 4 | 5 | 6 | 6 | 6 | 7 | 8 | 10 | 15 | 38 | 27 | 14 | 13 | 22 | 6 | 15 | 22 | 67 | 92 | 184 | 51 | 34 | 27.83 | 184 |
| Chico | 060070008 | 3 | 88502 | 11/8/2018 | 6 | 6 | 4 | 1 | 2 | 6 | 6 | 17 | 4 | 6 | 4 | 3 | 7 | 9 | 5 | 0 | 0 | 1 | 4 | 8 | 10 | 17 | 12 | 12 | 6.25 | 17 |
| Paradise | 060072002 | 3 | 88502 | 11/8/2018 | 4 | 2 | 2 | 2 | 4 | 3 | 4 | 2 | 210 | | | | | | | | | | | | | | | | 25.89 | 210 |
| Chico | 060070008 | 3 | 88502 | 11/9/2018 | 11 | 17 | 12 | 17 | 14 | 14 | 17 | 17 | 25 | 15 | 14 | 12 | 36 | 129 | 226 | 368 | 701 | 995 | 995 | 995 | 831 | 580 | 347 | 327 | 279.79 | 995 |
| Gridley | 060074001 | 3 | 88502 | 11/9/2018 | 7 | 10 | 8 | 7 | 9 | 8 | 8 | 7 | 7 | | 6 | | 25 | 12 | 12 | 7 | 21 | 27 | 26 | 21 | 30 | 38 | 40 | 38 | 17.00 | 40 |
| Gridley | 060074001 | 3 | 88502 | 11/10/2018 | 52 | 70 | 128 | 128 | 126 | 113 | 115 | 107 | 101 | 112 | 110 | 125 | 102 | 123 | 115 | 90 | 119 | 168 | 181 | 195 | 238 | 236 | 288 | 769 | 162.96 | 769 |
| Chico | 060070008 | 3 | 88502 | 11/10/2018 | 287 | 248 | 237 | 227 | 217 | 199 | 171 | 164 | 148 | 164 | 163 | 149 | 179 | 132 | 100 | 104 | 203 | 596 | 649 | 644 | 399 | 234 | 172 | 138 | 246.83 | 649 |
| Gridley | 060074001 | 3 | 88502 | 11/11/2018 | 395 | 190 | 73 | 63 | 26 | 14 | 13 | 12 | 15 | 28 | 30 | 14 | 27 | 20 | 9 | 6 | 5 | 7 | 7 | 21 | 71 | 99 | 94 | 96 | 55.63 | 395 |
| Chico | 060070008 | 3 | 88502 | 11/11/2018 | 125 | 116 | 71 | 62 | 59 | 53 | 45 | 27 | 25 | 4 | 5 | 6 | 5 | 3 | -1 | 3 | 2 | -3 | | 1 | 23 | 51 | 57 | 52 | 34.39 | 125 |
| Chico | 060070008 | 3 | 88502 | 11/12/2018 | 45 | 43 | 33 | 30 | 37 | 41 | 49 | 43 | 58 | 40 | 47 | 91 | 99 | 87 | 167 | 210 | 256 | 281 | 273 | 290 | 230 | 205 | 189 | 162 | 125.25 | 290 |
| Gridley | 060074001 | 3 | 88502 | 11/12/2018 | 103 | 93 | 86 | 86 | 93 | 90 | 83 | 84 | 78 | 54 | 45 | 59 | 40 | 50 | 76 | 117 | 132 | 125 | 126 | 125 | 128 | 112 | 99 | 94 | 90.75 | 132 |
| Gridley | 060074001 | 3 | 88502 | 11/13/2018 | 93 | 80 | 82 | 111 | | 126 | 149 | 141 | 173 | 172 | 235 | 332 | 245 | 189 | 150 | 167 | 179 | 177 | 160 | 156 | 144 | 147 | 168 | 166 | 162.70 | 332 |
| Chico | 060070008 | 3 | 88502 | 11/13/2018 | 184 | 180 | 147 | 141 | 145 | 147 | 140 | 136 | 155 | 159 | 148 | 104 | 85 | 79 | 75 | 72 | 79 | 83 | 82 | 95 | 80 | 91 | 131 | 158 | 120.67 | 184 |
| Gridley | 060074001 | 3 | 88502 | 11/14/2018 | 171 | 176 | 184 | 173 | 174 | 172 | 153 | 153 | 81 | 42 | | 148 | 247 | 341 | 341 | 356 | 352 | 361 | 373 | 420 | 457 | 400 | 374 | 342 | 260.48 | 457 |
| Chico | 060070008 | 3 | 88502 | 11/14/2018 | 155 | 157 | 154 | 141 | 166 | 178 | 192 | 185 | 184 | 190 | 198 | 133 | 169 | 195 | 193 | 188 | 195 | 219 | 236 | 264 | 290 | 301 | 278 | 270 | 201.29 | 301 |
| Chico | 060070008 | 3 | 88502 | 11/15/2018 | 279 | 280 | 296 | 328 | 334 | 333 | 254 | 184 | 146 | 147 | 145 | 149 | 182 | 211 | 418 | 455 | 436 | 403 | 393 | 396 | 410 | 402 | 389 | 379 | 306.21 | 455 |
| Gridley | 060074001 | 3 | 88502 | 11/15/2018 | 331 | 320 | 318 | 309 | 305 | 308 | 318 | 374 | 278 | 204 | 210 | 206 | 215 | 217 | 245 | 247 | 252 | 262 | 236 | 229 | 242 | 251 | 266 | 262 | 266.88 | 374 |
| **Chico** | **060070008** | **3** | 88502 | **11/16/2018** | **352** | **342** | **323** | **303** | **280** | **265** | **264** | **255** | **266** | **258** | **368** | **501** | **563** | **585** | **581** | **584** | **569** | **557** | **543** | **510** | **500** | **449** | **408** | **384** | **417.08** | **585** |
| Gridley | 060074001 | 3 | 88502 | 11/16/2018 | 268 | 279 | 273 | 271 | 248 | 248 | 244 | 236 | 204 | 164 | 137 | 149 | 170 | 152 | 127 | 121 | 106 | 192 | 251 | 157 | 156 | 194 | 203 | 190 | 197.50 | 279 |
| Chico | 060070008 | 3 | 88502 | 11/17/2018 | 347 | 309 | 284 | 259 | 260 | 225 | 199 | 192 | 180 | 182 | 173 | 139 | 151 | 146 | 143 | 141 | 139 | 146 | 167 | 160 | 159 | 159 | 154 | 147 | 190.04 | 347 |
| Gridley | 060074001 | 3 | 88502 | 11/17/2018 | 197 | 209 | 203 | 198 | 192 | 196 | 213 | 217 | 220 | 208 | 251 | 220 | 196 | 221 | 262 | 243 | 275 | 236 | 244 | 240 | 241 | 231 | 235 | 227 | 223.96 | 275 |
| Chico | 060070008 | 3 | 88502 | 11/18/2018 | 145 | 145 | 142 | 146 | 146 | 139 | 143 | 141 | 141 | 206 | 246 | 249 | 195 | 140 | 110 | 105 | 99 | 100 | 117 | 116 | 124 | 112 | 113 | 115 | 143.13 | 249 |
| Gridley | 060074001 | 3 | 88502 | 11/18/2018 | 235 | 225 | 223 | 222 | 220 | 216 | 215 | 205 | 188 | 123 | 152 | 119 | 112 | 101 | 68 | 50 | 56 | 56 | 60 | 71 | 74 | 94 | 104 | 102 | 137.13 | 235 |
| Gridley | 060074001 | 3 | 88502 | 11/19/2018 | 120 | 119 | 116 | 125 | 128 | 117 | 114 | 81 | 69 | 49 | 47 | 38 | 44 | 55 | 48 | 61 | 91 | 97 | 92 | 103 | 96 | 86 | 80 | 80 | 85.67 | 128 |
| Chico | 060070008 | 3 | 88502 | 11/19/2018 | 111 | 87 | 87 | 73 | 66 | 65 | 59 | 51 | | 44 | 37 | 20 | 27 | 36 | 32 | 32 | 52 | 70 | 87 | 82 | 71 | 72 | 70 | 72 | 61.00 | 111 |
| Chico | 060070008 | 3 | 88502 | 11/20/2018 | 70 | 71 | 56 | 51 | 46 | 52 | 79 | 42 | 51 | 52 | 60 | 102 | 136 | 142 | 163 | 137 | 143 | 156 | 139 | 144 | 108 | 80 | 79 | 80 | 93.29 | 163 |
| Gridley | 060074001 | 3 | 88502 | 11/20/2018 | 87 | 80 | 78 | 71 | 83 | 76 | 72 | 74 | 79 | 68 | 95 | 98 | 81 | 71 | 47 | 33 | 32 | 39 | 36 | 36 | 29 | 33 | 28 | 27 | 60.54 | 98 |
| Chico | 060070008 | 3 | 88502 | 11/21/2018 | 81 | 94 | 97 | 96 | 107 | 89 | 78 | 76 | 35 | 31 | 28 | 21 | 18 | 16 | 12 | 11 | 12 | 11 | 8 | 5 | 5 | 6 | 3 | 5 | 39.38 | 107 |
| Gridley | 060074001 | 3 | 88502 | 11/21/2018 | 24 | 22 | 21 | 20 | 16 | 21 | 25 | 22 | 21 | 19 | 30 | 30 | 28 | 23 | 19 | 17 | 15 | 12 | 12 | 10 | 6 | 5 | 9 | 9 | 18.17 | 30 |
| Gridley | 060074001 | 3 | 88502 | 11/22/2018 | 21 | 7 | 7 | 6 | 6 | 11 | 11 | 9 | 10 | 10 | 9 | 5 | 4 | 6 | 6 | 6 | 3 | 4 | 6 | 5 | 3 | 3 | 3 | 5 | 6.92 | 21 |
| Chico | 060070008 | 3 | 88502 | 11/22/2018 | 6 | 1 | 1 | 3 | 5 | 7 | 5 | 0 | 3 | 4 | 5 | 8 | 7 | 5 | 1 | -3 | 0 | 4 | -2 | -1 | 2 | 4 | 3 | 1 | 2.88 | 8 |

**Source: AQS Database (**https://aqs.epa.gov/aqsweb/airdata/download_files.html#Raw**). Data were collated by the EPA as noted on its website on November 24, 2021.**

**Table A-2. Hourly average $PM_{2.5}$ concentrations (Missoula County, Montana) during the Rice Ridge Fire for the August 4 – September 7, 2017 period. Units are $\mu g/m^3$.**

| Site | AQS ID | POC | Parm. | Date (LST) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | Avg. | Max. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Seeley | 300630038 | 3 | 88502 | 8/4/2017 | 581 | 678 | 689 | 690 | 811 | 893 | 995 | 995 | 973 | 729 | 347 | 68 | 43 | 37 | 35 | 39 | 53 | 56 | 33 | 34 | 25 | 20 | 21 | 22 | 369.37 | 995 |
| Seeley | 300630038 | 3 | 88502 | 8/5/2017 | 22 | 27 | 26 | 31 | 35 | 49 | 94 | 145 | 31 | 19 | 13 | 17 | 19 | 17 | 25 | 31 | 29 | 19 | 19 | 23 | 17 | 18 | 19 | 26 | 32.025 | 145 |
| Seeley | 300630038 | 3 | 88502 | 8/6/2017 | 59 | 221 | 350 | 459 | 571 | 666 | 691 | 591 | 185 | 63 | 19 | 13 | 14 | 19 | 35 | 42 | 50 | 50 | 31 | 22 | 20 | 16 | 16 | 40 | 176.69 | 691 |
| Seeley | 300630038 | 3 | 88502 | 8/7/2017 | 266 | 598 | 725 | 765 | 824 | 831 | 831 | 527 | 397 | 119 | 46 | 14 | 22 | 18 | 14 | 15 | 23 | 29 | 32 | 42 | 48 | 155 | 262 | 321 | 288.4 | 831 |
| Seeley | 300630038 | 3 | 88502 | 8/8/2017 | 346 | 442 | 509 | 596 | 693 | 661 | 648 | 445 | 242 | 155 | 34 | 23 | 25 | 25 | 22 | 29 | 41 | 30 | 35 | 36 | 32 | 27 | 27 | 35 | 214.73 | 693 |
| Seeley | 300630038 | 3 | 88502 | 8/9/2017 | 35 | 35 | 43 | 82 | 169 | 262 | 313 | 277 | 146 | 62 | 30 | 24 | 27 | 25 | 33 | 59 | 83 | 50 | 72 | 53 | 31 | 27 | 34 | 158 | 88.671 | 313 |
| Seeley | 300630038 | 3 | 88502 | 8/10/2017 | 436 | 562 | 664 | 669 | 741 | 823 | 866 | 958 | 759 | 291 | 53 | 26 | 30 | 40 | 53 | 57 | 53 | 51 | 51 | 52 | 27 | 57 | 128 | 92 | 314.08 | 958 |
| Seeley | 300630038 | 3 | 88502 | 8/11/2017 | 79 | 113 | 208 | 321 | 398 | 510 | 595 | 697 | 658 | 235 | 49 | 28 | 44 |  | 60 | 57 | 53 | 49 | 47 | 53 | 55 | 86 | 124 | 120 | 201.62 | 697 |
| Seeley | 300630038 | 3 | 88502 | 8/12/2017 | 115 | 91 | 99 | 67 | 71 | 76 | 99 | 142 | 58 | 32 | 26 | 28 | 35 | 43 | 52 | 31 | 54 | 61 | 59 | 61 | 62 | 87 | 143 | 295 | 78.6 | 295 |
| Seeley | 300630038 | 3 | 88502 | 8/13/2017 | 197 | 128 | 141 | 212 | 133 | 169 | 182 | 217 | 119 | 78 | 50 | 42 | 39 | 28 | 33 | 23 | 21 | 24 | 26 | 19 | 21 | 24 | 23 | 23 | 81.988 | 217 |
| Seeley | 300630038 | 3 | 88502 | 8/14/2017 | 20 | 26 | 60 | 104 | 103 | 122 | 103 | 124 | 152 | 72 | 17 | 15 | 16 | 16 | 7.8 | 9 | 12 | 12 | 17 | 36 | 44 | 35 | 160 | 222 | 62.567 | 222 |
| Seeley | 300630038 | 3 | 88502 | 8/15/2017 | 256 | 359 | 379 | 383 | 388 | 480 | 568 | 328 | 253 | 137 | 40 | 42 | 39 | 38 | 31 | 14 | 12 | 11 | 15 | 28 | 35 | 72 | 189 | 354 | 185.47 | 568 |
| Seeley | 300630038 | 3 | 88502 | 8/16/2017 | 382 | 496 | 606 | 646 | 690 | 670 | 683 | 635 | 422 | 197 | 39 | 21 | 25 | 19 | 23 | 24 | 26 | 27 | 36 | 47 | 48 | 149 | 266 | 487 | 277.63 | 690 |
| Seeley | 300630038 | 3 | 88502 | 8/17/2017 | 550 | 507 | 433 | 427 | 463 | 499 | 641 | 576 | 440 | 295 | 28 | 14 | 17 | 14 | 14 | 16 | 27 | 27 | 45 | 45 | 44 | 82 | 156 | 270 | 234.5 | 641 |
| Seeley | 300630038 | 3 | 88502 | 8/18/2017 | 365 | 422 | 459 | 527 | 581 | 616 | 628 | 532 | 316 | 176 | 53 | 42 | 17 | 15 | 19 | 17 | 16 | 34 | 44 | 33 | 29 | 29 | 34 | 33 | 209.81 | 628 |
| Seeley | 300630038 | 3 | 88502 | 8/19/2017 | 45 | 76 | 179 | 334 | 461 | 529 | 629 | 608 | 401 | 191 | 15 | 8.5 | 16 | 15 | 32 | 10 | 18 | 20 | 10 | 10 | 10 | 16 | 21 | 128 | 157.53 | 629 |
| Seeley | 300630038 | 3 | 88502 | 8/20/2017 | 212 | 324 | 365 | 442 | 500 | 575 | 591 | 532 | 285 | 158 | 37 | 41 | 8.5 | 23 | 22 | 15 | 17 | 21 | 24 | 20 | 29 | 40 | 59 | 131 | 186.15 | 591 |
| Seeley | 300630038 | 3 | 88502 | 8/21/2017 | 268 | 300 | 358 | 459 | 523 | 578 | 646 | 440 | 266 | 226 | 228 | 127 | 29 | 15 | 17 | 15 | 16 | 8.7 | 9.7 | 12 | 17 | 38 | 103 | 170 | 202.88 | 646 |
| Seeley | 300630038 | 3 | 88502 | 8/22/2017 | 270 | 321 | 372 | 497 | 579 | 661 | 707 | 637 | 477 | 287 | 150 | 52 | 55 |  | 94 | 86 | 36 | 28 | 28 | 34 | 45 | 125 | 223 | 328 | 264.71 | 707 |
| Seeley | 300630038 | 3 | 88502 | 8/23/2017 | 371 | 568 | 717 | 680 | 725 | 721 | 791 | 888 | 778 | 467 | 261 |  | 76 | 81 | 81 | 49 | 42 | 51 | 49 | 61 | 79 | 209 | 290 | 322 | 363.23 | 888 |
| Seeley | 300630038 | 3 | 88502 | 8/24/2017 | 402 | 463 | 411 | 404 | 392 | 457 | 513 | 191 | 214 | 200 | 38 | 24 | 27 | 29 | 37 | 54 | 42 | 44 | 39 | 26 | 27 | 50 | 129 | 181 | 183.16 | 513 |
| Seeley | 300630038 | 3 | 88502 | 8/25/2017 | 296 | 129 | 139 | 249 | 363 | 435 | 518 | 479 | 378 | 159 | 40 | 52 | 45 | 31 | 11 | 25 | 14 | 15 | 10 | 20 | 48 | 150 | 273 | 387 | 177.68 | 518 |
| Seeley | 300630038 | 3 | 88502 | 8/26/2017 | 566 | 723 | 695 | 691 | 703 | 755 | 777 | 742 | 631 | 465 | 202 | 63 | 68 | 38 | 22 | 9.3 | 9.8 | 34 | 8.5 | 16 | 20 | 99 | 268 | 391 | 333.23 | 777 |
| Seeley | 300630038 | 3 | 88502 | 8/27/2017 | 472 | 566 | 655 | 656 | 692 | 754 | 865 | 995 | 768 | 511 | 289 | 182 | 106 | 214 | 223 | 157 | 45 | 39 | 21 | 21 | 43 | 121 | 309 | 388 | 378.81 | 995 |
| Seeley | 300630038 | 3 | 88502 | 8/28/2017 | 461 | 557 | 664 | 692 | 808 | 838 | 861 | 962 | 995 | 694 | 468 | 244 | 64 | 63 | 63 | 34 | 24 | 25 | 28 | 33 | 36 | 80 | 85 | 180 | 373.26 | 995 |
| Seeley | 300630038 | 3 | 88502 | 8/29/2017 | 260 | 264 | 253 | 262 | 268 | 215 | 211 | 351 | 371 | 484 | 291 | 140 | 119 | 71 | 64 | 42 | 46 | 64 | 53 | 63 | 72 | 97 | 262 | 413 | 197.28 | 484 |
| Seeley | 300630038 | 3 | 88502 | 8/30/2017 | 521 | 712 | 615 | 756 | 839 | 921 | 995 | 995 | 895 | 694 | 332 | 128 | 98 | 102 | 103 | 85 | 78 | 75 | 128 | 322 | 244 | 246 | 244 | 325 | 435.48 | 995 |
| Seeley | 300630038 | 3 | 88502 | 8/31/2017 | 278 | 244 | 399 | 511 | 551 | 669 | 824 | 843 | 577 | 440 | 185 | 57 | 29 | 33 | 37 | 53 | 33 | 29 | 41 | 42 | 27 | 32 | 27 | 31 | 249.62 | 843 |
| Seeley | 300630038 | 3 | 88502 | 9/1/2017 | 50 | 55 | 126 | 461 | 818 | 977 | 995 | 995 | 734 | 357 | 136 | 67 | 42 | 34 | 31 | 32 | 33 | 22 | 19 | 21 | 46 | 74 | 76 | 130 | 263.75 | 995 |
| Seeley | 300630038 | 3 | 88502 | 9/2/2017 | 281 | 621 | 867 | 995 | 995 | 829 | 686 | 695 | 561 | 483 | 369 | 238 | 91 | 46 | 7.8 | 17 | 27 | 29 | 22 | 20 | 27 | 50 | 136 | 401 | 353.73 | 995 |
| Seeley | 300630038 | 3 | 88502 | 9/3/2017 | 566 | 560 | 486 | 308 | 327 | 416 | 477 | 549 | 395 | 285 | 376 | 457 | 145 | 147 | 116 | 100 | 69 | 62 | 59 | 62 | 86 | 74 | 84 | 294 | 270.71 | 566 |
| Seeley | 300630038 | 3 | 88502 | 9/4/2017 | 848 | 810 | 356 | 398 | 272 | 235 | 241 | 227 | 222 | 205 | 128 | 128 | 131 | 125 | 107 | 106 | 111 | 124 | 180 | 177 | 155 | 162 | 253 | 368 | 252.91 | 848 |
| Seeley | 300630038 | 3 | 88502 | 9/5/2017 | 552 | 717 | 817 | 811 | 761 | 847 | 933 | 995 | 995 | 864 | 503 | 290 | 64 | 43 |  |  | 90 | 76 | 91 | 95 | 182 | 330 | 461 | 570 | 503.89 | 995 |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Seeley | 300630038 | 3 | 88502 | 9/6/2017 | 696 | 710 | 814 | 904 | 937 | 995 | 995 | 995 | 737 | 942 | 737 | 555 | 504 | 443 | 461 | 327 | 378 | 308 | 209 | 398 | 467 | 565 | 641 | 694 | 641.98 | 995 |
| Seeley | 300630038 | 3 | 88502 | 9/7/2017 | 641 | 653 | 720 | 892 | 995 | 995 | 995 | 995 | 995 | 995 | 966 | 660 | 394 | 281 | 189 | 102 | 72 | 79 | 92 | 156 | 164 | 286 | 369 | 416 | 545.84 | 995 |

**Source: AQS Database (**https://aqs.epa.gov/aqsweb/airdata/download_files.html#Raw**). Data were collated by the EPA as noted on its website on May 18, 2021.**

**Table A-3. Hourly average $PM_{2.5}$ concentrations (Ventura County, California) during the Thomas Fire for the December 5 - 17, 2017 period. Units are μg/$m^3$.**

| Site | AQS ID | POC | Parm. | Date (LST) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | Avg. | Max. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ojai | 061111004 | 3 | 88101 | 12/5/2017 | | | | | | | | | | | | | 5 | 6 | 16 | 69 | 280 | 186 | 173 | 135 | 202 | 231 | 237 | 255 | 149.58 | 280 |
| Ojai | 061111004 | 3 | 88101 | 12/6/2017 | 273 | 355 | 469 | 655 | 688 | 610 | 650 | 494 | 436 | 454 | 445 | 529 | 612 | 499 | 613 | 979 | 833 | 596 | 810 | 697 | 588 | 382 | 361 | 342 | 557.08 | 979 |
| Ojai | 061111004 | 3 | 88101 | 12/7/2017 | 299 | 269 | 152 | 142 | 148 | 137 | 185 | 267 | 342 | 363 | 391 | 113 | 132 | 92 | 86 | 73 | 33 | 26 | 184 | 216 | 161 | 176 | 217 | 272 | 186.50 | 391 |
| Ojai | 061111004 | 3 | 88101 | 12/8/2017 | 402 | 495 | 603 | 692 | 649 | 685 | 640 | 566 | 590 | 719 | 782 | 758 | 624 | 601 | 490 | 496 | 471 | 462 | 454 | 364 | 280 | 277 | 302 | 304 | 529.42 | 782 |
| Ojai | 061111004 | 3 | 88101 | 12/9/2017 | 291 | 324 | 290 | 306 | 285 | 256 | 250 | 249 | 221 | 196 | 209 | 71 | 53 | 37 | 33 | 29 | 48 | 88 | 138 | 171 | 182 | 191 | 194 | 181 | 178.88 | 324 |
| Ojai | 061111004 | 3 | 88101 | 12/10/2017 | 162 | 126 | 116 | 102 | 96 | 66 | 44 | 40 | 43 | 36 | 15 | 18 | 20 | 14 | 12 | 13 | 14 | 18 | 21 | 23 | 28 | 40 | 33 | 30 | 47.08 | 162 |
| Ojai | 061111004 | 3 | 88101 | 12/11/2017 | 38 | 42 | 39 | 34 | 33 | 37 | 43 | 70 | 78 | 76 | 91 | 63 | 63 | 40 | 18 | 24 | 27 | 37 | 36 | 42 | 55 | 57 | 70 | 73 | 49.42 | 91 |
| Ojai | 061111004 | 3 | 88101 | 12/12/2017 | 67 | 66 | 62 | 58 | 57 | 45 | 39 | 40 | 37 | | 80 | 93 | 84 | 61 | 193 | 345 | 359 | 353 | 301 | 331 | 402 | 399 | 332 | 229 | 175.35 | 402 |
| Ojai | 061111004 | 3 | 88101 | 12/13/2017 | 210 | 157 | 116 | 91 | 89 | 80 | 77 | 70 | 89 | 337 | 101 | 104 | 89 | 139 | 143 | 178 | 181 | 165 | 144 | 128 | 107 | 107 | 112 | 106 | 130.00 | 337 |
| Ojai | 061111004 | 3 | 88101 | 12/14/2017 | 105 | 97 | 83 | 76 | 78 | 70 | 64 | 64 | 76 | 103 | 112 | 80 | 53 | 35 | 31 | 41 | 46 | 35 | 33 | 46 | 58 | 51 | 53 | 54 | 64.33 | 112 |
| Ojai | 061111004 | 3 | 88101 | 12/15/2017 | 57 | 59 | 71 | 66 | 72 | 72 | 81 | 103 | 119 | 127 | 143 | 194 | 157 | 77 | 52 | 78 | 73 | 78 | 80 | 74 | 68 | 69 | 72 | 73 | 88.13 | 194 |
| Ojai | 061111004 | 3 | 88101 | 12/16/2017 | 88 | 87 | 91 | 105 | 89 | 100 | 102 | 95 | 98 | 104 | 129 | 158 | 122 | 122 | 109 | 110 | 127 | 121 | 111 | 89 | 77 | 65 | 61 | 59 | 100.79 | 158 |
| Ojai | 061111004 | 3 | 88101 | 12/17/2017 | 50 | 37 | 40 | 44 | 50 | 52 | 72 | 45 | 32 | 31 | 39 | 29 | 26 | 15 | 15 | 9 | 18 | 29 | 31 | 35 | 32 | 39 | 28 | 21 | 34.13 | 72 |

**Source: AQS Database (https://aqs.epa.gov/aqsweb/airdata/download_files.html#Raw). Data were collated by the EPA as noted on its website on November 24, 2021.**