ENCLOSURE: TECHNICAL SUPPORT DOCUMENT FOR EPA CONCURRENCE ON O_3 EXCEEDANCES MEASURED IN WASHOE COUNTY ON AUGUST 18, AUGUST 19, AND AUGUST 21, 2015, AS EXCEPTIONAL EVENTS

EXCEPTIONAL EVENTS RULE REQUIREMENTS

EPA promulgated the Exceptional Events Rule (EER) in 2007, pursuant to the 2005 amendment of Clean Air Act (CAA) Section 319. In 2016, EPA finalized revisions to the EER. The 2007 EER and the 2016 revisions added 40 CFR §50.1(j)-(r); §50.14; and §51.930 to the Code of Federal Regulations (CFR). These sections contain definitions, criteria for EPA approval, procedural requirements, and requirements for air agency demonstrations. EPA reviews the information and analyses in the air agency's demonstration package using a weight of evidence approach and decides to concur or not concur. The demonstration must satisfy all of the EER criteria for the EPA to concur with excluding the air quality data from regulatory decisions.

Under 40 CFR §50.14(c)(3)(iv), the air agency demonstration to justify data exclusion must include:

A. "A narrative conceptual model that describes the event(s) causing the exceedance or violation and a discussion of how emissions from the event(s) led to the exceedance or violation at the affected monitor(s);"

B. "A demonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance or violation;"

C. "Analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times" to support requirement (B) above;

D. "A demonstration that the event was both not reasonably controllable and not reasonably preventable;" and

E. "A demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event."[1]

In addition, the air agency must meet several procedural requirements, including:

1. submission of an Initial Notification of Potential Exceptional Event and flagging of the affected data in the EPA's Air Quality System (AQS) as described in 40 CFR §50.14(c)(2)(i),

2. completion and documentation of the public comment process described in 40 CFR

[1] A natural event is further described in 40 CFR §50.1(k) as "an event and its resulting emissions, which may recur at the same location, in which human activity plays little or no direct causal role. For purposes of the definition of a natural event, anthropogenic sources that are reasonably controlled shall be considered to not play a direct role in causing emissions."

§50.14(c)(3)(v), and

3. implementation of any applicable mitigation requirements as described in 40 CFR §51.930.

For data influenced by exceptional events to be used in initial area designations, air agencies must also meet the initial notification and demonstration submission deadlines specified in Table 2 to 40 CFR §50.14.

Narrative Conceptual Model

EPA expects that a narrative conceptual model of the event will describe and summarize the event in question and provide context for analyzing the required statutory and regulatory technical criteria. Air agencies may support the narrative conceptual model with summary tables or maps. For wildfire ozone (O_3) events, the EPA recommends that the narrative conceptual model also discuss the interaction of emissions, meteorology, and chemistry of event and non-event O_3 formation in the area, and, under 40 CFR §50.14(a)(1)(i), the regulatory significance of the requested data exclusion.

Clear Causal Relationship (CCR) and Supporting Analyses

EPA considers a variety of evidence when evaluating whether there is a clear causal relationship between the specific event and the monitored exceedance or violation. For wildfire O_3 events, air agencies should compare the O_3 data requested for exclusion with historical concentrations at the air quality monitor to establish a clear causal relationship between the event and the monitored data. In addition to providing this information on the historical context for the event-influenced data, air agencies should further support the clear causal relationship criterion by providing evidence that the wildfire's emissions were transported to the monitor, that the emissions from the wildfire influenced the monitored concentrations, and, in some cases, air agencies may need to provide evidence of the contribution of the wildfire's emissions to the monitored O_3 exceedance or violation.

For wildfire O_3 events, EPA has published a guidance document[2] that provides three different tiers of analyses that apply to the "clear causal relationship" criterion within an air agency's exceptional events demonstration. This tiered approach recognizes that some wildfire events may be more clear and/or extreme and, therefore, require relatively less evidence to satisfy the rule requirements. If a wildfire O_3 event satisfies the key factors for either Tier 1 or Tier 2 clear causal analyses, then those analyses are the only analyses generally necessary to support the clear causal relationship criterion within an air agency's demonstration for that particular event. Other wildfire/O_3 events will be considered based on Tier 3 analyses.

- Tier 1: Wildfires that clearly influence monitored O_3 exceedances or violations when they occur in an area that typically experiences lower O_3 concentrations.

[2] "Guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events that May Influence Ozone Concentrations," dated September 16, 2016 ("EPA's wildfire O_3 guidance document").

- *Key Factor*: seasonality and/or distinctive level of the monitored O_3 concentration. The event-related exceedance occurs during a time of year that typically has no exceedances, or is clearly distinguishable (*e.g.*, 5-10 ppb higher) from non-event exceedances.
- In these situations, O_3 impacts should be accompanied by clear evidence that the wildfire's emissions were transported to the location of the monitor.

- Tier 2: The wildfire event's O_3 influences are higher than non-event related concentrations, and fire emissions compared to the fire's distance from the affected monitor indicate a clear causal relationship.
  - *Key Factor 1*: fire emissions and distance of fire(s) to affected monitoring station location(s). Calculated fire emissions of nitrogen oxides (NO_x) and reactive-volatile organic compounds (VOC) in tons per day (Q) divided by the distance from the fire to the monitoring station (D) should be equal to or greater than 100 tons per day/kilometers ($Q/D \geq 100$ tpd/km). EPA's wildfire O_3 guidance document provides additional information on the calculation of Q/D.
  - *Key Factor 2*: comparison of the event-related O_3 concentration with non-event related high O_3 concentrations. The exceedance due to the exceptional event:
    - is in the 99_{th} or higher percentile of the 5-year distribution of O_3 monitoring data, OR
    - is one of the four highest O_3 concentrations within 1 year (among those concentrations that have not already been excluded under the Exceptional Events Rule, if any).
  - In addition to the analysis required for Tier 1, the air agency should supply additional evidence to support the weight of evidence that emissions from the wildfire affected the monitored O_3 concentration.

- Tier 3: The wildfire does not fall into the specific scenarios (i.e. does not meet the key factors) that qualify for Tier 1 or Tier 2, but the clear causal relationship criterion can still be satisfied by a weight of evidence showing.
  - In addition to the analyses required for Tier 1 and Tier 2, an air agency may further support the clear causal relationship with additional evidence that the fire emissions caused the O_3 exceedance.

Not Reasonably Controllable or Preventable (nRCP)

The EPA requires that air agencies establish that the event be both not reasonably controllable and not reasonably preventable at the time the event occurred. This requirement applies to both natural events and events caused by human activities; however, it is presumed that wildfires on wildland will satisfy both factors of the "not reasonably controllable or preventable" element unless evidence in the record clearly demonstrates otherwise.[3]

[3] A wildfire is defined in 40 CFR §50.1(n) as "any fire started by an unplanned ignition caused by lightning; volcanoes; other acts of nature; unauthorized activity; or accidental, human-caused actions, or a prescribed fire that has developed into a wildfire. A wildfire that predominantly occurs on wildland is a natural event." Wildland is defined in 40 CFR 50.1(o) as "an area in which human activity and development are essentially non-existent, except for roads, railroads, power lines, and similar transportation facilities. Structures, if any, are widely scattered."

Natural Event or Event Caused by Human Activity That is Unlikely to Recur

According to the CAA and the Exceptional Events Rule, an exceptional event must be "an event caused by human activity that is unlikely to recur at a particular location *or* a natural event" (emphasis added). The 2016 EER includes in the definition of wildfire that "[a] wildfire that predominantly occurs on wildland is a natural event." Once an agency provides evidence that a wildfire on wildland occurred and demonstrates that there is a clear causal relationship between the measurement under consideration and the event, the EPA expects minimal documentation to satisfy the "human activity that is unlikely to recur at a particular location or a natural event" element. The EPA will address wildfires on other lands on a case-by-case basis.

OVERVIEW OF EVENTS

On June 3, 2016, Washoe County Health District (WCHD) submitted an Initial Notification of Potential Exceptional Event for several exceedances of the 2015 8-hour O_3 National Ambient Air Quality Standard (NAAQS) and the 2006 24-hour $PM_{2.5}$ NAAQS that occurred at monitoring stations within Washoe County, Nevada during August 18-21, 2015.[4] EPA determined at the time that data exclusion of some of the exceedances of the O_3 NAAQS may have a regulatory significance for initial area designations for the 2015 8-hour O_3 NAAQS, and worked with WCHD to identify the relevant exceedances and monitoring stations affected.[5]

On November 10, 2016, WCHD submitted an exceptional events demonstration for one exceedance of the 2015 8-hour O_3 NAAQS that occurred at the Reno3 monitoring station on August 21, 2015.[6] Subsequently, WCHD and EPA determined that additional data identified in the initial notification had regulatory significance for initial area designations for the 2015 8-hour O_3 NAAQS. On March 17, 2017, consistent with the dates provided in the initial notification, WCHD submitted an addendum to their exceptional events demonstration that included additional evidence and expanded the scope to include two additional exceedances of the 2015 8-hour O_3 NAAQS that occurred at the Reno3 monitoring station on August 18 and August 19, 2015.[7] Table 1 summarizes these exceedances.

In their demonstration and addendum, WCHD stated that the three O_3 exceedances measured on August 18, August 19, and August 21, 2015, were caused by emissions from wildfires. Specifically, WCHD stated that "smoke from numerous lightning caused wildfires in California, Oregon, and Washington was transported into the Reno/Sparks, Nevada area. This resulted in elevated ozone (O_3) and fine particulate matter ($PM_{2.5}$) concentrations." [8] The $PM_{2.5}$ exceedance

[4] "Initial Notification of Potential Exceptional Event Information Summary," dated June 3, 2016 ("initial notification").
[5] See email, "Washoe County, EE Initial Notification for Wildfire event August 2015," from Meredith Kurpius, U.S. EPA Region 9 Air Division, to Daniel Inouye, WCHD Air Quality Management Division, dated June 21, 2016.
[6] "Exceptional Events Demonstration for 2015 Ozone Exceedance in Washoe County from the 2015 California Wildfires August 21, 2015," dated November 10, 2016 ("demonstration").
[7] "Addendum to the Exceptional Events Demonstration for 2015 Ozone Exceedance in Washoe County from the 2015 California Wildfires August 21, 2015," dated March 17, 2017 ("addendum"). Addendum was submitted by WCHD to EPA in response to evaluation of 2014-2016 design values as compared to 2013-2015 design values, revealing the need for analyses for subsequent event days. EPA determined it was appropriate to consider the addendum as supplemental to the submitted demonstration, as it was consistent with the dates requested for data exclusion in WCHD's initial notification for that demonstration.
[8] See demonstration, p. 9.

described in the initial notification did not have regulatory significance, and thus the demonstration did not include a request to exclude the $PM_{2.5}$ data.

Table 1: EPA 8-hour O_3 Exceedance Summary

Exceedance Date	Monitor/Station Name	AQS ID	Max. 8-hour Avg. (ppm)
August 18, 2015	Reno3	32-031-0016	0.075
August 19, 2015	Reno3	32-031-0016	0.073
August 21, 2015	Reno3	32-031-0016	0.073

Narrative Conceptual Model

WCHD's demonstration and addendum provided a narrative conceptual model to describe how emissions from several wildfires in northern California, as well as wildfires in Oregon and Washington (*i.e.*, the Pacific Northwest), caused O_3 exceedances at the Reno3 monitoring station. Section 1 of the demonstration and addendum included non-event characteristics of Washoe County and the Reno/Sparks area, such as general descriptions of the geography, topography, and meteorology; a description of the ambient air quality monitoring network; and a summary of typical non-event O_3 formation in the Reno/Sparks area, including discussion of O_3 precursor emissions, seasonal patterns, and meteorology associated with typical exceedances.

Section 2 of the demonstration and addendum described event-related characteristics, and included WCHD's claims that the exceedances observed were caused by emissions from wildfires in California, Oregon, and Washington, and that these exceedances qualify as an exceptional event under the EER. WCHD also identified that the proposed data exclusion has regulatory significance for initial area designations for the 2015 8-hour O_3 NAAQS. WCHD summarized the event, asserting that wildfire emissions began to impact the Reno/Sparks area on August 16, 2015, and continued to impact the region throughout much of the remainder of August. WCHD specifically identified the Fork, Mad River, South, Route, River, Gasquet, and Nickowitz wildfires in California as contributing to the smoke transported to the Reno/Sparks area. In the addendum, WCHD stated that large wildfire complexes in Oregon and Washington also contributed to the smoke observed at the Reno3 monitoring station. WCHD provided maps of wildfire locations and perimeter maps; satellite imagery of smoke in the area on August 16 through August 21; and Hazard Mapping System (HMS) smoke contours, along with descriptive text from the product indicating that smoke from California and Pacific Northwest wildfires was observed in northern Nevada and the Reno/Sparks area during this time period.

WCHD presented 8-hour maximum O_3 concentrations for all O_3 monitoring stations in the WCHD network between August 14 and August 28, 2015. WCHD also plotted an hourly time series of O_3, NO_x, and $PM_{2.5}$ concentrations at the Reno3 monitoring station, along with an hourly time series of O_3 and $PM_{2.5}$ concentrations at the other stations in the WCHD network covering the same period. WCHD stated that between August 18 and August 21, nine exceedances of the 2015 8-hour O_3 NAAQS and two exceedances of the 24-hour $PM_{2.5}$ NAAQS were monitored across its air quality monitoring network, which covers the greater Reno/Sparks and northeastern Lake Tahoe area. WCHD also stated that elevated $PM_{2.5}$ and NO_x concentrations support the presence of wildfire emissions during the event, and that elevated

concentrations throughout the network demonstrate that the impacts from wildfire emissions were regional and consistent with dispersion from fires 300 to 1,000 km away.

WCHD used daily weather maps from August 17 through August 21, 2015 to analyze large-scale meteorological features during the event, and compared meteorology (temperature and wind speeds) in the Reno/Sparks area during the event days with meteorology on days before and after the event. WCHD also used visibility data from nearby airports to identify effects from wildfire emissions on visibility measurements in the Reno area on August 21, and to show that smoke may have been transported to the Reno/Sparks area from the north or east after transport from northern California into northern Nevada, rather than direct west-to-east transport from the wildfires to the Reno/Sparks area. WCHD included an area forecast discussion from the National Weather Service (NWS) in Reno indicating that smoke was present in the region on August 21. WCHD also included media reports of smoke in the area during August 18 through August 21, 2015, which in some cases included photographs showing smoke or haze in the area, and described their public notification process for alerting the public of pollution episodes such as this event.

Based on the information described above, WCHD's demonstration, with addendum, meets the narrative conceptual model criterion of the EER.

Table 2: Documentation of Narrative Conceptual Model

Exceedance Date	**Demonstration Citation**	**Quality of Evidence**	**Criterion Met?**
August 18, 2015	Demonstration, Section 1: p 1-7 Demonstration, Section 2: p 8-32 Addendum, Section 2: p 2-35	Sufficient	Yes
August 19, 2015	Demonstration, Section 1: p 1-7 Demonstration, Section 2: p 8-32 Addendum, Section 2: p 2-35	Sufficient	Yes
August 21, 2015	Demonstration, Section 1: p 1-7 Demonstration, Section 2: p 8-32 Addendum, Section 2: p 2-35 Demonstration, Appendix E	Sufficient	Yes

Clear Causal Relationship (CCR)

WCHD's demonstration included several analyses to support a clear causal relationship between the wildfire event and the monitored exceedances. These analyses are presented in Section 3 of the demonstration and addendum, or in some cases, in the conceptual model (Section 2).

Comparison with historical concentrations

WCHD's demonstration and addendum included a comparison with historical concentrations, as required by 40 CFR §50.14(c)(3)(iv)(C). WCHD compared the event-related O_3 concentrations with all summertime (June through August) concentrations from 2010-2015 (Section 3.2). The plots provided show that 8-hour maximum O_3 concentrations for all three days are at or above the 99^{th} percentile value (0.073 ppm) for the O_3 season, calculated using 2010-2015 data. The historical concentration plots also show that this monitor has observed concentrations at or above 0.073 ppm on eight other occasions during the summertime (June through August), and that

exceedances, including those at or above 0.073 ppm, have been observed throughout the summertime months.

Tier 1: Key Factor

To meet the key factor for a Tier 1 analysis, exceedances should be clearly higher than other, non-event related exceedances, or occur during a time of year that typically experiences no exceedances. The event-related exceedances identified in this demonstration and addendum occurred during the regular O_3 season, during times when other exceedances similar in magnitude were measured. Therefore, the event exceedances do not meet the Tier 1 Key Factor, and additional evidence beyond a Tier 1 analysis is needed to support the clear causal relationship.

Tier 2: Key Factors

WCHD evaluated the Tier 2 Key Factors in Section 3.3 of the demonstration and addendum. For Tier 2 Key Factor 1, WCHD provided an analysis of fire emissions (Q) and distance (D) of the wildfires to the affected monitoring station location. While preparing the addendum, WCHD identified errors in their initial calculations of Q/D that were submitted in the demonstration. This technical support document (TSD) relies on the Q/D calculations submitted with the addendum.

WCHD calculated Q/D separately for each California wildfire, for each day between August 17 through 21, using BlueSky Playground.[9] WCHD also calculated Q/D for the wildfires in Oregon and Washington for some of the days where data were available.[10] To help evaluate Q/D, EPA aggregated the individual Q/D calculations for the California wildfires into a single Q/D value, as described in EPA's wildfire O_3 guidance document, for each day between August 17 and August 21. These values are presented in Table 2a below. EPA did not include wildfires in Oregon and Washington in the aggregated Q/D value due to lack of data for some days, as well as the large difference in distances from those wildfires to the monitoring station as compared with the California wildfires, and the uncertainty in selecting the appropriate day to calculate Q/D for each monitored exceedance given the lengthy transport time to the affected monitor. EPA acknowledges that, if included, the emissions from the Oregon and Washington wildfires could increase the Q/D value for these events. As the Q/D calculations in Table 2a do not include these wildfires, the values presented are likely lower than Q/D for the aggregate effects of all the potentially contributing wildfires.

Table 2a: Aggregate Q/D calculations for California wildfires between August 17 and 21.

Day	August 17	August 18	August 19	August 20	August 21
Q/D (tpd/km)	21	41	39	41	21

The daily aggregate Q/D values in Table 2a are below the Tier 2 Key Factor 1 screening value of 100 tpd/km. WCHD stated that the combination of Q/D from multiple days may be appropriate for at least some of the event days, as it is likely that emissions from multiple days may have been present during the exceedance days and the smoke plume did not fully dissipate before

[9] See demonstration, p. 37-38, and addendum, p. 41-46. U.S. Forest Service's Bluesky Playground is available at https://tools.airfire.org/playground/.
[10] See demonstration, p. 37-38, and addendum, p. 41-46.

additional smoke was transported to the area.[11] EPA agrees that aggregation of Q/D from multiple days may be appropriate for this event, based on information presented later in this TSD. Also, addition of Q/D from wildfires in Oregon and Washington may act to further increase the calculated Q/D values. Therefore, effective Q/D values may be closer to 60-90 tpd/km. However, these values are still below the Tier 2 Key Factor 1 threshold of 100 tpd/km identified as the critical value in EPA's wildfire O_3 guidance document.

For Tier 2 Key Factor 2, WCHD provided evidence that the exceedances are at or above the 99th percentile of the past six years of data from the O_3 season (June through August).[12] WCHD's analysis calculated the percentile for summertime O_3 data only rather than the full year, which acts to increase the 99th percentile value and is a more stringent metric. Also, WCHD provided evidence that the exceedances were three of the four highest concentrations in 2015. Therefore, WCHD has demonstrated that the event exceedances meet Tier 2 Key Factor 2.

Based on the analysis of the Key Factors for Tier 2, EPA's wildfire O_3 guidance document indicates that a Tier 3 analysis is appropriate for this event. As described below, WCHD's demonstration included the required elements for a Tier 3 clear causal relationship analysis, based on EPA's wildfire O_3 guidance document. This includes evidence to support that (1) wildfire emissions were transported from the wildfire to the monitor; (2) wildfire emissions affected the monitor; and (3) wildfire emissions caused the O_3 exceedances.

Evidence of transport of wildfire emissions from the wildfire to the monitor

WCHD presented a trajectory analysis using the HYSPLIT model, along with HMS smoke contours for light, medium, and heavy smoke. In the demonstration, WCHD included 24-hour back trajectories from the Reno3 monitoring station at 1000 and 1500 meter (m) altitudes on August 21, as well as forward trajectories from monitoring stations between the California wildfires and the Reno3 monitoring station on August 20, to show transport of wildfire emissions affecting the Reno/Sparks area on August 21.[13] In the addendum, WCHD included 72-hour back trajectories from the Reno3 monitoring station at 500, 1000, and 1500 m altitudes on August 18 and August 19.[14] The trajectories are consistent with transport from areas containing heavy, medium, or light density smoke associated with both California and Pacific Northwest wildfires (as indicated by HMS smoke contours and descriptive text product) to the Reno/Sparks area and the Reno3 monitoring station on all three O_3 exceedance days.

In addition to the trajectory analysis, WCHD provided an analysis of synoptic scale meteorological features using weather maps from August 17 through August 21.[15] The analysis was generally consistent with the transport of wildfire emissions from the wildfires to the Reno/Sparks area and the Reno3 monitoring station. WCHD also included satellite imagery, as well as the HMS smoke contours previously described, that show areas of light to moderate smoke density in or near the Reno/Sparks area and the Reno3 monitoring station on August 18, August 19, and August 21.[16]

[11] See demonstration, p. 38.
[12] See demonstration, p. 16-17, p. 33-35, and p. 39, and addendum, p. 32, p. 36-28, and p. 47.
[13] See demonstration, p. 39-50 and Appendix F.
[14] See addendum, p. 47-53.
[15] See demonstration, p. 20-25.
[16] See demonstration, p. 11-12 and p. 40, and addendum, p. 5-29.

EPA's wildfire O_3 guidance document suggests that to show transport, satellite imagery should be accompanied by evidence of the plume reaching the ground.[17] WCHD provided photographic evidence of reduced visibility in the Reno/Sparks area, media reports of smoke presence in the area, and elevated hourly $PM_{2.5}$ measurements to support that the plume reached the ground on all three exceedance days; WCHD further supported that the plume reached the ground on August 21 with visibility data from nearby airports and 24-hour $PM_{2.5}$ concentrations.[18]

Overall, the trajectory analysis, satellite imagery, and evidence of smoke reaching the ground show that emissions from wildfires in northern California and the Pacific Northwest were transported to the Reno/Sparks area and the Reno3 monitoring station on all three exceedance days.

Evidence that the wildfire emissions affected the monitor

WCHD provided several forms of compelling evidence that the wildfire emissions reached the ground and affected the Reno3 monitoring station. As described above, WCHD included photographic evidence of reduced visibility in the Reno/Sparks area and media reports of smoke presence in the area to support that smoke reached the ground on all three exceedance days, as well as visibility data from nearby airports and a NWS weather area forecast discussion to additionally support that smoke reached the ground on August 21.[19] These documents support the weight of evidence that smoke was observed at ground level and affected air quality in the greater Reno/Sparks area.

WCHD also provided hourly pollutant concentrations for $PM_{2.5}$, NO_x, and O_3 at the Reno3 monitoring station, and for O_3 and $PM_{2.5}$ at other stations within the WCHD monitoring network.[20] $PM_{2.5}$ in particular is a good indicator for wildfire emissions during summer months in the Reno/Sparks area; the area typically experiences low $PM_{2.5}$ unless affected by wildfire smoke, or by dust events tied to thunderstorms (which did not occur prior to or during the event period). The hourly pollutant data show elevated concentrations, particularly for $PM_{2.5}$, at several times including on August 18, the morning of August 19, and late on August 20 through August 21. Hourly data for NO_x and O_3 also indicate elevated concentrations of NO_x and elevated O_3 at times on the three exceedance days, which may indicate increased precursor (NO_x) concentrations from wildfire emissions and related effects on O_3 concentrations. WCHD also compared 24-hour average $PM_{2.5}$ concentrations for all three days to historical data from August in 2011-2015, excluding data that WCHD flagged for wildfire impact due to large wildfires in 2013 (the Rim Fire and American Fire).[21] The 24-hour average $PM_{2.5}$ concentration on August 21 exceeded the $PM_{2.5}$ 24-hour NAAQS, and is much higher than the 98th percentile value for non-flagged data. Concentrations on August 18 and August 19, 2015 were the highest on those specific dates in the past five years (excluding flagged data) and were above the median value; a more detailed analysis of hourly $PM_{2.5}$ values provided later in this TSD supports that concentrations were affected by wildfire smoke only during some hours each day on August 18 and August 19, potentially explaining why 24-hour $PM_{2.5}$ concentrations on these days were high

[17] See EPA's wildfire O_3 guidance document, p. 14-15.
[18] See demonstration, p. 16-19, p. 26-32, p. 50-51, and Appendix E, and addendum, p. 24-34.
[19] See demonstration, p. 26-32 and Appendix E, and addendum, p. 24-31.
[20] See demonstration, p. 16-19, and addendum, p. 32-34.
[21] See demonstration, p. 50-51, and addendum, p. 54-55.

but still within the range of normal non-event concentrations. These analyses further support that wildfire emissions reached the ground and affected air quality at the Reno3 monitoring station.

WCHD also examined speciation data from the Chemical Speciation Network (CSN) available at the Reno3 monitoring station for elemental carbon (EC) and organic carbon (OC).[22] WCHD presented EC and OC concentrations for every three days between August 16 and August 28, 2015, corresponding with the CSN operating schedule. WCHD also compared these concentrations to the median, 90th percentile, and 95th percentile concentration for each species from June through August of 2010-2014, excluding flagged data as described previously. Concentrations for both EC and OC were near the median for each value on August 16, as well as August 25 and August 28. Concentrations of OC were 4.00 µg/m^3 (approximately 2.5 times the median) on August 19, and 7.17 µg/m^3 (approximately 4.5 times the median) on August 22; both concentrations were well above the 95th percentile value for OC. Concentrations of EC were elevated on August 19 and August 22 as well, with concentrations on August 19 slightly above the median, and concentrations on August 22 near the 95th percentile value. The EC and OC concentrations, particularly OC, strongly support that wildfire emissions were present and affected air quality at the Reno3 monitoring station on August 19 and August 22. These observations also support that wildfire emissions were very likely present at the monitor on the other exceedance days (August 18 and August 21), although observations were not collected on those dates due to the sampling schedule.

Finally, WCHD evaluated $PM_{2.5}$/carbon monoxide (CO) enhancement ratios.[23] This more detailed analysis of ozone precursors adds to the weight of evidence that smoke affected the Reno3 monitoring station. As explained by Laing, et al.,[24] $PM_{2.5}$/CO enhancement ratios can be calculated by determining the regression slope of CO versus $PM_{2.5}$ during a smoke or pollution event, and can be used as an indicator of smoke impact. Mobile emission and urban background $PM_{2.5}$/CO ratios are much lower than typical wildfire smoke ratios; typical urban measurements are on the order of 20-45 µg/m^3 ppmv^{-1}, while wildfire smoke ratios are typically well-correlated and above 100 µg/m^3 ppmv^{-1}. For each of the three exceedance days (August 18, August 19, and August 21), WCHD calculated slopes based on hourly $PM_{2.5}$ and CO values, and compared these to a slope calculated on a non-event day (August 24, 2015). WCHD's non-event slope was approximately 5 µg/m^3 ppmv^{-1}, with a very low R^2 (0.0014). On August 21, the slope (~102 µg/m^3 ppmv^{-1}) and R^2 (0.7354) clearly indicate the influence of wildfire emissions. On August 18 and 19, slopes (65 and 69 µg/m^3 ppmv^{-1}) are larger than the non-event slope, and are also well above the range of normal urban ratios, suggesting mixing of the smoke-related $PM_{2.5}$ and CO signal with ambient urban air. Increases in R^2 (0.328 and 0.4415) on these days when compared to the non-event day also support that concentrations of these pollutants were affected by wildfire emissions. This analysis strongly adds to the weight of evidence that wildfire emissions reached the ground and affected air quality within the Reno/Sparks area and specifically at the Reno3 monitoring station.

[22] See demonstration, p. 52-53, and addendum, p. 56-57.
[23] See addendum, p. 58-59.
[24] Laing J.R., Jaffe D.A., Slavens A.P., Li W., Wang, W. Using ΔPM2.5/ΔCO and ΔNOy/ΔCO Enhancement Ratios to Identify Wildfire Smoke in Urban Areas. Submitted to Aerosol and Air Quality Research, Feb. 2017.

Overall, the media reports, photographic evidence, and airport visibility data, elevated hourly $PM_{2.5}$, NO_x and O_3 concentrations and 24-hour $PM_{2.5}$ concentrations, elevated OC and EC concentrations, and elevated $PM_{2.5}$/CO ratios and correlation coefficients clearly support that wildfire emissions reached the ground and affected measurements at the Reno3 monitoring station on August 18, August 19, and August 21.

Additional evidence that the wildfire emissions caused the O_3 exceedance

WCHD provided additional evidence to support that the wildfire emissions specifically affected O_3 concentrations at the Reno3 monitoring station and caused the O_3 exceedances. WCHD's analyses of NO_x and OC data from the Reno3 monitoring station during the event, discussed previously, suggest that O_3 precursors were elevated due to wildfire emissions. This information adds to the weight of evidence that wildfire emissions increased precursor concentrations and thus caused increases in O_3 concentrations at the Reno3 monitoring station.

WCHD also included a comparison of the basic meteorology and maximum 8-hour O_3 concentration on event days with data from days before and after the event (August 16 and August 25), along with historical average wind speeds and temperatures.[25] High temperatures can contribute to high O_3 concentrations during non-event periods; WCHD's conceptual model also described the Washoe Zephyr, or afternoon high-speed westerly winds, as a factor that acts to reduce O_3 in the area. The comparison shows that temperatures during the event days were above the historical average and wind speeds were near or slightly below the historical average. However, during the non-event days, temperatures were similarly above the historical average and wind speeds near or below the historical average, but that maximum 8-hour O_3 concentrations were 12-26 ppb lower than event concentrations. The differences in maximum O_3 concentration between event days and non-event days are large enough to suggest that maximum O_3 concentrations on event days were not solely related to meteorological effects. This further supports that wildfire emissions affected O_3 concentrations at the Reno3 monitoring station.

WCHD also assessed diurnal patterns in O_3 concentrations by comparing hourly O_3 concentrations for August 18, August 19, and August 21 with the 5^{th}, 50^{th}, and 95^{th} percentile O_3 concentrations for each hour, based on 2010-2015 data.[26] The three percentile hourly profiles show a similar pattern to one another, with the lowest O_3 concentrations typically observed around 6am, steeply increasing to a peak around 12pm (consistent with photochemical production of O_3 caused by increasing light intensity and precursor concentrations), and then slowly decreasing throughout the afternoon, evening, and night. On the three event exceedance days, hourly O_3 profiles showed some clear differences from the typical profiles. Around the typical daily minimum hourly concentration (approximately 6am), O_3 concentrations dropped relative to the percentile line by approximately 25 to 90 percentile points, the amount varying with the event day. Each of these larger-than-usual decreases was followed by steeper-than-usual increases, with peak hourly concentrations on all three days exceeding the 95^{th} percentile peak value by approximately 10-15 ppb. O_3 concentrations on August 18 also peaked approximately 3 hours later than usual. The peak O_3 concentrations on each day exceeded the 95^{th} percentile for approximately 4 hours, then dropped and approximately followed the 95^{th} percentile line for the remainder of the evening. The early decrease in O_3 concentrations, steeper-than-normal O_3

[25] See addendum, p. 35.
[26] See demonstration, p. 33 and p. 36, and addendum, p. 36 and p. 39-40.

production, maximum hourly concentrations greatly exceeding the 95th percentile values, and later-than-usual peaks in hourly concentrations all suggest increased precursor concentrations during hours critical for O_3 production. This is consistent with the elevated concentrations of NO_x and of OC in particulate matter, suggesting higher-than-typical O_3 precursor concentrations due to the presence of wildfire emissions, which caused O_3 exceedances at the Reno3 monitoring station.

To further support the relationship between precursors, wildfire indicators, and O_3 concentrations, EPA has analyzed profile percentile plots of CO, $PM_{2.5}$, and NO_x, similar to those provided by WCHD for O_3, on the three exceedance days. As already discussed, WCHD's demonstration clearly showed evidence that increased pollutant concentrations were due to wildfire emissions affecting the Reno3 monitoring station on all three exceedance days; elevated hourly CO, $PM_{2.5}$, and NO_x concentrations relative to the percentile plots can therefore provide information on the timing of wildfire effects. EPA's analysis is shown in Appendix A to this TSD.

For all three exceedance days, all three pollutant concentrations showed increases relative to percentile lines during morning hours (5am-12pm). On August 19 and 21, $PM_{2.5}$ and CO also show relatively high concentrations continuing in early morning hours (12am-5am) from the previous day. This suggests a carryover effect from the previous day on August 19 and 21, as well as the introduction of wildfire emissions, including O_3 precursors, in the morning during a critical period for O_3 formation on all three exceedance days. The CO, $PM_{2.5}$, and NO_x profile features are highly consistent with the features in the O_3 profiles described above, as elevated morning NO_x concentrations would initially reduce O_3 concentrations through reaction with nitric oxide, causing the observed decrease at minimum O_3 concentrations; similarly, elevated precursor concentrations throughout the morning hours are consistent with higher-than-usual O_3 production and the observed steep increase in O_3 concentrations and extremely high peak hourly O_3 values.

Also, while $PM_{2.5}$ and CO concentrations remained high throughout the afternoon and evening of August 18 and into early morning hours on August 19, pollutant concentrations dropped relative to percentiles in the early afternoon, suggesting that smoke began to clear out of the area after effects on O_3 had already occurred. This explains why the 24-hour $PM_{2.5}$ concentration on August 19 was higher than usual but not clearly outside of the typical historical range, as the average includes cleaner air not affected by smoke from the afternoon and evening. Further, on August 20, morning pollutant peaks were similar to historical non-event peaks, and $PM_{2.5}$ and CO concentrations suggest only minimal smoke presence that did not begin until the afternoon; notably, the Reno3 monitoring station did not exceed the O_3 NAAQS on August 20 despite high baseline O_3 carried over from the previous day, further suggesting that O_3 exceedances were due specifically to wildfire emission effects on morning photochemistry. Very strong wildfire emission effects returned in the late evening hours on August 20, with an additional increase in the morning of August 21 leading to another O_3 exceedance. The hourly CO, $PM_{2.5}$, and NO_x data analysis thus provides strong additional support that wildfire emissions caused the O_3 exceedances at the Reno3 monitoring station.

CCR conclusion

WCHD stated, "The comparisons and statistical analyses provided in Section 3.0 of this addendum support [WCHD's] demonstration that the wildfire event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedances on August 18 and 19, 2015. Section 3.0 thus satisfies the clear causal relationship criterion as required by the EER and 40 CFR 50.14(c)(3)(iv). This addendum further supports the August 21, 2015 exceptional event demonstrated in the 2015 EE Demonstration." [27]

The analyses included in the demonstration and addendum, specifically, the comparison with historical O_3 8-hour maximum concentrations, Q/D analysis, HYSPLIT analysis, HMS contours, media reports of smoke and visibility analysis, time series plots of hourly concentrations of O_3 and related pollutants, 24-hour $PM_{2.5}$ concentrations, EC/OC speciation data, $PM_{2.5}$/CO enhancement ratios, general comparison to non-event days with similar meteorology, and O_3 hourly percentile profile analysis, as well as EPA's hourly CO, $PM_{2.5}$, and NO_x profile analysis, sufficiently demonstrate a clear causal relationship between the emissions generated by wildfires in northern California and the Pacific Northwest and the exceedances measured at the Reno3 monitoring station.

Table 3: Documentation of CCR

Exceedance Date	**Demonstration Citation**	**Quality of Evidence**	**Criterion Met?**
August 18, 2015	Demonstration, Section 2: p 8-32 Addendum, Section 2: p 2-35 Demonstration, Section 3: p 33-53 Addendum, Section 3: p 36-60 Appendix A to this TSD: p A1-A6	Sufficient	Yes
August 19, 2015	Demonstration, Section 2: p 8-32 Addendum, Section 2: p 2-35 Demonstration, Section 3: p 33-53 Addendum, Section 3: p 36-60 Appendix A to this TSD: p A1-A6	Sufficient	Yes
August 21, 2015	Demonstration, Section 2: p 8-32 Addendum, Section 2: p 2-35 Demonstration, Section 3: p 33-53 Addendum, Section 3: p 36-60 Appendix A to this TSD: p A1-A6	Sufficient	Yes

Not Reasonably Controllable or Preventable (nRCP)

The Exceptional Events Rule presumes that wildfire events on wildland are not generally reasonable to control or prevent.[28] WCHD's demonstration and addendum provided evidence that the wildfire event meets definition of wildfire. Specifically, WCHD stated that "These wildfire events occurred on wildland, as documented in Section 2.0, due to lightning… Additionally, as demonstrated in Section 2.0 by location maps of the wildfires, the wildfire events were on wildlands occurring on Federal or State owned lands." [29] Fire location and perimeter maps provided in Section 2 indicate that the fires occurred predominantly on

[27] See addendum, p. 60.
[28] See 40 CFR §50.14(b)(4).
[29] See addendum, p. 61.

wildland.[30] Therefore, the documentation provided sufficiently demonstrates that the event was not reasonably controllable and not reasonably preventable.

Table 4: Documentation of nRCP

Exceedance Date	Demonstration Citation	Quality of Evidence	Criterion Met?
August 18, 2015	Addendum, Section 5: p 62 Addendum, Section 4: p 61 Demonstration, Section 2: p 10-15 Addendum, Section 2: p 4-29	Sufficient	Yes
August 19, 2015	Addendum, Section 5: p 62 Addendum, Section 4: p 61 Demonstration, Section 2: p 10-15 Addendum, Section 2: p 4-29	Sufficient	Yes
August 21, 2015	Addendum, Section 5: p 62 Addendum, Section 4: p 61 Demonstration, Section 2: p 10-15 Addendum, Section 2: p 4-29	Sufficient	Yes

Natural Event

The definition of "wildfire" at 40 CFR §50.1(n) states, "A wildfire that predominantly occurs on wildland is a natural event." WCHD's demonstration and addendum included documentation that the event meets the definition of a wildfire and occurred predominantly on wildland. WCHD has therefore shown that the event was a natural event.

Table 5: Documentation of Natural Event

Exceedance Date	Demonstration Citation	Quality of Evidence	Criterion Met?
August 18, 2015	Addendum, Section 4: p 61 Demonstration, Section 2: p 10-15 Addendum, Section 2: p 4-29	Sufficient	Yes
August 19, 2015	Addendum, Section 4: p 61 Demonstration, Section 2: p 10-15 Addendum, Section 2: p 4-29	Sufficient	Yes
August 21, 2015	Addendum, Section 4: p 61 Demonstration, Section 2: p 10-15 Addendum, Section 2: p 4-29	Sufficient	Yes

Schedule and Procedural Requirements

In addition to technical demonstration requirements, 40 CFR §50.14(c) and 40 CFR §51.930 specify schedule and procedural requirements an air agency must follow to request data exclusion. Table 6 outlines EPA's evaluation of these requirements.

As these events may impact initial area designations for the 2015 8-hour O_3 NAAQS, the demonstrations are subject to the deadlines found in 40 CFR §50.14 Table 2. WCHD's initial notification was submitted June 3, 2016, prior to the July 1, 2016, deadline. WCHD's

[30] See demonstration, p. 10-15, and addendum, p. 3-4 and p. 7-26.

demonstration was submitted November 10, 2016, prior to the November 29, 2016, deadline. WCHD's addendum, which was submitted March 17, 2017, is considered supplemental to the initial demonstration. Therefore, EPA considers WCHD to have met the submission deadline requirements.

Table 6: Schedules and Procedural Criteria

Criterion	Reference	Demonstration Citation	Criterion Met?
Did the agency provide prompt public notification of the event?	40 CFR §50.14 (c)(1)(i)	Demonstration, Section 2: p 30	Yes
Did the agency submit an Initial Notification of Potential Exceptional Event and flag the affected data in the EPA's Air Quality System (AQS)?	40 CFR §50.14 (c)(2)(i)	Demonstration, Section 2: p 9 Addendum, Section 2: p 2 Demonstration, Appendix C	Yes
Did the initial notification and demonstration submittals meet the deadlines for data influenced by exceptional events for use in initial area designations, if applicable? Or the deadlines established by EPA during the Initial Notification of Potential Exceptional Events process, if applicable?	40 CFR §50.14 Table 2 40 CFR §50.14 (c)(2)(i)(B)	Demonstration, Appendix C November 10, 2016 Letter[31]	Yes
Was the public comment process followed and documented? • Did the agency document that the comment period was open for a minimum of 30 days? • Did the agency submit to EPA any public comments received? • Did the state address comments disputing or contradicting factual evidence provided in the demonstration?	40 CFR §50.14 (c)(3)(v)	Demonstration, Section 2: p 9 Demonstration, Appendix D Addendum, Section 2: p 2 April 18, 2017 Letter[32]	Yes
Has the agency met requirements regarding submission of a mitigation plan, if applicable?	40 CFR §51.930 (b)	NA	NA

Conclusion

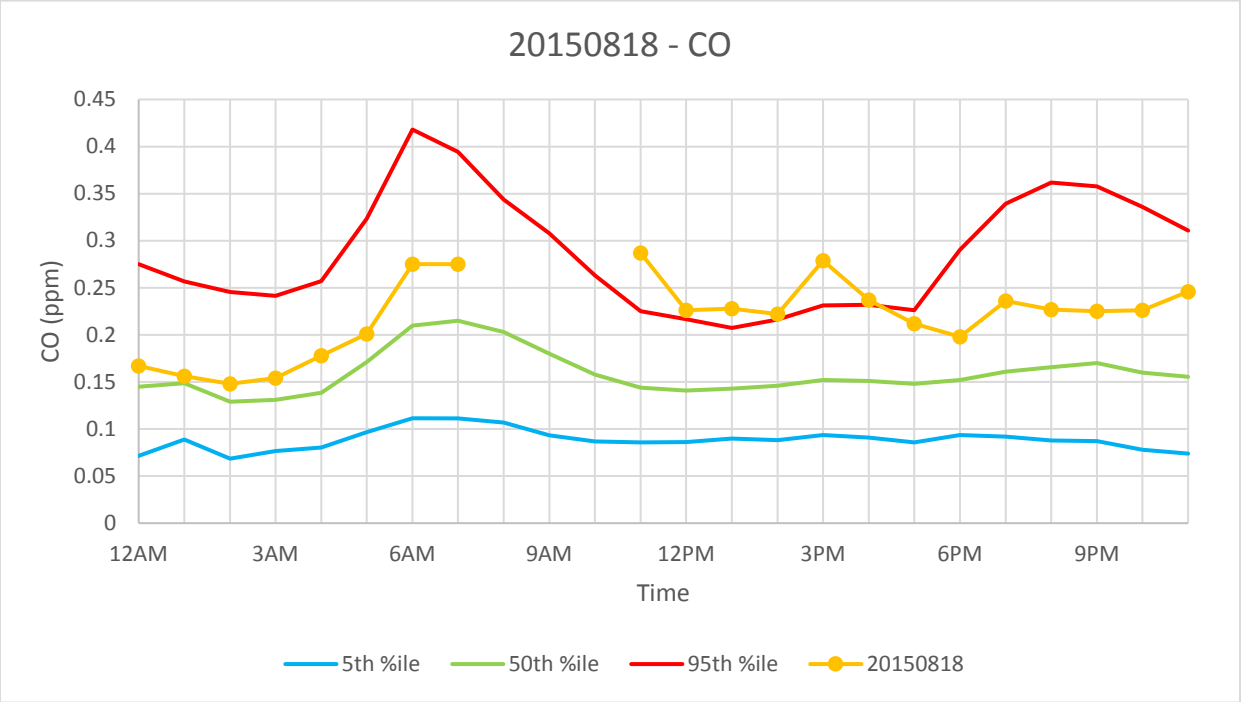
EPA has reviewed the documentation provided by WCHD to support claims that smoke from wildfires in California and the Pacific Northwest caused exceedances of the 2015 8-hour O_3 NAAQS at the Reno3 monitoring station on August 18, August 19, and August 21, 2015. EPA

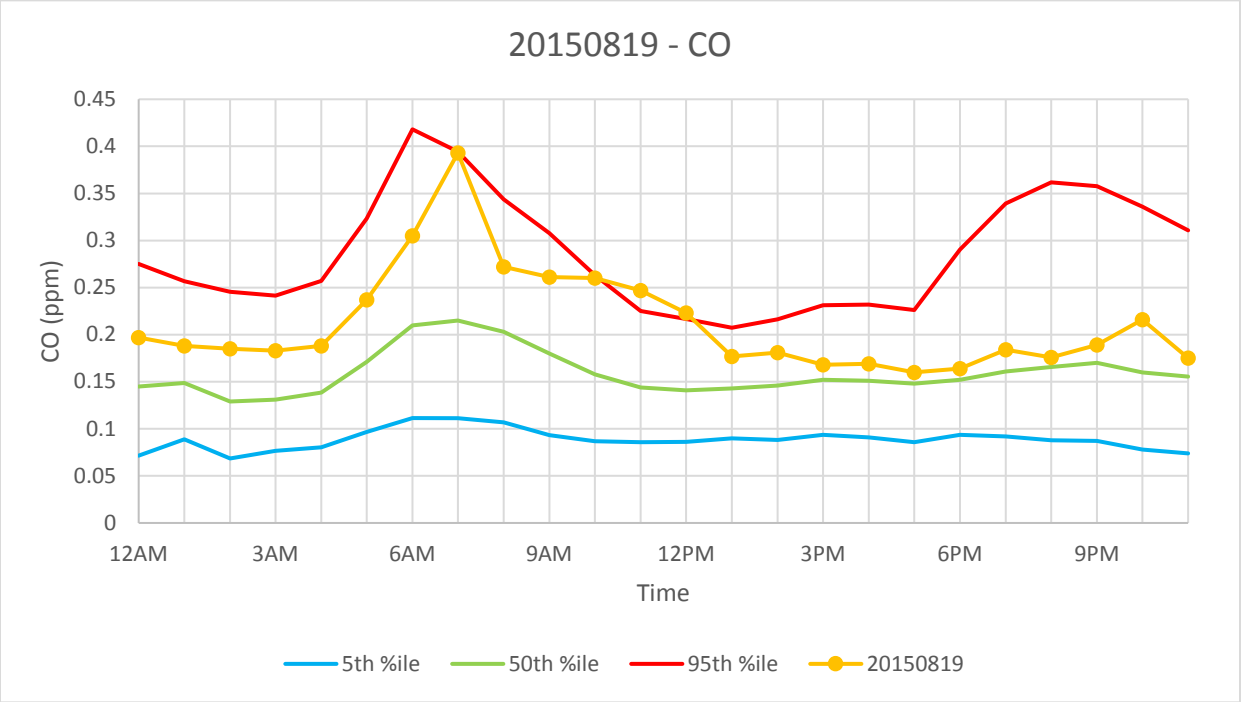
[31] See letter from Charlene Albee, WCHD Air Quality Management Division, to Meredith Kurpius, U.S. EPA Region 9 Air Division, dated November 10, 2016.
[32] See letter from Charlene Albee, WCHD Air Quality Management Division, to Meredith Kurpius, U.S. EPA Region 9 Air Division, dated April 18, 2017.

has determined that the flagged exceedances at this monitoring station on these days meet the definition of an exceptional event: the event affected air quality in such a way that there exists a clear causal relationship between the event and the monitored exceedance, was not reasonably controllable or preventable, and meets the definition of a natural event. EPA has also determined that the WCHD has satisfied the schedule and procedural requirements for data exclusion.

APPENDIX A. EPA analysis of hourly percentile profiles of CO, $PM_{2.5}$, and NO_x on August 18 through 21, 2015.

CO





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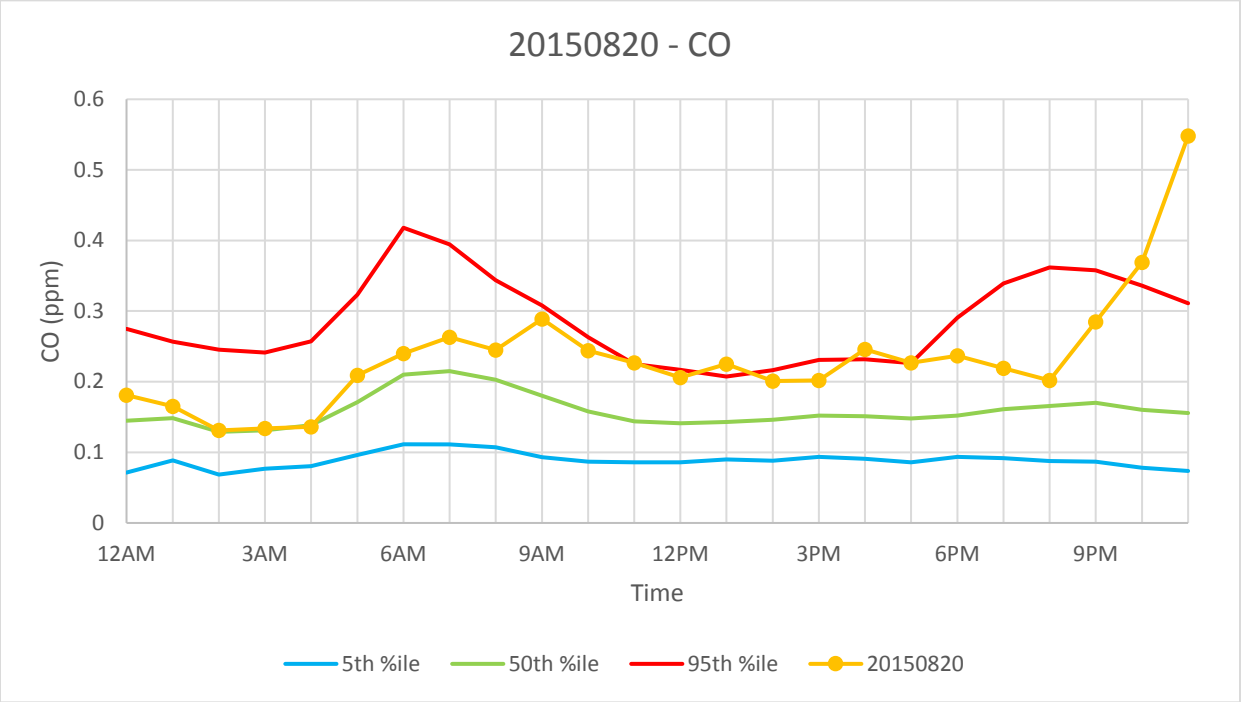
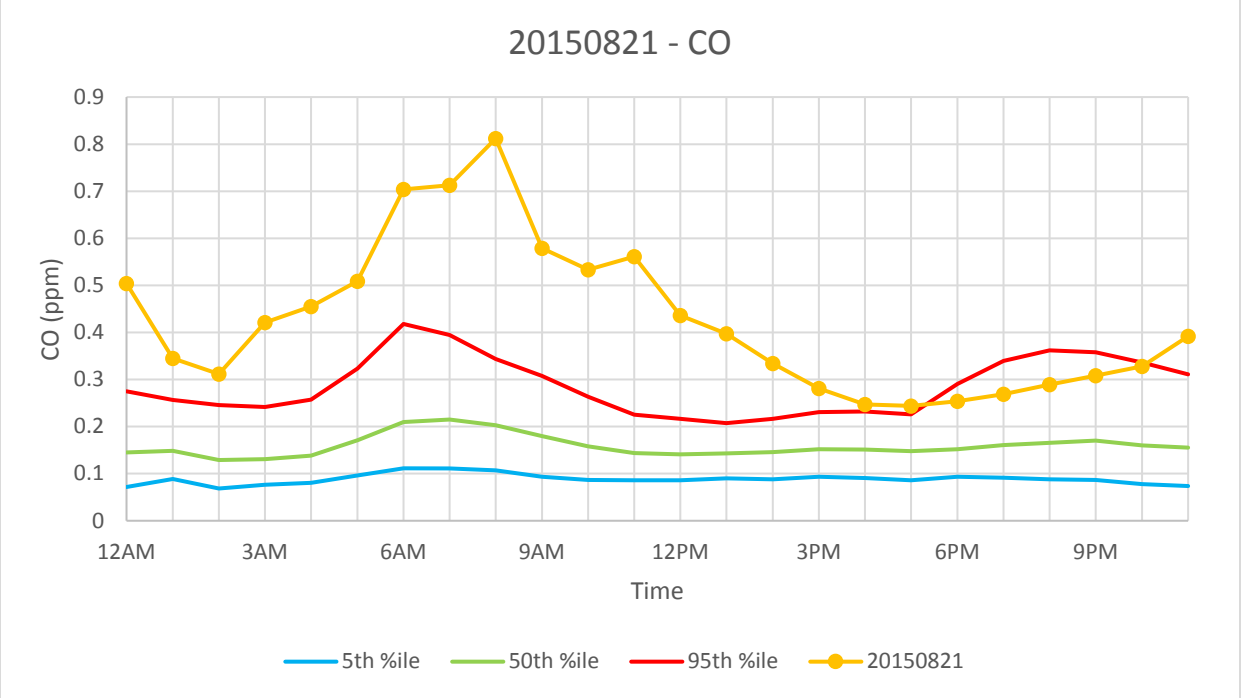
CO (cont.)





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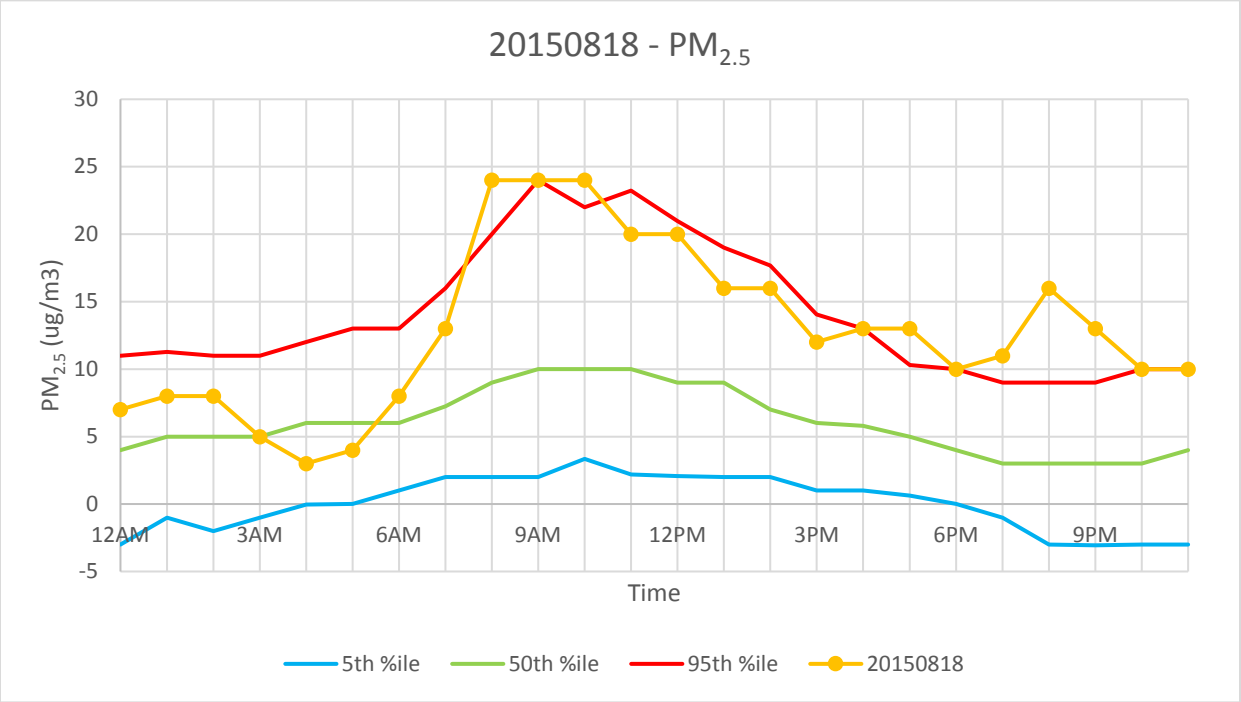
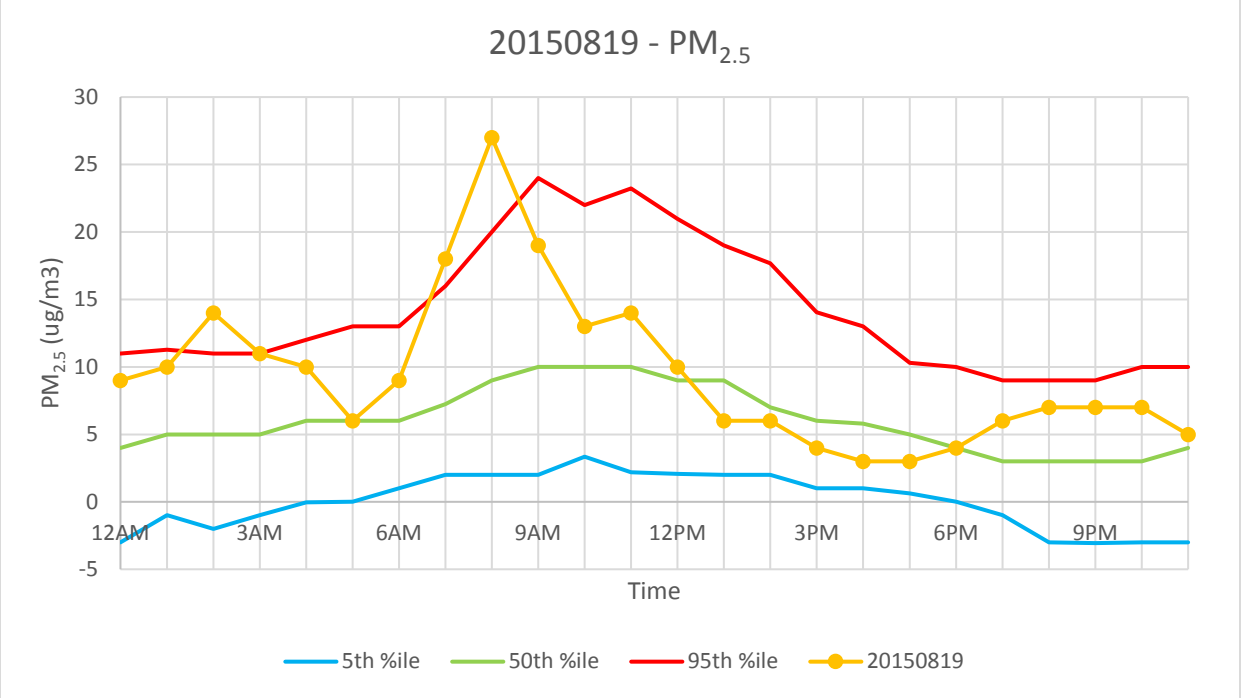
$PM_{2.5}$





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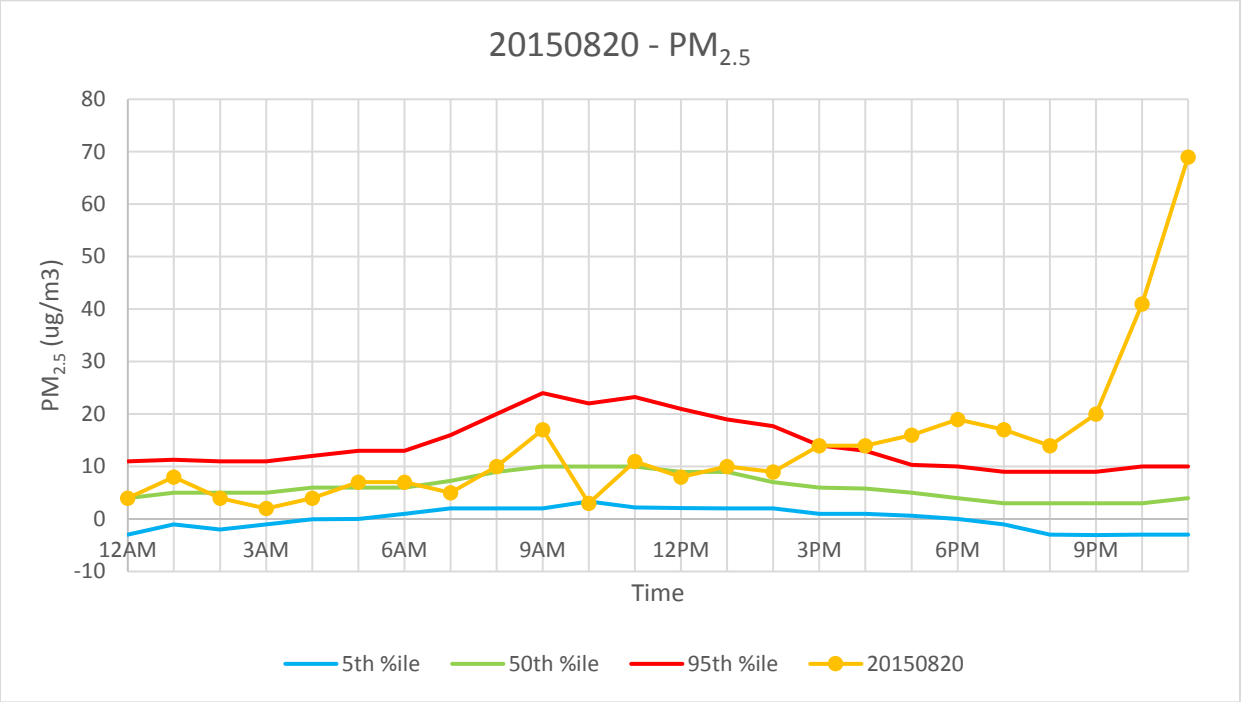
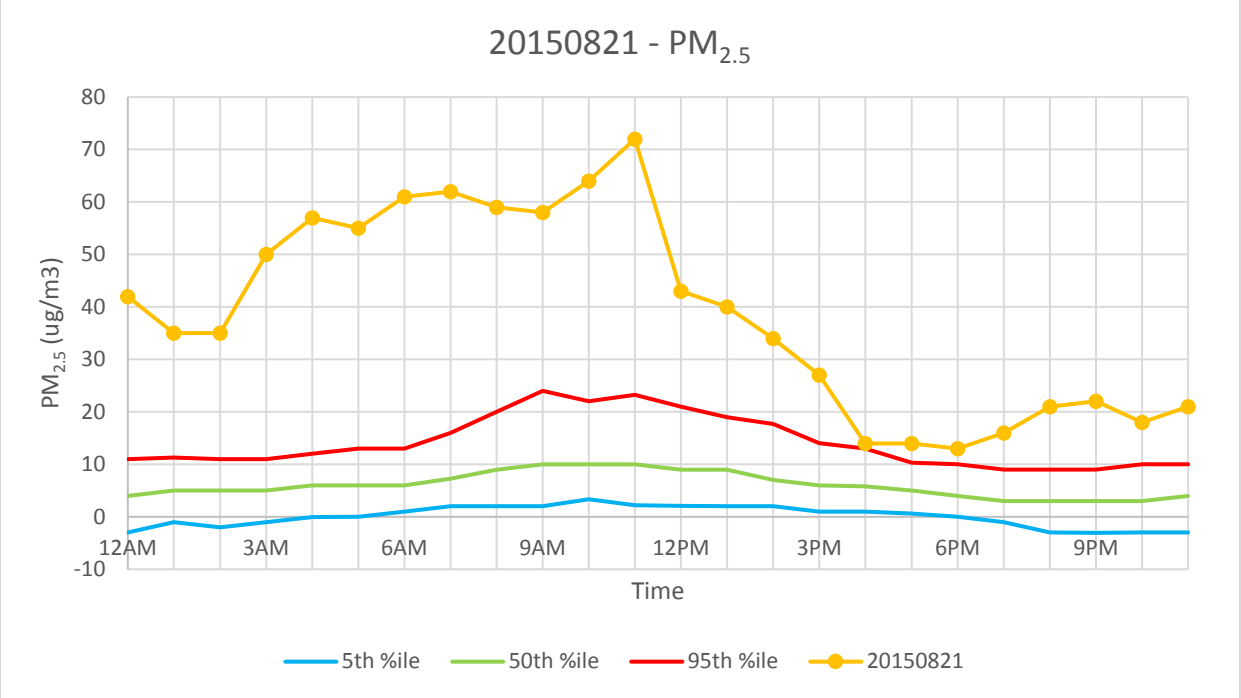
$PM_{2.5}$ (cont.)





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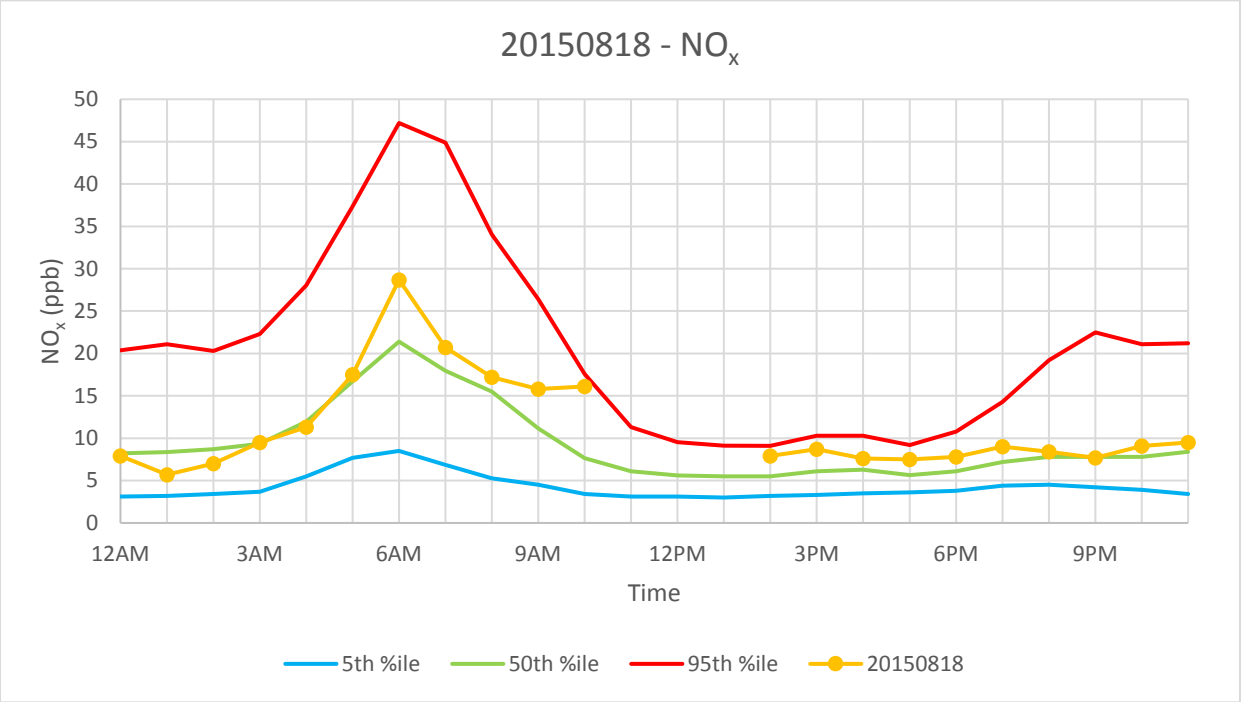
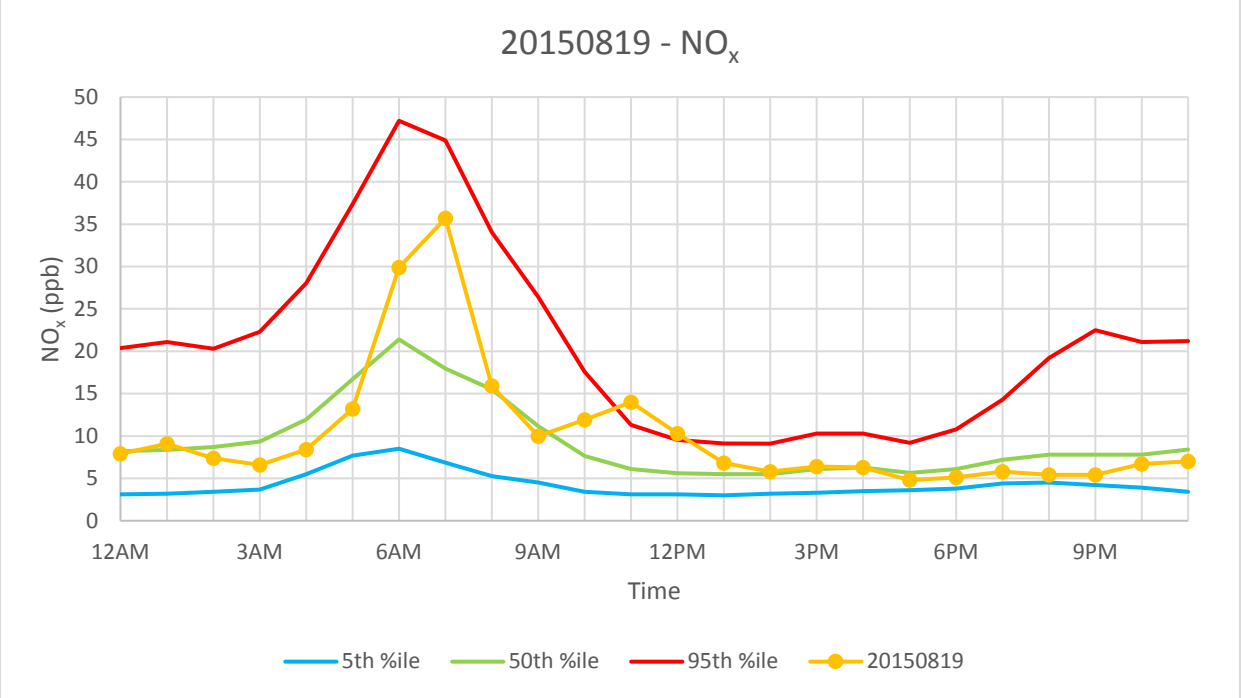
NO_x





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NO_x