Appendix H
Weight of Evidence

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Appendix H: Weight of Evidence

[This Appendix provided by the California Air Resources Board]

Weight of Evidence

San Joaquin Valley

Attainment Plan for the 0.070 ppm 8-Hour Ozone SIP

April 2022

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1. Introduction

This weight of evidence (WOE) document provides support for the modeled attainment demonstration that projects the San Joaquin Valley (Valley or SJV) air basin will attain the National Ambient Air Quality Standard (NAAQS or standard) of 0.070 parts per million (ppm) for 8-hour ozone by 2037.

This introduction includes a brief description of the elements of a WOE analysis, a physical context for the processes that lead to ozone formation in the Valley, and an assessment of current ozone air quality in the Valley. The remainder of the document provides a broad foundation of information that corroborates the modeled attainment demonstration.

1.1 Elements Commonly Included in an Attainment Demonstration

The attainment demonstration portion of a State Implementation Plan (SIP) consists of the analyses used to determine whether the current control strategy provides the reductions necessary to meet the standard by the specified attainment year. This attainment demonstration includes photochemical modeling which predicts that projected controls on ozone forming emissions will result in an 8-hour design value for the Valley that is below the level of the national standard of 0.070 ppm (70 parts per billion (ppb)) by 2037.

Due to inherent uncertainties in photochemical modeling, the U.S. Environmental Protection Agency (U.S. EPA) requires states to supplement the modeling results with a WOE assessment. The WOE assessment provides a set of analyses that complement the photochemical modeling. In this document, the analyses include consideration of measured air quality, emissions inventories, and meteorological data. All analysis methods have innate strengths and weaknesses, so examining an air quality problem in a variety of ways can help to offset the limitations and uncertainties inherent to individual methods. This approach also provides a better understanding of the overall problem, as well as insight about the level and mix of emissions controls needed for attainment.

The scope of the WOE analysis is different for each nonattainment area, with the level of appropriate detail dependent upon the complexity of the air quality problem, how far into the future the attainment deadline is, and the amount of data and modeling available. In this case, the Valley is moving towards attainment of the 8-hour ozone standard, and the projected attainment date (2037) is based on multiple methods to evaluate the modeling results. This document summarizes the analyses that provide a WOE assessment that complement the model results.

1.2 Physical Context

Ozone forms in the lower atmosphere through a complex set of processes that are initiated by sunlight; therefore, ozone is called a photochemical pollutant. The sun’s energy also drives meteorological processes through diurnal cycles from sunrise to sunrise and through seasonal cycles from winter to winter. As a result of these photochemical and meteorological processes, the “ozone season” with relatively high ambient ozone levels in California’s San Joaquin Valley is defined, for this document, as May through October.

The San Joaquin Valley is located in the Central Valley of California, in a semi-arid climate with long, hot, dry summers, and mild winters. The Valley is also situated between two mountain ranges which meet in the south of the Valley near Bakersfield. On the west side of the Valley is the Coastal mountain range and on the east side is the Sierra Nevada mountain range. During the summer season, a high-pressure system builds up over the eastern Pacific Ocean and a thermal low pressure system forms over the desert in the southwestern United States; this produces hot, dry conditions that cause thermally driven wind flow patterns across the Valley. These meteorological conditions cause poor dispersion and stagnation which are conducive to the formation of elevated ozone concentrations.

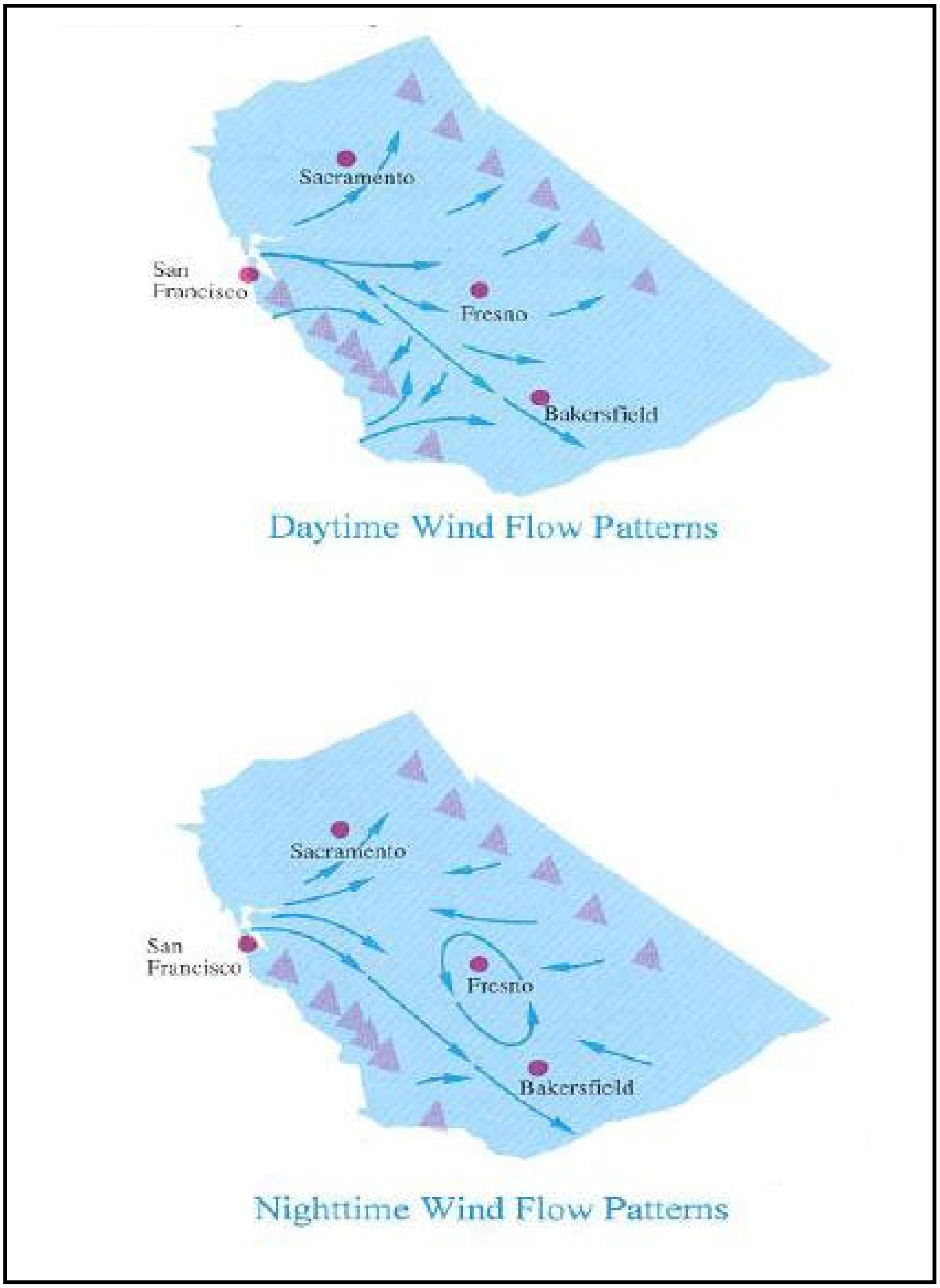
Wind speed plays a significant role in the dispersion of air pollutants. Figure 1 depicts the typical daytime and nighttime wind flow patterns during the ozone season in the Valley. The dominant wind flow pattern during the daytime in the Valley is from the northwest to the southeast. Surface winds, known as onshore flow, enter the Valley from the northwest through the delta and passes in the Coastal Range. The airflow generally moves from Stockton to Bakersfield, carrying ozone and the precursor emissions that contribute to ozone formation from both the San Francisco Bay area and the Sacramento Valley.

The effect of transport is seen in the accumulation of ozone in the central and southern portions of the Valley. Historically, the cities of Fresno, Clovis, and Parlier (downwind of Fresno), and the communities of Edison and Arvin (downwind of Bakersfield) have often experienced the highest ozone levels in the Valley. High ozone levels can also occur closer to emission sources. In recent years, the highest ozone levels have occurred in the cities of Clovis, Fresno, Arvin, Bakersfield, and Edison. In the Valley, high ozone has a large component that is due to local emission production, as the ozone is generally lowest for each city at the upwind site, increases in the city, and is highest at downwind locations.

At night, the general northwest to southeast surface wind flow pattern continues along the western portion of the Valley; however, some nighttime wind circulation changes also occur when:

1. The airflow is no longer able to exit the southern end of the Valley because it encounters cooler drainage winds from the surrounding mountains.
2. A nocturnal jet stream approximately 1,000 feet above the surface flows at speeds up to 33 miles per hour (mph), transporting air rapidly into the southern portion of the Valley; however, the mountains surrounding the southern end of the Valley cause the air to turn counterclockwise and flow back toward the north along the eastern edge of the Valley. This flow, referred to as the Fresno eddy, circulates the pollution plume back toward Fresno, where it encounters more ozone precursors.
3. Pollutants carried in the upslope mountain flow during the day via daytime heating are carried back downslope toward the Valley floor via drainage flows caused by nocturnal surface cooling.

Figure 1. San Joaquin Valley Wind Pattern During the Ozone Season[1].



A third of the basin population lives in the northern Valley. This lowland area is bordered by the Sacramento Valley and Delta lowland to the north, the central portion of the San Joaquin Valley to the south, and by mountains on the other two sides. Due to the marine influence,

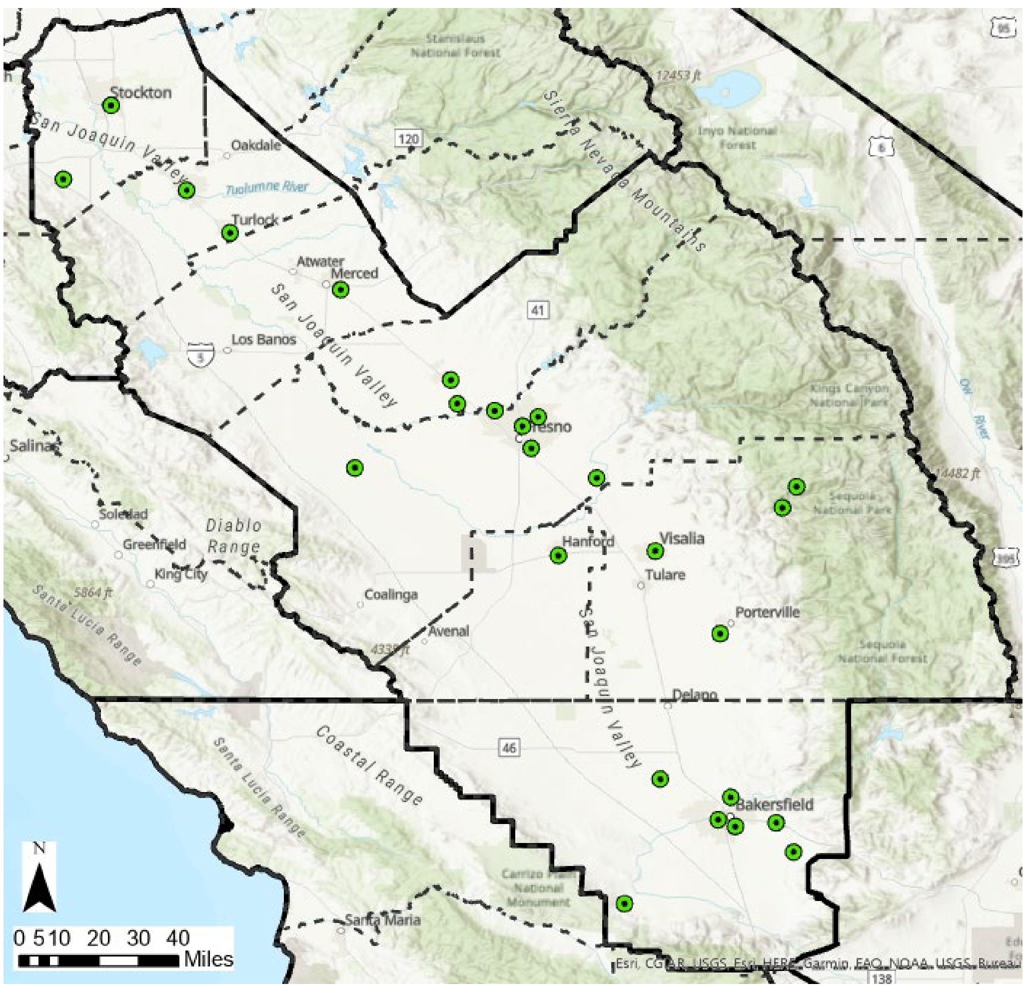
[1]Source: *http://www.valleyair.org/Air_Quality_Plans/OzoneOneHourPlan2013/05AppendixAAmbientAnalysis.pdf*

which extends into this area through gaps in the Coastal Range to the west, the northern Valley experiences a more temperate climate than the rest of the basin. These cooler temperatures and the predominant air flow patterns generally favor better ozone air quality.

In contrast to the northern Valley, most of the Valley population lives in the central and southern portions of the basin, in and around the Fresno and Bakersfield urban areas. Sites in the central and southern areas exceed the national standard by the greatest margin, and geography, emissions, and climate pose significant challenges to air quality progress. Similar to the northern Valley, the central and southern Valley are also low-lying areas, flanked by mountains on their west and east sides. The southern Valley represents the terminus of the Valley and is flanked by mountains to the south, as well. The surrounding mountains in both areas act as barriers to air flow, and combined with recirculation patterns and stable air, trap emissions and pollutants. The higher temperatures and more stagnant conditions in these two regions lead to a build-up of ozone and overall poorer air quality.

As shown in Figure 2, an extensive network of air pollution monitors is operated throughout the San Joaquin Valley including a total of 25 active ozone monitoring sites.

Figure 2. Active Ozone Monitoring Sites in San Joaquin Valley Air Basin.



1.3 Recent Air Quality

The San Joaquin Valley has one of the most challenging ozone problems in the nation and is one of only two nonattainment areas classified as extreme. In 2020 only three sites attained the national 8-hour ozone standard. However, recent trends are showing that ozone has become increasingly more responsive to emissions reductions, and the Valley's highest ozone levels today are much lower than they were just 10 years ago.

Table 1 shows the current operational sites in the Valley and their most recent design values. The scope of this document includes official data submitted through 2020. A preliminary look at 2021 using available official data, supplemented with preliminary data, is evaluated at the end of this document.

Stockton-Hazelton Street (66 ppb), Tracy-Airport (70 ppb) and Tranquility- 32650 West Adams Avenue (70 ppb) are the only sites that have 2020 design values that meet the current standard of 70 ppb. The northern region generally has the lowest ozone values in the Valley with two of the five sites meeting the standard (Stockton-Hazelton and Tracy-Airport) and the highest site being Turlock-S Minaret Street with a design value of 80 ppb in 2020. In 2020, the central region had one site meet the standard (Tranquility) and the peak sites are Fresno-Drummond Street (80 ppb), Hanford-S Irwin Street (80 ppb), Clovis-N Villa Avenue (84 ppb), Fresno-Garland (84 ppb), and Parlier (91 ppb). Finally, the highest sites in the southern region are Arvin-Di Giorgio (89 ppb), Edison (93 ppb), and Sequoia and Kings Canyon National Park (88 ppb). With Edison having the highest ozone design values in the Valley.

In recent years, some of the sites have seen a slight increase in design values. This recent increase in design values could be due to the increased frequency of wildfires in 2016-2018 and 2020 and will be discussed in more details in a later section.

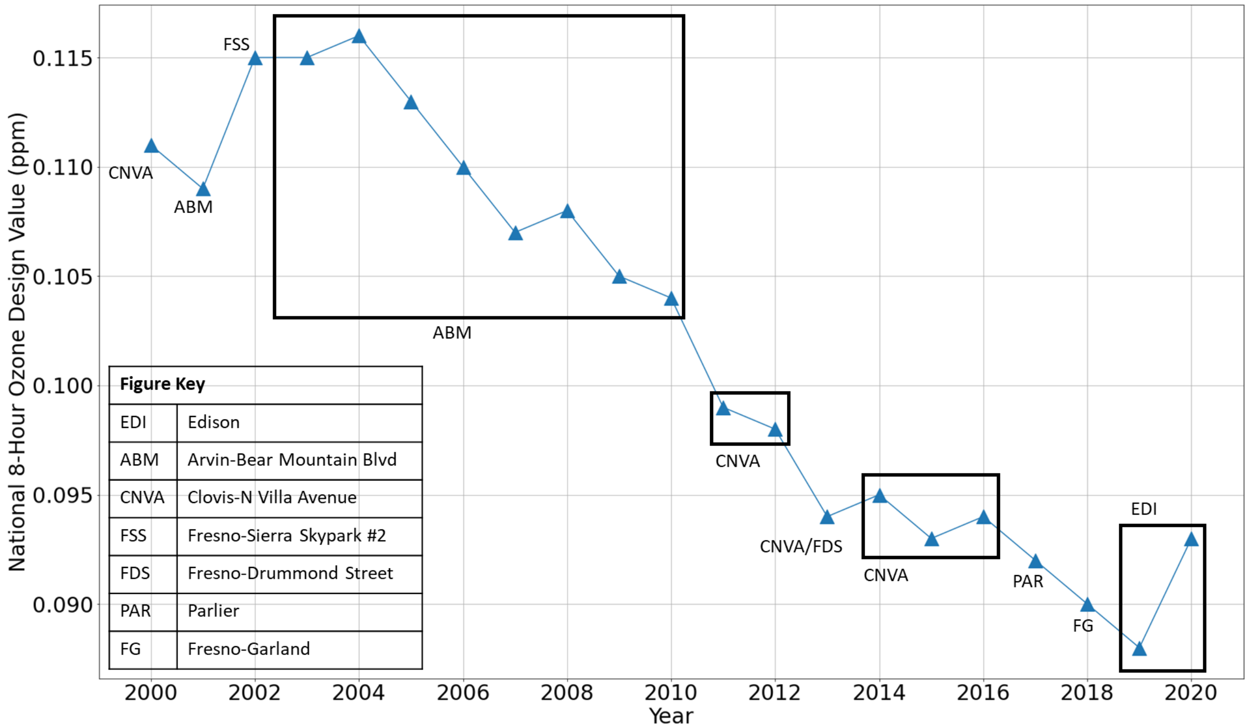
Table 1. Recent Design Values for Sites Currently Operating in the SJV (in ppb)

	County	Site	2015	2016	2017	2018	2019	2020
Northern	Merced	Merced-S Coffee Avenue	82	82	81	79	76	76
Northern	San Joaquin	Stockton-Hazelton Street	68	68	66	66	66	66
Northern	San Joaquin	Tracy-Airport	76	79	77	76	73	70
Northern	Stanislaus	Modesto-14th Street	79	81	82	80	80	79
Northern	Stanislaus	Turlock-S Minaret Street	82	83	84	84	82	80
Central	Fresno	Clovis-N Villa Avenue	93	94	90	89	84	84
Central	Fresno	Fresno-Drummond Street	86	86	89	86	82	80
Central	Fresno	Fresno-Garland	87	89	91	90	86	84
Central	Fresno	Fresno-Sierra Skypark #2	86	86	84	83	80	79
Central	Fresno	Parlier	91	91	92	88	84	81
Central	Fresno	Tranquility- 32650 West Adams Avenue	75	76	76	75	72	70
Central	Kings	Hanford-S Irwin Street	85	84	84	82	80	80
Central	Madera	Madera-28261 Avenue 14	83	83	84	81	78	78
Central	Madera	Madera-Pump Yard	82	83	80	78	76	76
Southern	Kern	Arvin-Di Giorgio	87	87	86	89	87	89
Southern	Kern	Bakersfield - 5558 California Avenue	85	84	86	88	87	85
Southern	Kern	Bakersfield - Municipal Airport	90	90	90	88	84	85
Southern	Kern	Edison	84	87	87	89	88	93
Southern	Kern	Maricopa-Stanislaus Street	79	81	83	85	83	85
Southern	Kern	Oildale-3311 Manor Street	79	77	79	82	84	83
Southern	Kern	Shafter-Walker Street	80	81	80	81	79	82
Southern	Tulare	Porterville - 1839 Newcomb Street	81	83	86	83	77	80
Southern	Tulare	Sequoia and Kings Canyon Natl Park	89	89	89	89	86	88
Southern	Tulare	Sequoia Natl Park - Lower Kaweah	84	84	84	86	82	83
Southern	Tulare	Visalia-N Church Street	79	80	83	85	84	83

2. Assessment of Valley-Wide Air Quality Progress

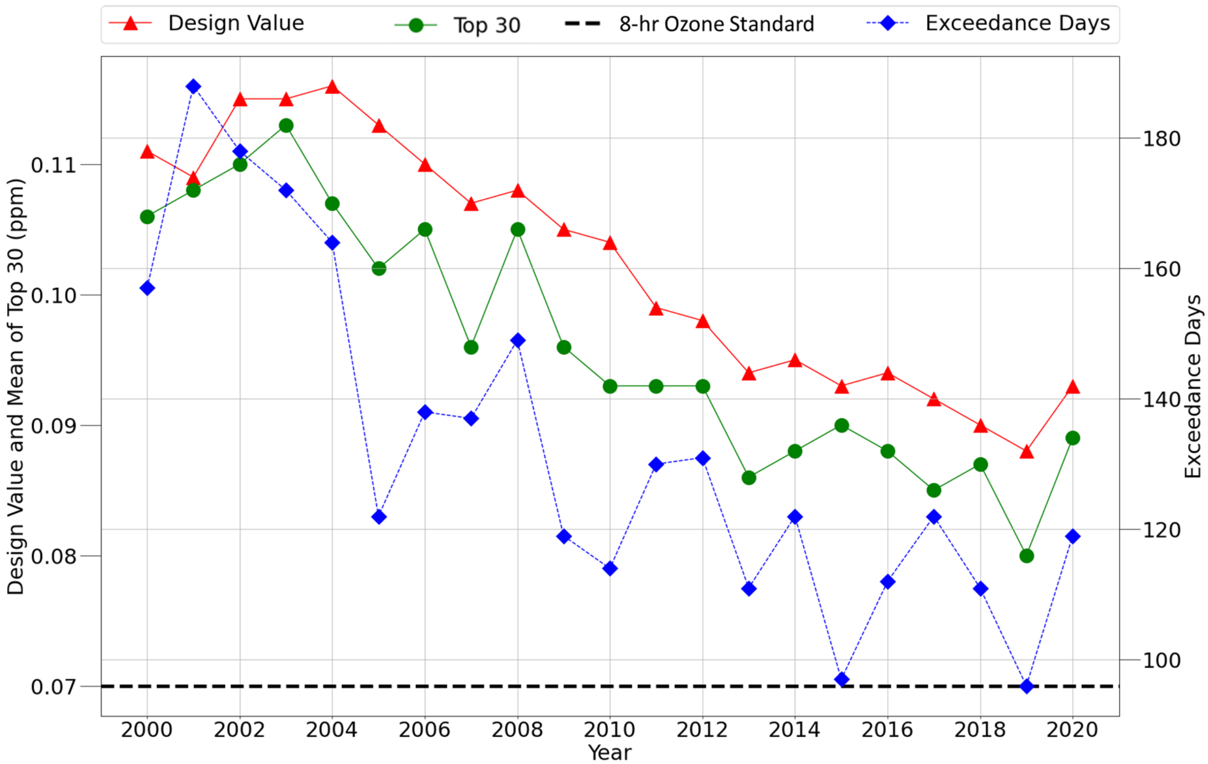
Figure 3 shows the basin wide design value trend from 2000 to 2020. Over the last 20 years, the design site has alternated between the central region (Clovis-N Villa Avenue, Fresno-Drummond, Fresno-Sierra Skypark #2, Fresno-Garland or Parlier) and the southern region (Edison and/or Arvin-Bear Mountain). The Valley experienced modest progress in the early 2000s; however, since 2004 there has been a consistent and substantial trend towards lower ozone levels.

Figure 3. Design Value Trend for the San Joaquin Valley Air Basin



Trends for three air quality indicators – design value, exceedance days, and mean of top 30 – are provided for the air basin from 2000-2020 in Figure 4. These three indicators address different aspects of ozone air quality, and together provide information to evaluate overall progress in reducing ozone exposure as well as attaining the standard. The design value (DV), U.S. EPA's compliance metric, is the average of the fourth highest daily maximum 8-hour concentration in each year measured over a consecutive three-year period. A site meets the standard when its design value is less than or equal to 0.070 ppm, the effective level of the standard. The mean of top 30 is a stable and responsive measure of progress as it represents the trend in the upper 8 percent of daily maximum 8-hour ozone levels during the year. Finally, the exceedance day metric shows how many days in a year the daily maximum 8-hour ozone was above the 2015 ozone standard (0.070 ppm). Due to the nature of this metric, exceedance days will generally show the most year-to-year variability. However, it is still an important metric to consider, as it does provide a measure of the frequency of exposure. Similar to the design value, the mean of top 30 and exceedance days has shown the most progress since 2004. Although there is some year-to-year variability such as the 2008, 2018 and 2020 ozone seasons which were heavily impacted by wildfires, every metric has shown considerable progress over the past decade. The recent increase in DV could be due to the 2018 and 2020 wildfires and will be discussed in more details in a later section.

Figure 4. Ozone Trends (2000-2020) in the San Joaquin Valley Air Basin



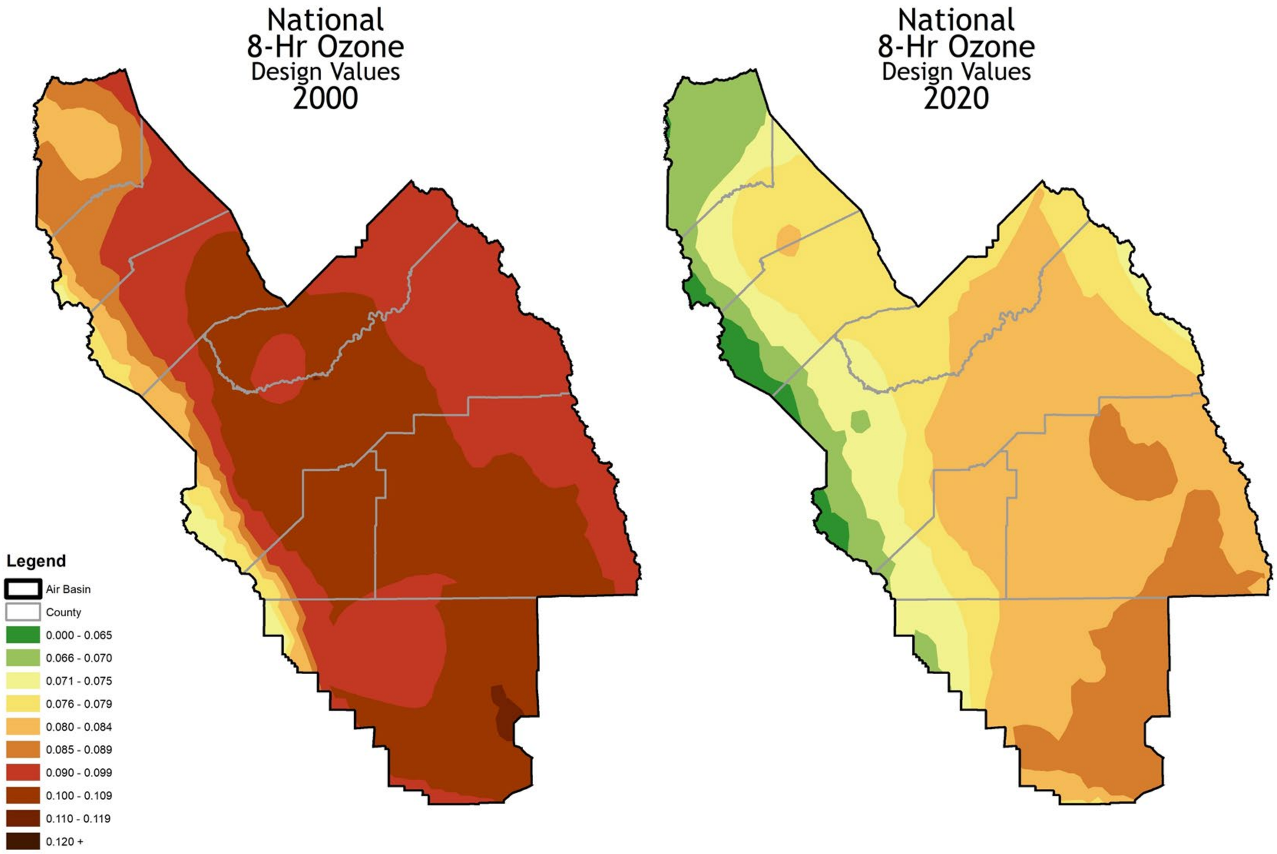
3. Recent Trends (2000-2020)

In the early 2000s, almost the entire Valley exceeded the 2015 8-hour ozone standard, and the standard was exceeded somewhere in the Valley approximately 150+ days during the ozone season each year. However, ozone air quality has improved throughout the region, with the basin wide design value (highest design value at any site in the basin) declining by 19 percent between 2000 and 2020, and basin wide exceedance days declining by 32 percent.

3.1 Basin-Wide Perspective

Figure 5 illustrates the progress that has been made in reducing the spatial extent of design values in the Valley. In 2000, most of the Valley was far above the 0.070 ppm ozone standard. Today, a larger portion of the Valley is in attainment, all the regions are significantly closer to the level of the standard, and the extent of the ozone problem is diminishing.

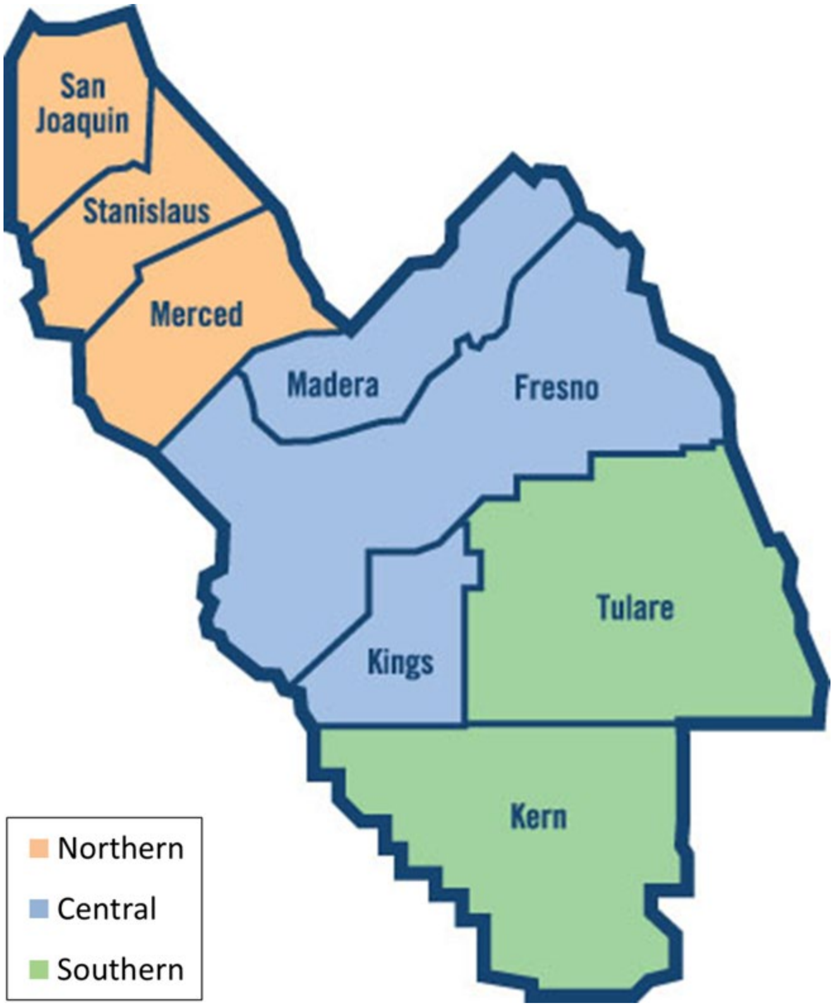
Figure 5. Reductions in Levels of Spatial Extent of Elevated Design Values in the San Joaquin Valley Air Basin



3.2 Regional Trends

For the purpose of this analysis, the Valley is split up into three different regions: northern, central, and southern. Figure 6 shows a map of the Valley and each county, split into the three regions. The following section shows trends for the highest sites in each region from 2000 through 2020. Data for the Fresno-1st Street and Fresno Garland sites have been merged into one data record because U.S. EPA considers Fresno Garland an official replacement for the Fresno-1st Street monitor. A map of the locations of these monitoring sites in each region is shown in Figure 7 (northern), Figure 12 (central), Figure 18 (southern), and Figure 24 (Sequoia National Park).

Figure 6. Counties and Regions in the San Joaquin Valley[2]



[2]Source: *https://www.valleyair.org/General_info/aboutdist.htm*

3.2.1 Northern Region

Figure 7. Active Ozone Sites in the Northern San Joaquin Valley

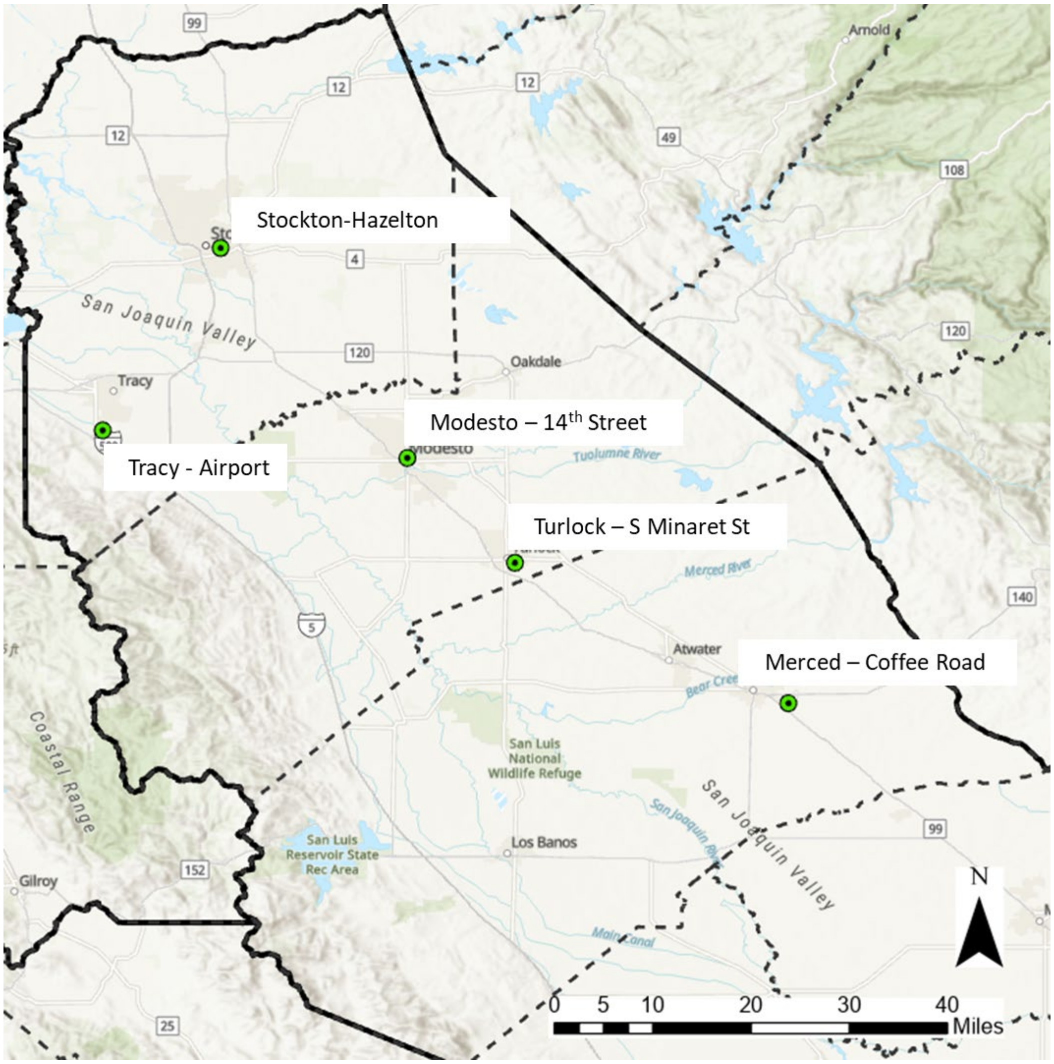


Figure 8 through Figure 11 show trends of selected sites in the northern region over the past two decades. The highest site in 2000, Merced-Coffee Road (Figure 10), has had a 28 percent decrease in design value (from 0.106 to 0.076 ppm), and a 79 percent decrease in exceedance days (from 95 to 20) when compared to 2020 values. Between 2000 and 2020 design values at Turlock-S Minaret Street (Figure 8) decreased by 17 percent (0.096 to 0.080 ppm) and Modesto-14th Street (Figure 9) decreased by 12 percent (from 0.090 to 0.079 ppm). Tracy-Airport (Figure 11) monitoring site decreased by 20 percent (from 0.087 to 0.070 ppm) from when it became active in 2008 to 2020 and is one of two sites in the northern region that is in attainment of the 0.070 ppm 8-hour ozone standard.

The northern region also demonstrates how local ozone production is a large contributor for the highest ozone values. The upwind site, Stockton-Hazelton Street and Tracy - Airport, are the only two sites that are in attainment of the 8-hour ozone standard at 0.066 and 0.070 ppm, respectively (Table 1). Moving south along the predominant wind flow direction, ozone levels increase at Modesto-14th Street (0.079 ppm) and are highest at the downwind site of Turlock-S Minaret Street at 0.080 ppm.

Figure 8. Ozone Trends for Turlock – S Minaret Street Monitoring Station (2000–2020)

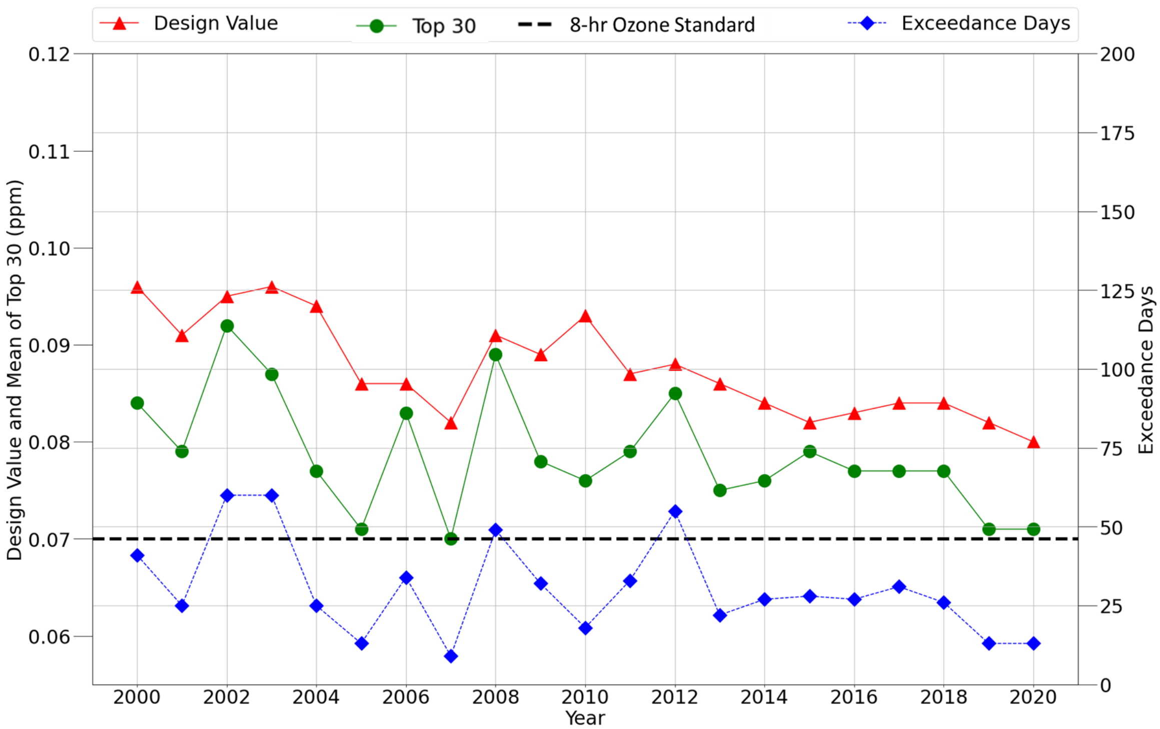


Figure 9. Ozone Trends for Modesto -14th Street Monitoring Station (2000–2020)

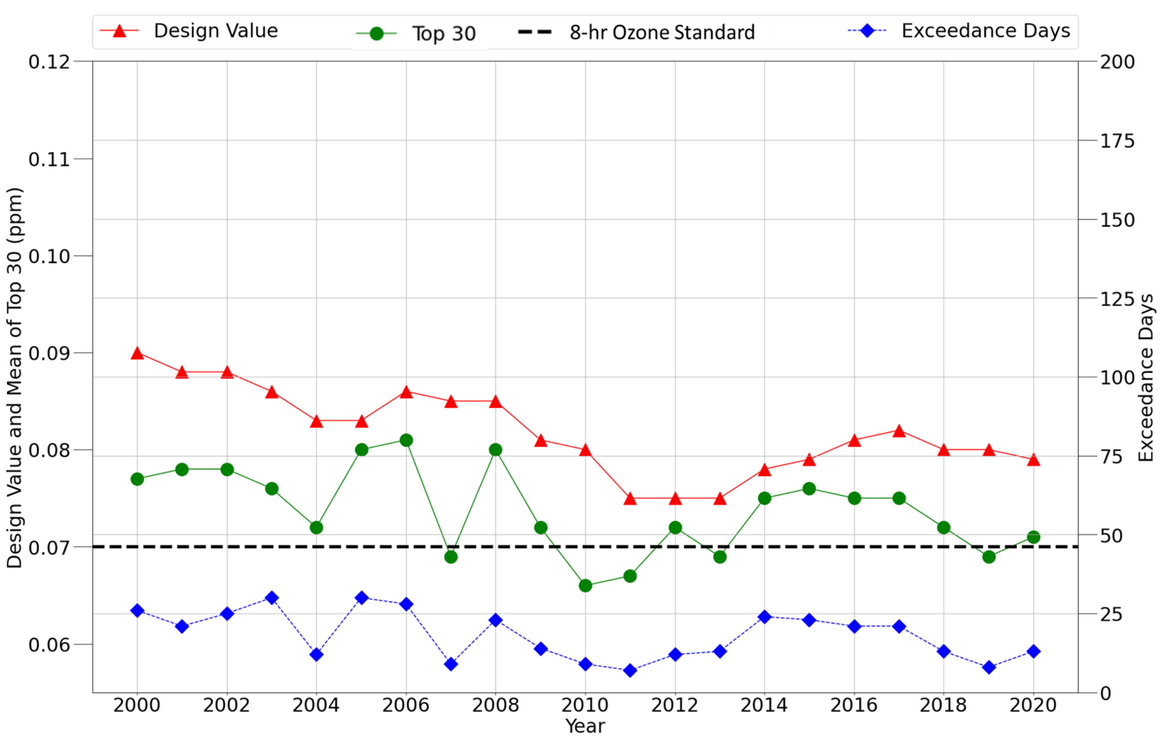


Figure 10. Ozone Trends for Merced – Coffee Road Monitoring Station (2000–2020)

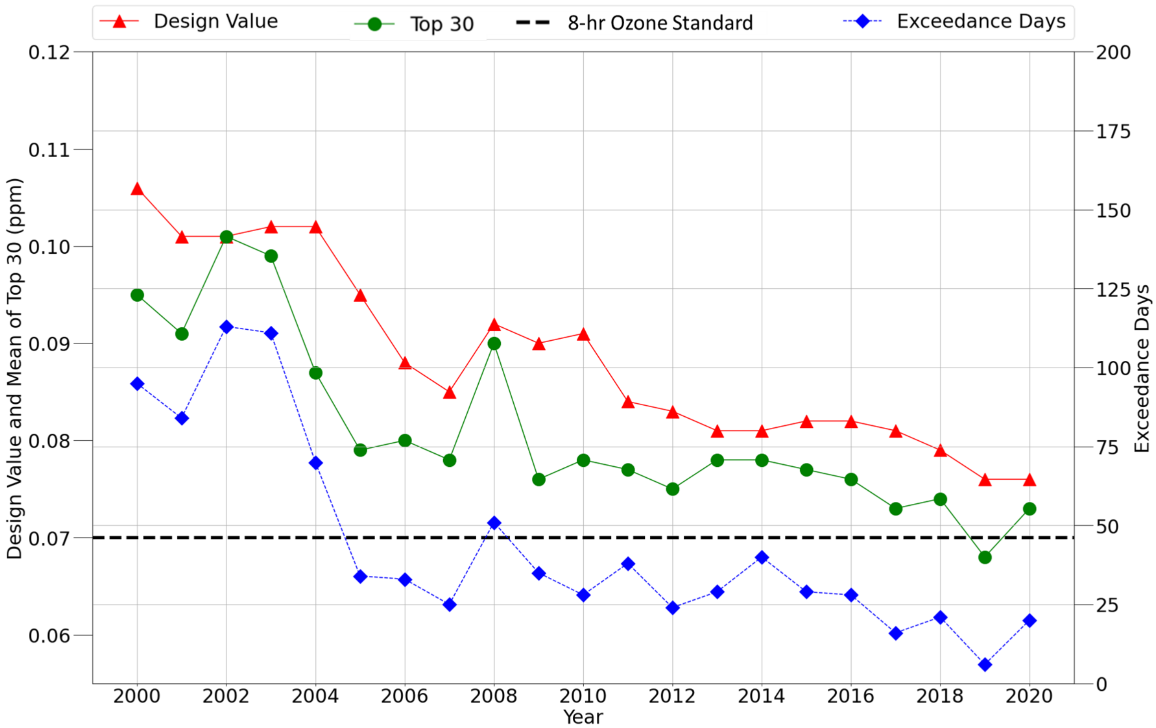
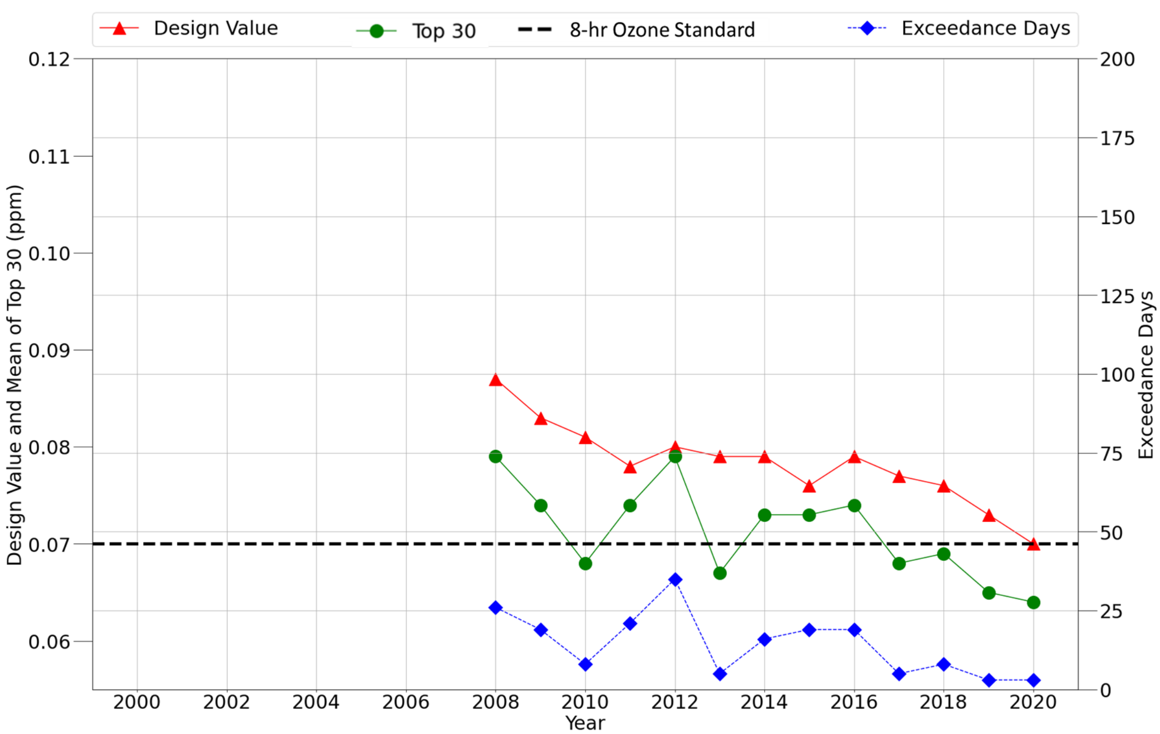


Figure 11. Ozone Trends for Tracy – Airport Monitoring Station (2008-2020)



3.2.2 Central Region

Figure 12. Active Ozone Sites in the Central San Joaquin Valley

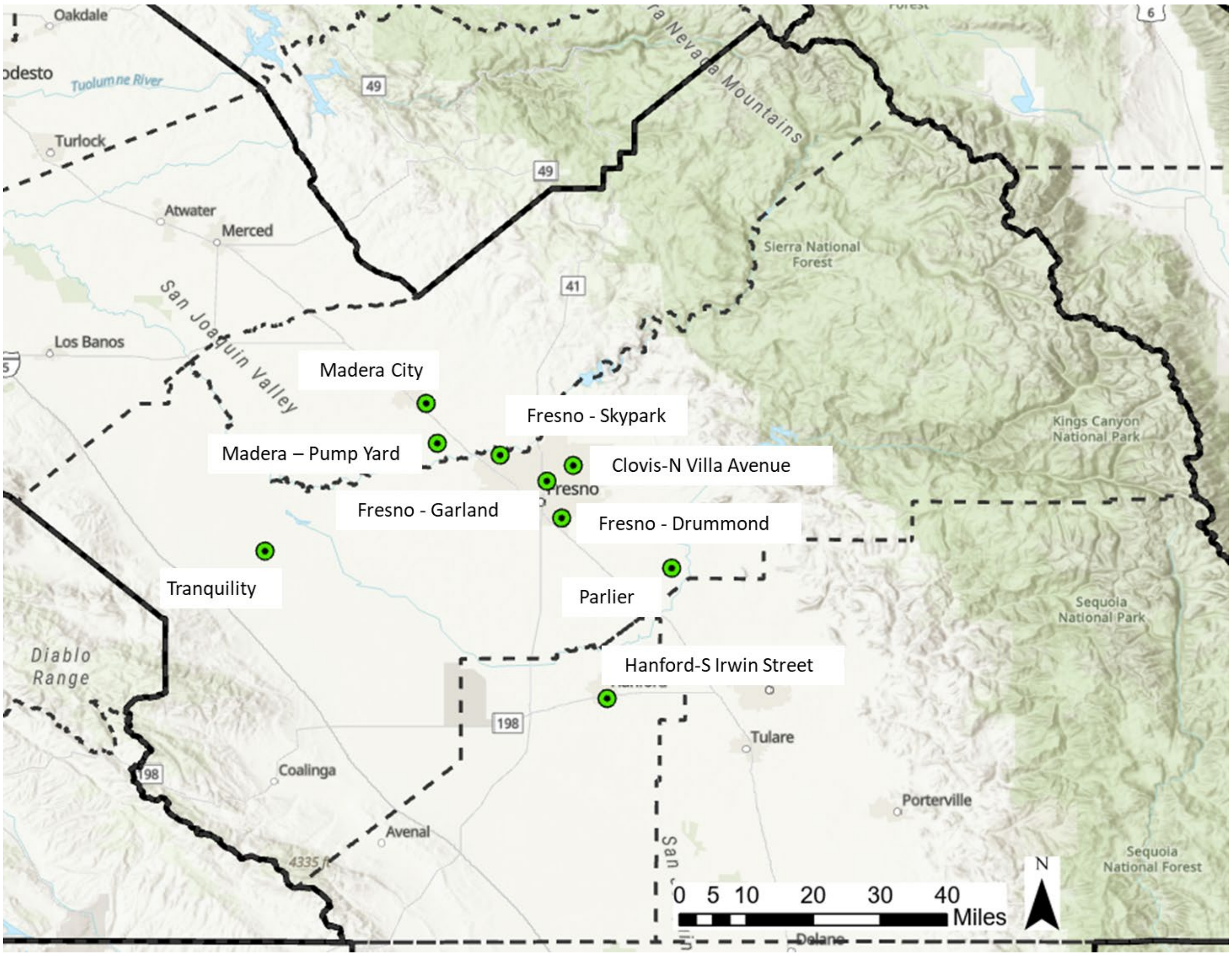


Figure 13 through Figure 17 show trends for selected sites in the central region. The more northern sites in this region: Tranquility, Madera Pump Yard, Fresno Sierra Skypark #2, and Madera – Avenue 14 have the lowest design values in the central region, with Tranquility being the only site in attainment of the 0.070 ppm 8-hour ozone standard. Since 2000, Clovis N Villa Avenue (Figure 13) had a 23 percent decrease (0.109 to 0.84 ppm), Fresno-1st Street/Garland (Figure 14) had a 22 percent decrease (0.108 to 0.084 ppm), Parlier (Figure 15) had a 24 percent decrease (0.107 to 0.081 ppm), Fresno Drummond (Figure 16) had a 23 percent decrease in design value (0.104 to 0.080 ppm), and Hanford-S Irwin Street (Figure 17) had a 22 percent decrease (0.102 to 0.080 ppm). The top 30 and exceedance days show decreasing trend with greater year to year variability for each site. Additional discussion of trends in the central region is provided in subsequent sections.

Figure 13. Ozone Trends for Clovis – N Villa Avenue Monitoring Station (2000-2020)

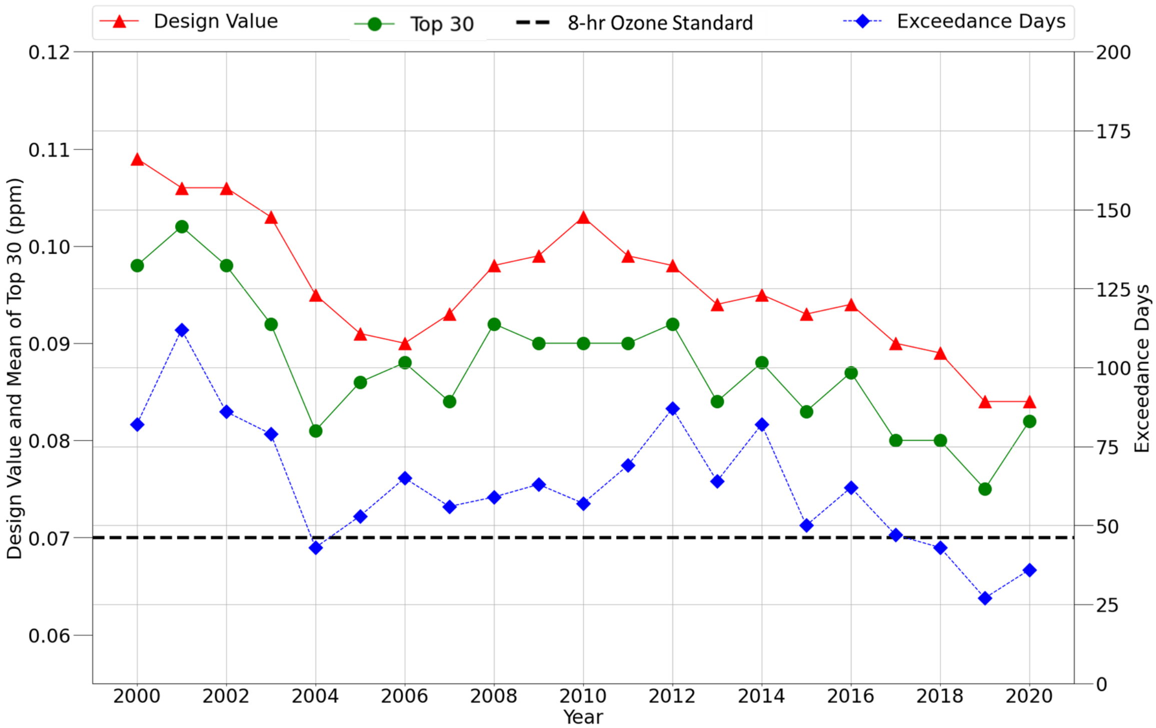


Figure 14. Ozone Trends for Fresno – 1st street and Garland Street Monitoring Station (2000-2020)

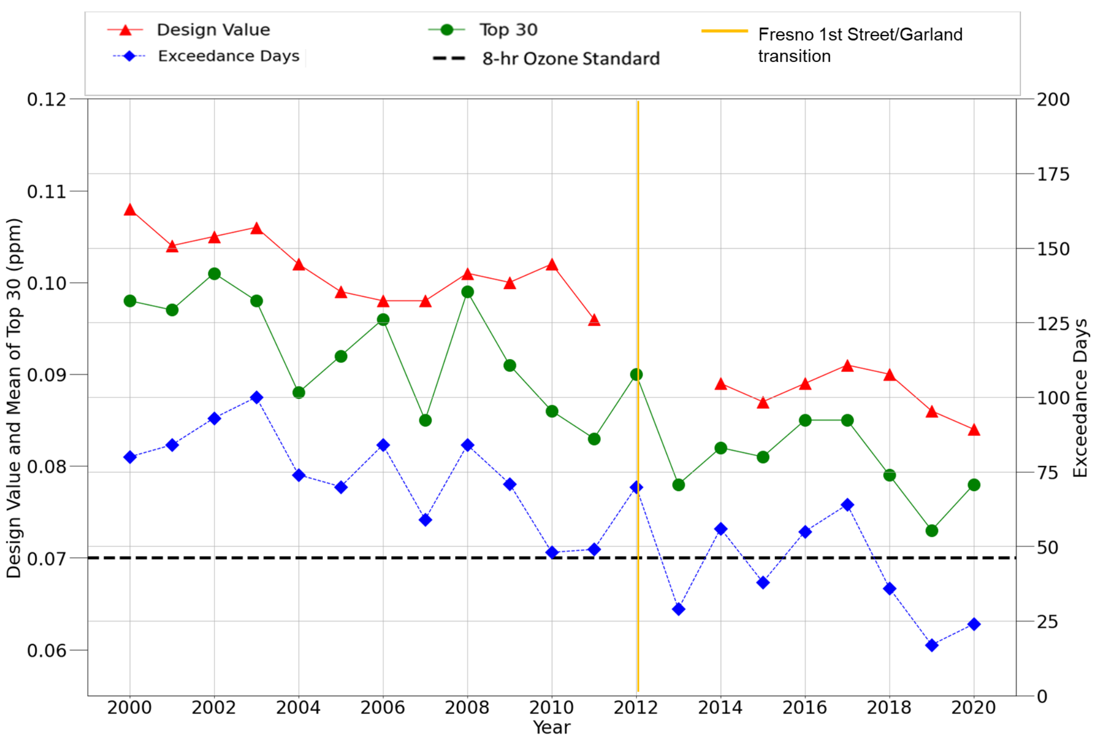


Figure 15. Ozone Trends for Parlier Street Monitoring Station (2000-2020)

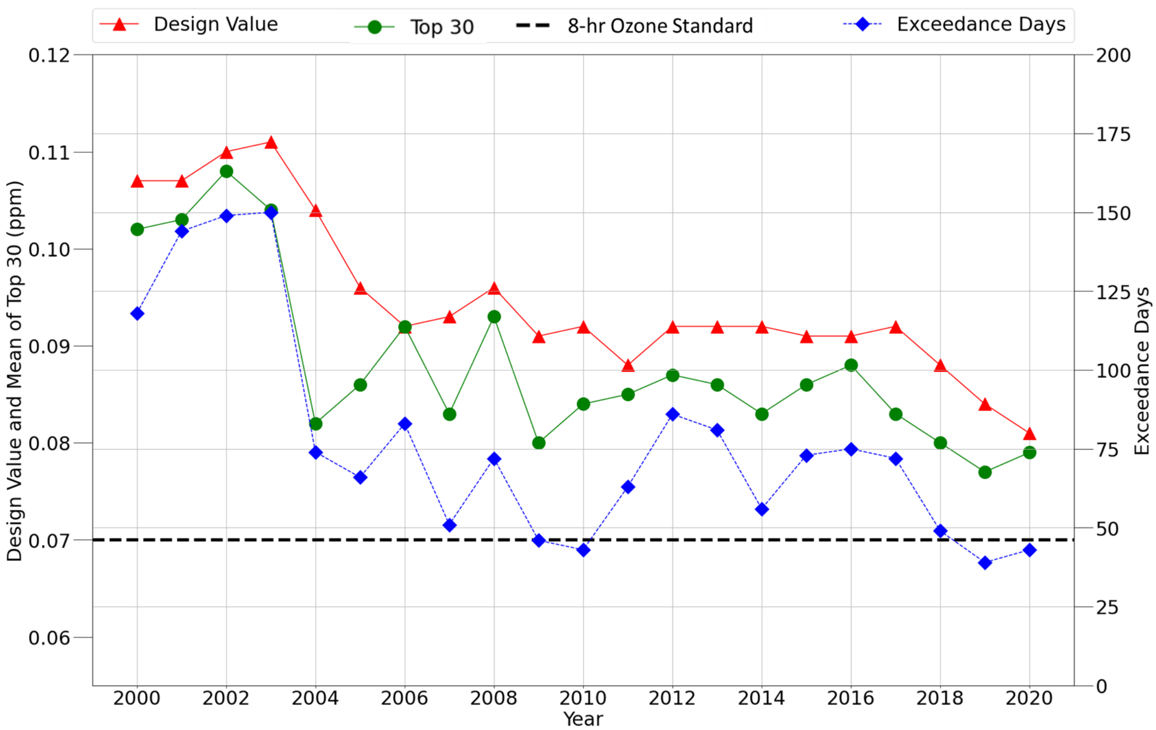


Figure 16. Ozone Trends for Fresno - Drummond Monitoring Station (2000-2020)

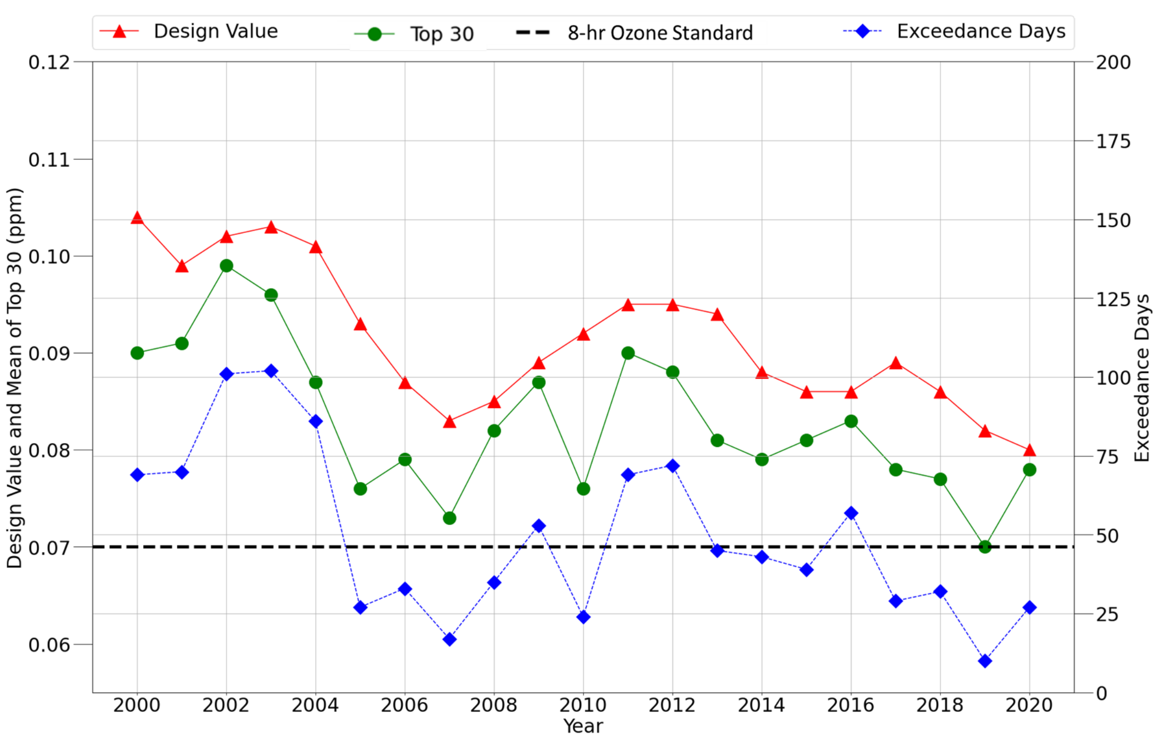
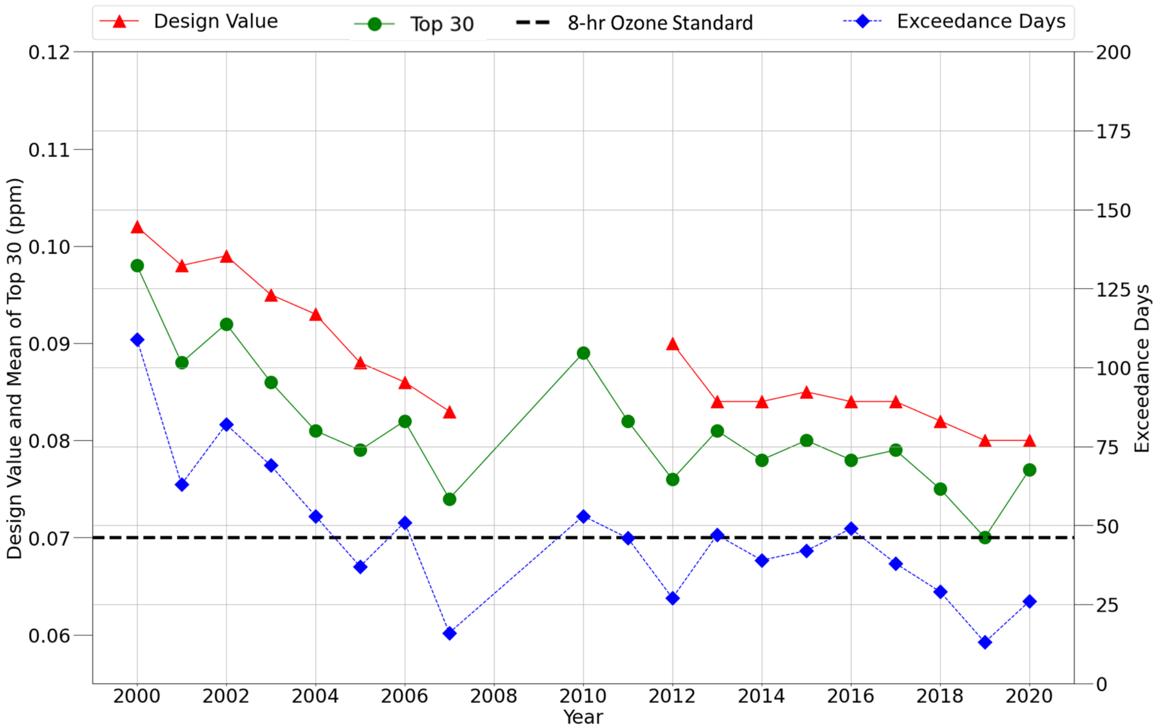


Figure 17. Ozone Trends for Hanford – S Irwin Street Monitoring Station (2000-2020)



3.2.3 Southern Region

Figure 18. Active Ozone Sites in the Southern San Joaquin Valley

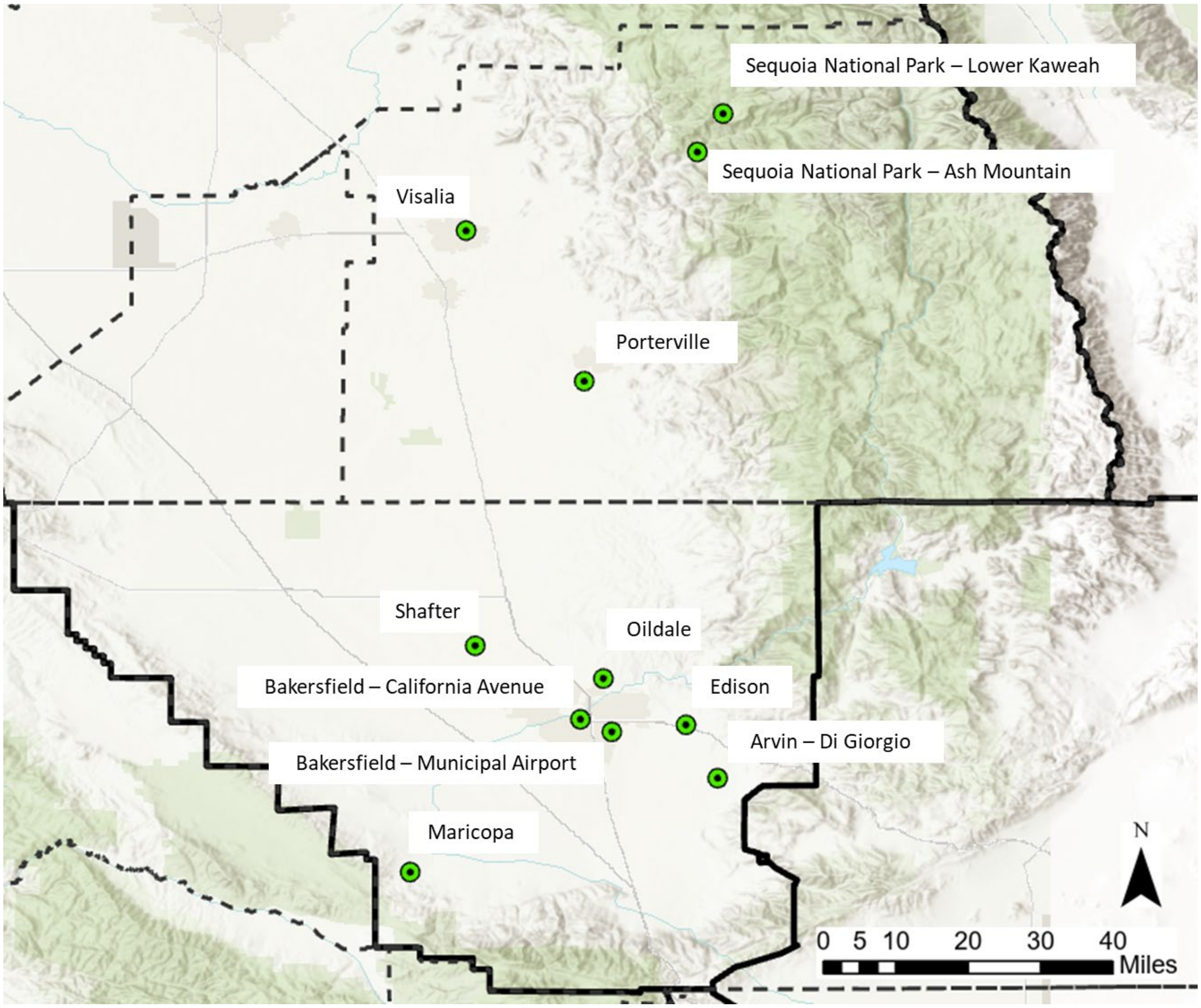


Figure 19 through Figure 23 show trends for the five highest sites in the southern region. In the past, the Valley's highest 8-hour concentrations occurred in the southern region. As demonstrated by Edison (Figure 19), Bakersfield-5558 California Ave (Figure 21) and Maricopa (Figure 22), this region has showed the most progress in the last two decades. Since 2000, Edison and Bakersfield-5558 California Ave have shown a 16 percent decrease in design value from 0.111 to 0.93 ppm and 0.101 to 0.85 ppm, respectively. Maricopa has decreased by 10 percent (0.094 to 0.085 ppm) in design value, since 2001. Similar to the design value, the top 30 and exceedance day metrics are showing steady declines, but with a bit more year-to-year variability. Arvin Di Giorgio (Figure 20) was established in 2010 as a replacement site for Arvin-Bear Mountain, which was shut down after the 2010 ozone season when the lease for that site was terminated. Since 2012, when the first design available was available at this site, the design value has decreased by 2 percent (0.091 to 0.089 ppm). Bakersfield Municipal Airport (Figure 21) was established in July 2012, with the first design value available in 2014. Since 2014, the design value at Bakersfield Municipal Airport has decreased by 7 percent (0.091 to 0.085 ppm).

Figure 19. Ozone Trends for Edison Monitoring Station (2000-2020)

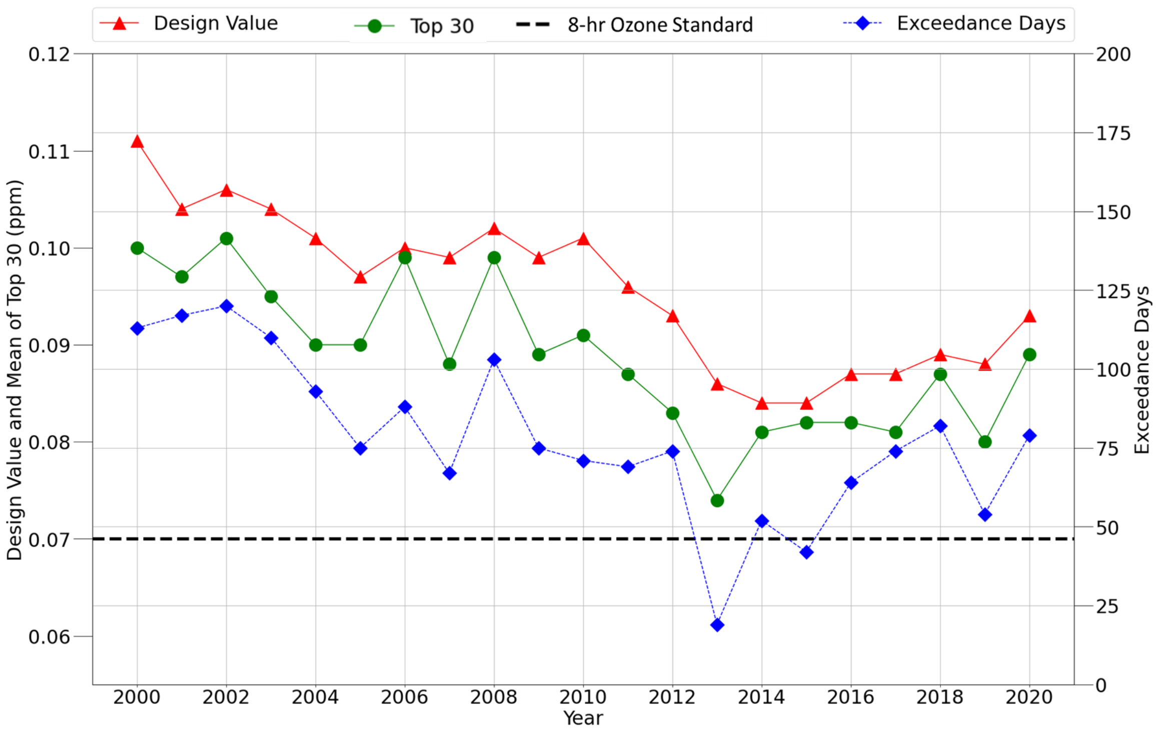


Figure 20. Ozone Trends for Arvin – Di Giorgio Monitoring Station (2012-2020)

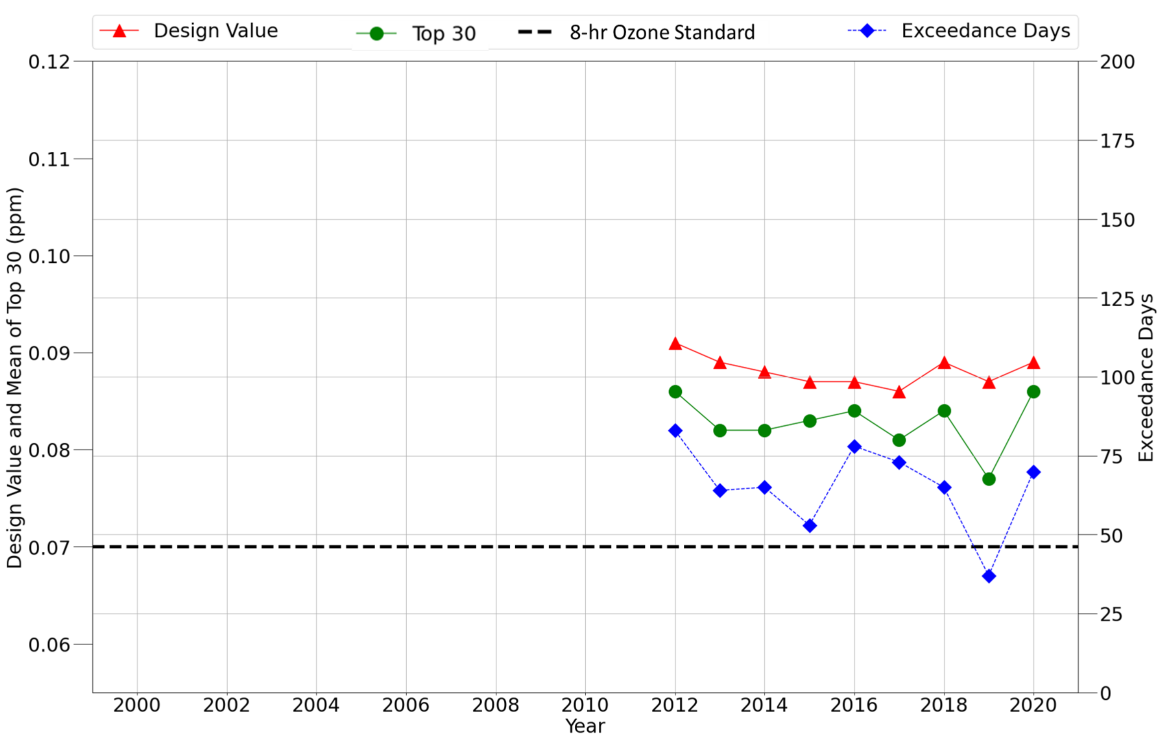


Figure 21. Ozone Trends for Bakersfield – California Avenue Monitoring Station (2000-2020)

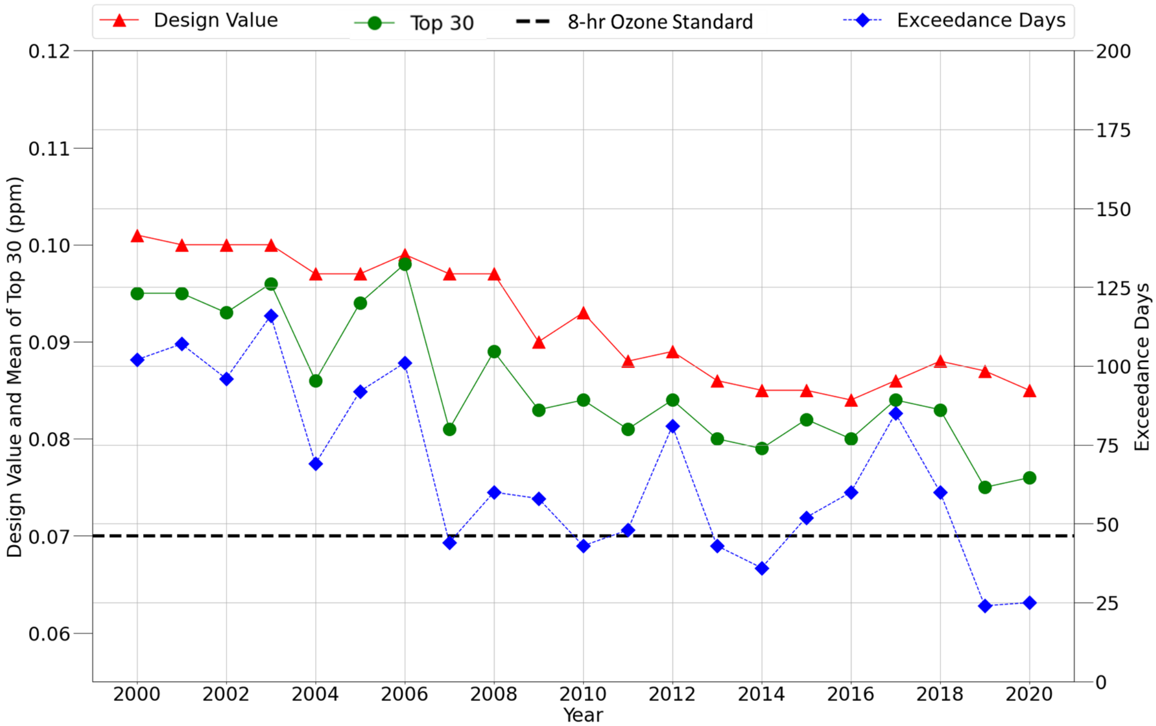


Figure 22. Ozone Trends for Maricopa Monitoring Station (2001-2020)

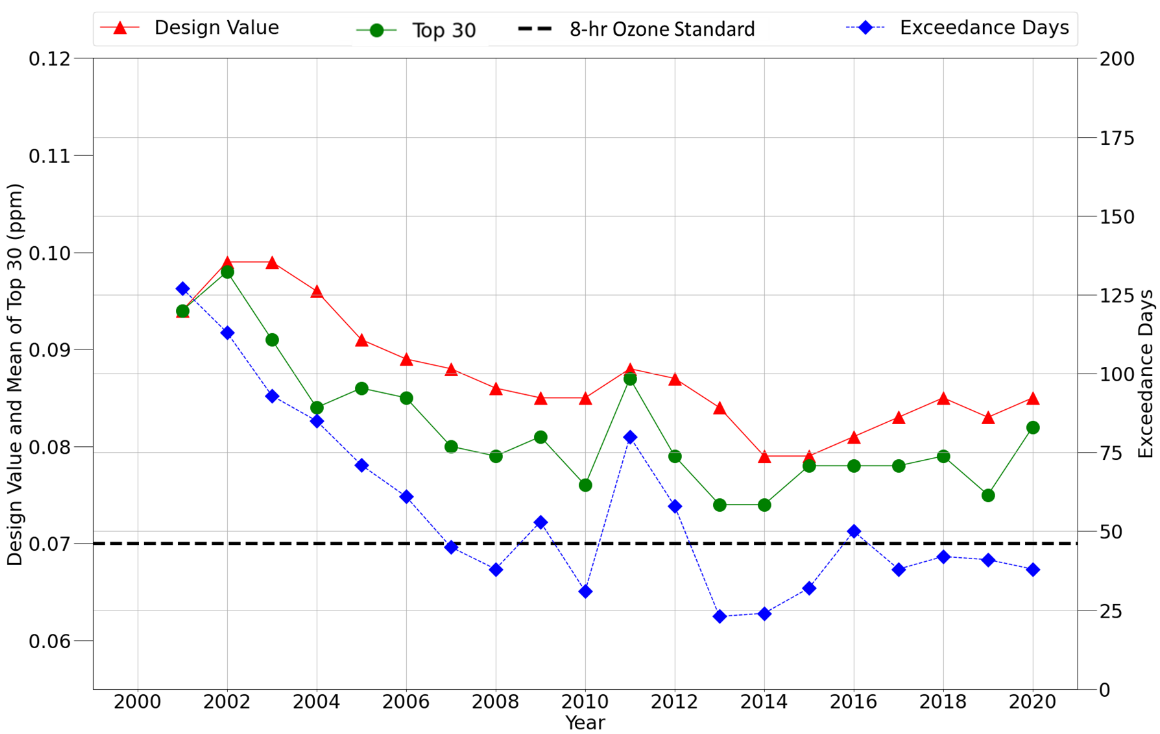
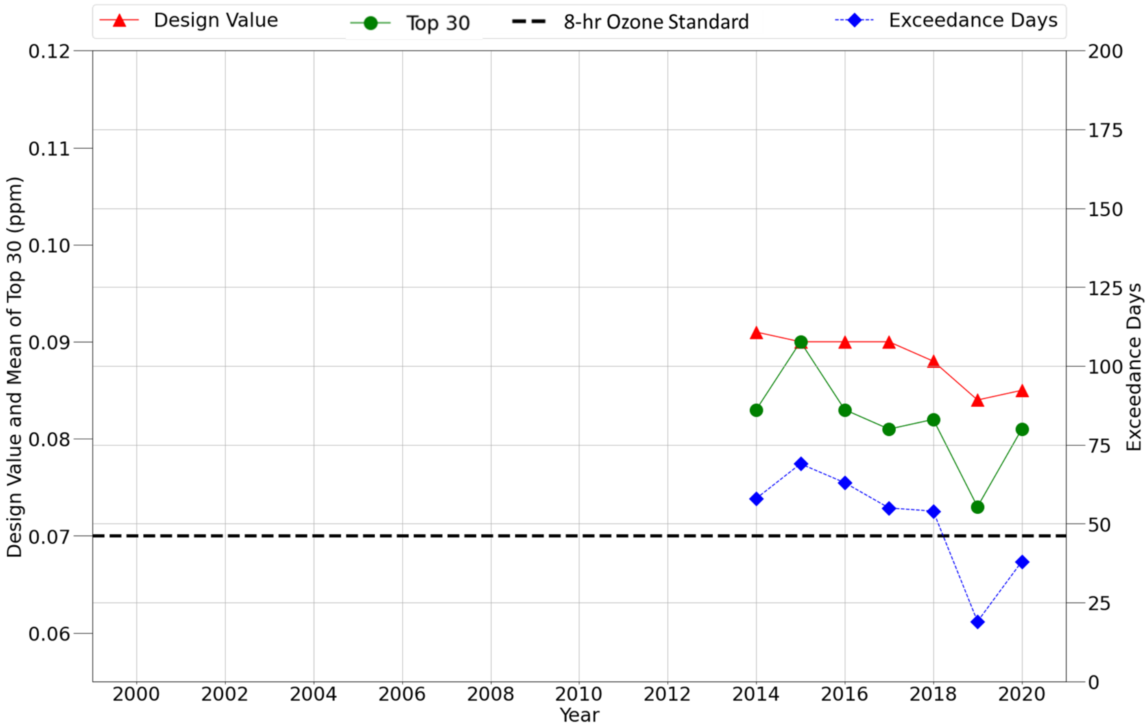


Figure 23. Ozone Trends for Bakersfield – Municipal Airport Monitoring Station (2014-2020)



3.2.4 Sequoia National Park

Figure 24. Active Ozone Sites in Sequoia National Park

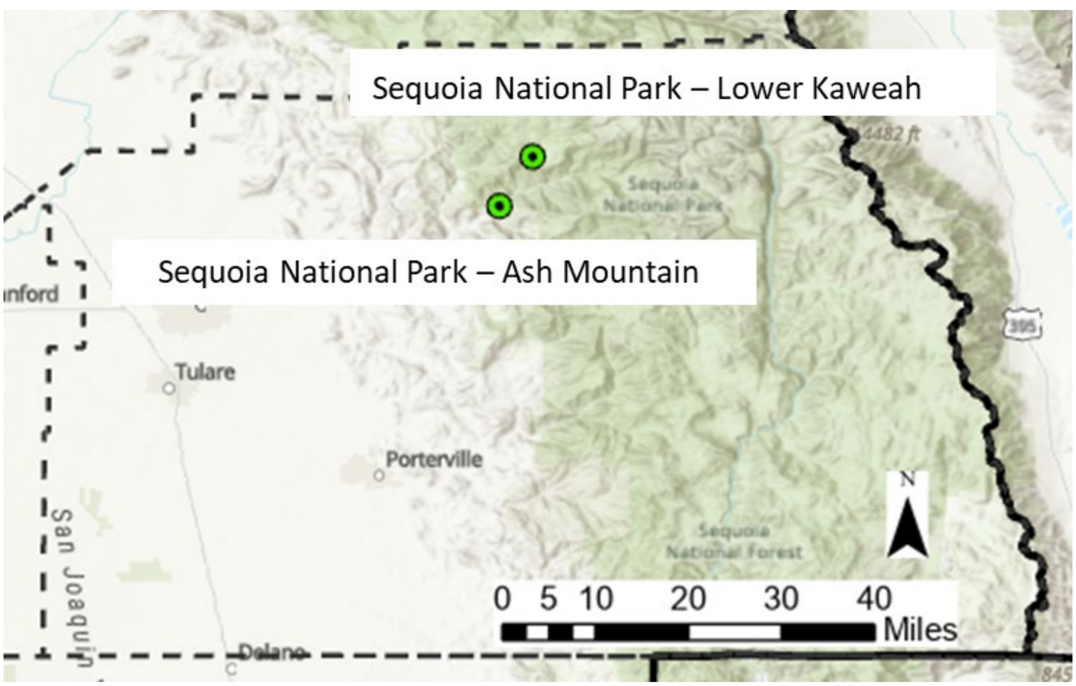


Figure 25 and Figure 26 show trends at the two sites in Sequoia National Park within Tulare County. These sites have unique dynamics, as they are elevated, downwind sites, far away from any urban center. In addition, as oxides of nitrogen (NO_x) emissions and ozone reach these sites, the remaining NO_x may react with high concentrations of biogenic emissions in these areas to form ozone. Sequoia and Kings Canyon National Park (Figure 25) has shown a 15 percent decrease in design value (0.104 to 0.088 ppm), an 11 percent decrease in top 30 (0.099 to 0.088 ppm), and a 40 percent decrease in exceedance days (144 to 86) between 2001 to 2020. Sequoia National Park Lower Kaweah (Figure 26) has shown a 12 percent decrease in design value (0.094 to 0.083 ppm), a 12 percent decrease in top 30 (0.090 to 0.079 ppm), and a 63 percent decrease in exceedance days (100 to 37) between 2001 to 2020.

Figure 25. Ozone Trends for Sequoia National Park – Ash Mountain Monitoring Station (2001-2020)

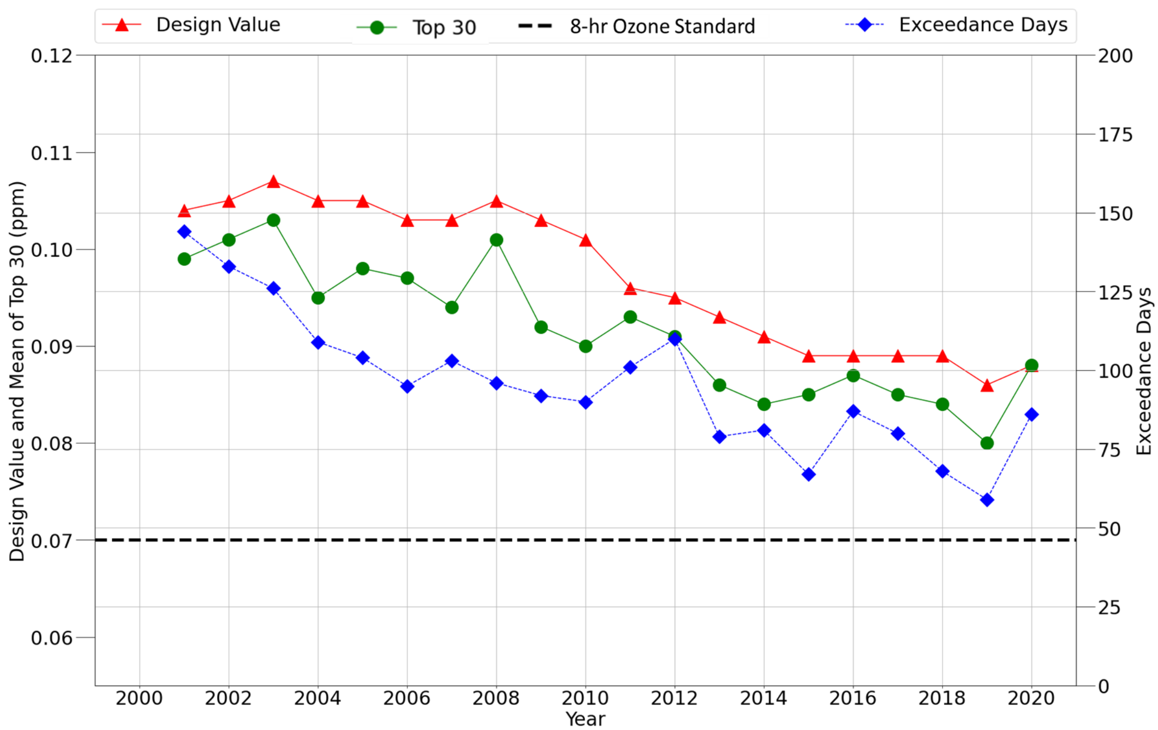
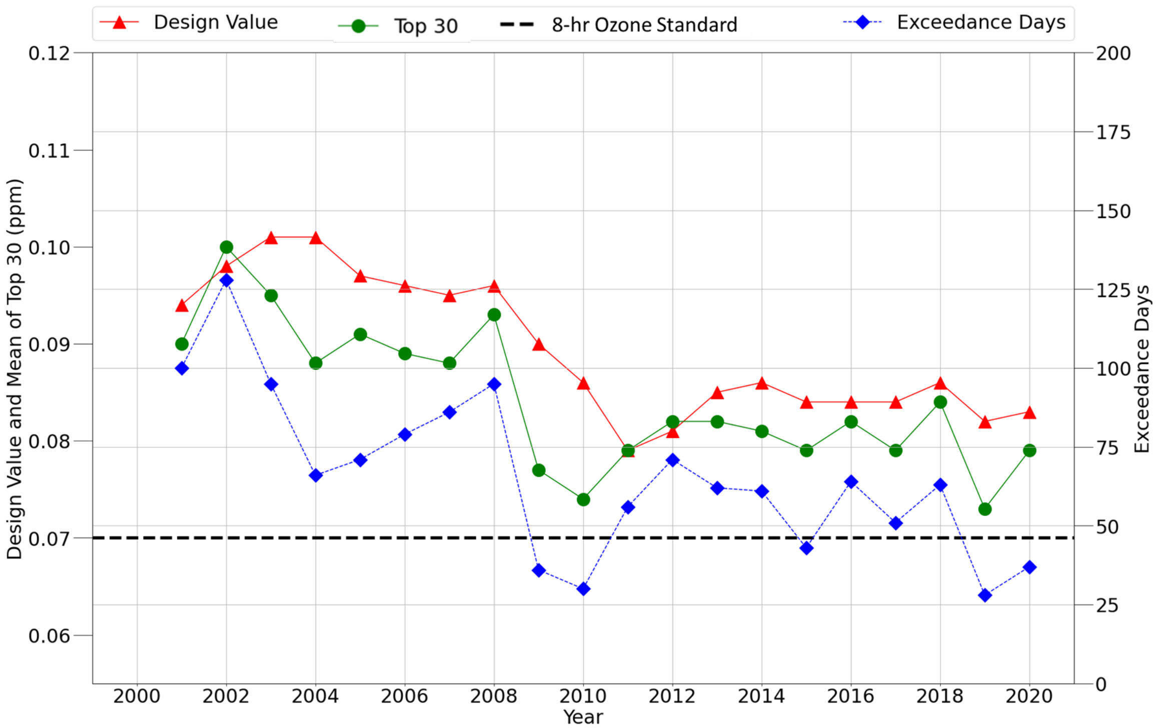


Figure 26. Ozone Trends for Sequoia National Park – Lower Kaweah Monitoring Station (2001-2020)



4. Wildfires

4.1 Wildfire Information

Wildfires have impacted the San Joaquin Valley ozone levels over the past years. The WOE includes analysis that accesses the dates that were impacted by wildfires and analyzes them in order to gain a better understanding on how the additional ozone precursors during the wildfire events could have impacted the design values for 2016-2020.

2016, 2017, 2018 and 2020 were extreme years for wildfires, with numerous wildfires active during the June through October, leading to many potential wildfires impacted days in the SJV and higher ozone levels due to the wildfire smoke. Table 2 through Table 6 list wildfires larger than 1,000 acres that were active between June through December in 2016 to 2020.

Table 2. 2016 Wildfires active in June through October[3]

Fire	Start	Containment	Latitude	Longitude	Total Acres
Erskine	6/23/2016	7/12/2016	35.6115	-118.45628	48,019
Trailhead	6/28/2020	7/18/2020	38.96741	-120.9375	5,646
Deer	7/1/2016	7/11/2016	35.20993	-118.72272	1,785
Curry	7/1/2016	7/5/2016	36.0749	-120.452041	2,944
Soberanes	7/22/2016	10/12/2016	36.45994	-121.89938	132,100
Goose	7/30/2016	8/9/2016	37.01591	-119.50507	2,241
Cold	8/2/2016	8/12/2016	38.52513	-122.06788	5,731
Mineral	8/9/2016	8/18/2016	36.09974	-120.51057	7,050
Chimney	8/13/2016	9/6/2016	35.70595	-120.98316	46,344
Clayton	8/13/2016	8/26/2016	38.89741	-122.60664	3,929
Ceder	8/16/2016	9/30/2016	35.7506	-118.5678	29,322
Gap	8/27/2016	9/17/2016	41.851	-123.118	33,867
Owens River	9/17/2016	10/15/2016	37.75985	-118.95309	5,443
Sawmill	9/25/2016	9/29/2016	38.80017	-122.82895	1,547
Marshes	9/26/2016	10/4/2016	37.79635	-120.32484	1,080
Loma	9/26/2016	10/12/2016	37.10632	-121.85318	4,474

3 Cal Fire 2016 Incidents. Accessed 11/24/2021. *https://www.fire.ca.gov/incidents/2016/*

Table 3. 2017 Wildfires active in June through November[4]

Fire	Start	Containment	Latitude	Longitude	Total Acres
Oakwood	6/10/2017	6/13/2017	37.0825	-119.8011	1,431
Highway	6/18/2017	6/28/2017	35.53456	-118.66733	1,522
Schaeffer	6/24/2017	8/10/2017	Sequoia National Forest		16,031
Salmon August Complex	6/25/2017	12/8/2017	41.841	-123.474	65,888
Winters	7/6/2017	7/12/2017	38.49521	-122.0251	2,269
Wall	7/7/2017	7/17/2017	39.45352	-121.41222	6,033
Parkfield	7/8/2017	7/11/2017	35.86949	-120.57894	1,816
Garza	7/9/2017	7/21/2017	35.93273	-120.20014	48,889
Long Valley	7/11/2017	7/21/2017	40.07045	-120.14013	83,733
Detwiler	7/16/2017	8/24/2017	37.61757	-120.21321	81,826
Modoc July Complex	7/24/2017	8/16/2017	Modoc National Forest		83,120
Orleans Complex	7/25/2017	8/26/2017	Six Rivers National Forest		27,276
Empire	8/1/2017	11/27/2017	37.644	-119.618	6,370
Parker 2	8/3/2017	8/29/2017	Modoc National Forest		7,697
Young	8/7/2017	8/28/2017	41.853	-123.676	2,500
South Fork	8/13/2017	11/27/2017			7,000
Eclipse Complex	8/15/2017	11/29/2017	41.841	-123.474	78,698
Pier	8/29/2017	11/29/2017	36.15356	-118.74103	36,556
Railroad	8/29/2017	10/24/2017	37.44663	-119.64622	12,407
Pondersosa	8/29/2017	9/9/2017	39.57701	-121.30209	4,016
Mud	8/29/2017	9/1/2017	40.43962	-120.22215	6,042
Slinkard	8/29/2017	9/12/2017	38.655	-119.55425	8,925
Helena	8/30/2017	11/15/2017	40.76025	-123.10003	21,846
Mission	9/3/2017	9/13/2017	37.21616	-119.48067	1,035
Buck	9/12/2017	11/20/2017	40.2275	-123.03583	13,417
Lion	9/24/2017	12/2/2017	36.27138	-118.48555	18,900

4 Cal Fire 2017 Incidents. Accessed 11/24/2021. https://www.fire.ca.gov/incidents/2017/

Table 4. 2018 Wildfires active in June through November[5]

Fire	Start	Containment	Latitude	Longitude	Total Acres
Airline	6/4/2018	6/14/2018	36.40755	-120.99322	1,314
Apple	6/9/2018	6/14/2018	39.94355	-122.3571	2,956
Lions	6/11/2018	10/1/2018	37.571	-119.118	13,347
Planada	6/15/2018	6/21/2018	37.39339	-120.34207	4,564
Yankee	6/15/2018	7/1/2018	35.73629	-120.75593	1,500
Ferguson	7/13/2018	11/28/2018	37.655	-119.886	96,901
Natchez	7/15/2018	1/4/2019	41.951	-123.546	38,134
Klondike	7/16/2018	11/28/2018	42.369	-123.86	175,528
Taylor Creek	7/16/2018	10/11/2018	42.528	-123.571	52,389
Carr	7/23/2018	8/30/2018	40.654	-122.624	229,651
Mendocino Complex (Ranch)	7/27/2018	9/19/2018	39.243	-123.103	410,203
Mendocino Complex (River)	7/27/2018	8/10/2018	39.047	-123.12	48,920
Butte	7/31/2018	8/2/2018	39.186	-121.793	1,200
Donnell	8/1/2018	1/4/2019	38.349	-119.929	36,450

Table 5. 2019 Wildfires active in June through November[6]

Fire	Start	Containment	Latitude	Longitude	Total Acres
Boulder	6/5/2019	6/11/2019	35.344	-199.914	1,127
West Butte	6/8/2019	6/17/2019	39.289	-121.859	1,350
Sand	6/8/2019	6/17/2019	38.890	-122.240	2,512
McMillan	6/12/2019	6/24/2019	35.663	-120.411	1,764
Rock	6/26/2019	6/27/2019	37.466	-121.283	2,422
Lonoak	6/26/2019	6/26/2019	36.284	-120.948	2,546
Tucker	7/28/2019	8/11/2019	41.796	-121.260	14,217
W1 McDonald	8/8/2019	8/11/2019	40.944	-120.275	1,020
Ward	8/9/2019	8/18/2019	42.033	-122.175	1,301
Gaines	8/16/2019	8/20/2019	37.536	-120.178	1,300
Long Valley	8/24/2019	8/27/2019	39.892	-120.030	2,438
R-1	8/28/2019	9/4/2019	40.593	-120.581	3,380
Walker	9/4/2019	9/25/2019	40.061	-120.681	54,612
Red Bank	9/5/2019	9/13/2015	40.12	-122.64	8,838
South Fire	9/5/2019	12/2/2019	40.109	-122.789	5,332
Taboose	9/6/2019	11/21/2019	37.034	-118.345	10,296

5 Cal Fire 2018 Incidents. Accessed 11/24/2021. *https://www.fire.ca.gov/incidents/2018/*

6 Cal Fire 2018 Incidents. Accessed 04/19/2022. https://www.fire.ca.gov/incidents/2019/

Fire	Start	Containment	Latitude	Longitude	Total Acres
Lone	9/6/2019	9/13/2019	41.748	-121.056	5,737
Spring	9/6/2019	10/24/2019	37.826	-188.872	4,840
Cow	9/6/2019	11/21/2019	36.284	-118.228	1,975
Lime	9/7/2019	9/19/2019	41.862	-122.662	1,872
Briceburg	10/6/2019	10/24/2019	37.605	-119.966	5,563
Caples	10/11/2019	11/01/2019	38.724	-120.145	3,435
Kincade	10/23/2019	11/6/2019	38.792	-122.780	77,758
Ranch	11/3/2019	11/14/2019	40.036	-122.638	2,534

Table 6. 2020 Wildfires active in July through December[7]

Fire	Start	Containment	Latitude	Longitude	Total Acres
Red Salmon Complex	7/27/2020	11/17/2020	41.16800	-123.40700	144,679
Loyalton Fire	8/14/2020	9/14/2020	39.70244	-120.14347	47,029
CZU Lightning Complex	8/16/2020	9/22/2020	37.17162	-122.22275	86,509
August Complex	8/16/2020	11/11/2020	39.77600	-122.67300	1,032,648
River Fire	8/16/2020	9/4/2020	36.60239	-121.62161	48,088
LNU Lightning Complex	8/17/2020	10/2/2020	38.48193	-122.14864	363,220
North Complex Fire	8/18/2020	12/3/2020	39.69072	-121.22718	318,935
Salt Fire	8/18/2020	8/24/2020	38.02792	-120.76326	1,789
Woodward Fire	8/18/2020	10/2/2020	38.01809	-122.83670	4,929
Carmel Fire	8/18/2020	9/4/2020	36.44630	-121.68181	6,905
SCU Lightning Complex	8/18/2020	10/1/2020	37.43944	-121.30435	396,624
Dolan Fire	8/19/2020	12/31/2020	36.12300	-121.60200	124,924
Butte/Tehama/Glenn Lightning Complex	8/19/2020	10/9/2020	40.09571	-122.43930	19,609
Moc Fire	8/20/2020	8/30/2020	37.81378	-120.31257	2,857
SQF Complex Fire (Includes Castle Fire and Shotgun Fire)	8/21/2020	1/6/2021	36.25500	-118.49700	174,178
Sheep Fire	8/22/2020	9/9/2020	40.27400	-120.75700	29,570
Creek Fire	9/4/2020	12/24/2020	37.19147	-119.26118	379,895
Slater Fire (includes Devil Fire)	9/7/2020	12/10/2020	41.86889	-123.44963	157,229

4.2 Summary of Event

Table 7 shows the potential wildfire impacted dates and the affected sites for the years 2016 through 2020; although not all wildfires impacted each monitor on any given day. These dates are assumed to be unusual event days, due to the excess ozone precursor emissions from the wildfire activities and the removal of these dates drops the 4th highest ozone date for most sites and therefore reduced the DV. Note that wildfire emissions may have impacted ozone concentrations on other dates and sites not listed here and may require further analysis.

7 Cal Fire 2020 Incidents. Accessed 11/24/2021. *https://www.fire.ca.gov/incidents/2020/*

Table 7. 2016 through 2020 List of Dates and Sites Affected by Wildfires

Date	Site(s)
2016-07-26	Fresno-Drummond, Parlier, Edison
2016-07-27	Fresno-Drummond, Fresno-Garland, Parlier, Hanford-S Irwin Street, Merced-Coffee Road, Edison, Porterville
2016-07-28	Parlier, Clovis-N Villa Avenue, Edison, Maricopa, Porterville
2016-07-29	Fresno-Drummond, Parlier, Edison
2016-08-17	Parlier, Hanford-S Irwin Street
2016-08-18	Madera City
2016-08-19	Clovis-N Villa Avenue
2017-08-28	Fresno-Drummond, Fresno-Garland, Fresno-Skypark, Parlier, Clovis-N Villa Avenue, Madera City, Madera-Pump Yard, Hanford-S Irwin Street, Arvin-Di Giorgio, Visalia, Bakersfield-Municipal Airport, Edison, Bakersfield-California Avenue, Oildale
2017-08-29	Clovis-N Villa Avenue, Madera City, Arvin-Di Giorgio, Bakersfield-Municipal Airport, Bakersfield-California Avenue
2017-08-30	Sequoia National Park-Ash Mountain
2017-08-31	Parlier, Visalia, Oildale
2017-09-01	Modesto-14th Street, Arvin-Di Giorgio, Bakersfield-Municipal Airport, Edison, Bakersfield-California Avenue, Oildale
2017-09-02	Fresno-Drummond, Fresno-Garland, Fresno-Skypark, Parlier, Clovis-N Villa Avenue, Madera City, Madera-Pump Yard, Hanford-S Irwin Street, Modesto-14th Street, Turlock-S Minaret Street, Arvin-Di Giorgio, Visalia, Bakersfield-Municipal Airport, Edison, Bakersfield-California Avenue, Maricopa, Oildale
2017-09-03	Modesto-14th Street
2018-07-24	Sequoia National Park-Ash Mountain, Sequoia National Park-Lower Kaweah
2018-07-26	Turlock-S Minaret Street
2018-07-29	Fresno-Garland, Clovis-N Villa Avenue, Bakersfield-Municipal Airport, Bakersfield-California Avenue, Oildale
2018-07-30	Arvin-Di Giorgio, Bakersfield-Municipal Airport, Modesto-14th Street, Turlock-S Minaret Street
2018-07-31	Modesto-14th Street, Turlock-S Minaret Street, Arvin-Di Giorgio, Bakersfield-Municipal Airport, Edison, Sequoia National Park-Ash Mountain, Bakersfield-California Avenue, Maricopa, Oildale
2018-08-01	Sequoia National Park-Ash Mountain
2018-08-04	Visalia, Edison, Bakersfield-California Avenue, Oildale, Sequoia National Park-Lower Kaweah, Hanford-S Irwin Street, Fresno-Drummond, Fresno-Garland
2018-08-06	Parlier, Arvin-Di Giorgio, Visalia, Sequoia National Park-Lower Kaweah
2018-08-07	Clovis-N Villa Avenue, Arvin-Di Giorgio, Visalia, Bakersfield-Municipal Airport, Edison, Sequoia National Park-Lower Kaweah, Fresno-Garland
2018-08-08	Fresno-Garland, Clovis-N Villa Avenue, Arvin-Di Giorgio, Visalia, Bakersfield-Municipal Airport, Edison, Bakersfield-California Avenue, Maricopa, Oildale, Sequoia National Park-Lower Kaweah, Shafter
2018-08-09	Fresno-Drummond, Fresno-Garland, Fresno-Skypark, Parlier, Clovis-N Villa Avenue, Modesto-14th Street, Turlock-S Minaret Street, Arvin-Di Giorgio, Visalia, Bakersfield-Municipal Airport, Edison, Bakersfield-California Avenue, Maricopa, Oildale, Sequoia National Park-Lower Kaweah, Shafter
2018-08-10	Fresno-Garland, Parlier, Clovis-N Villa Avenue, Arvin-Di Giorgio, Visalia, Bakersfield-Municipal Airport, Bakersfield-California Avenue, Maricopa, Oildale, Hanford-S Irwin Street

Date	Site(s)
2018-09-26	Bakersfield-California Avenue
2020-08-17	Fresno-Drummond, Fresno-Garland, Parlier, Clovis-N Villa Avenue, Madera City
2020-08-18	Fresno-Garland, Hanford-S Irwin Street
2020-08-19	Arvin-Di Giorgio, Bakersfield-Municipal Airport, Edison, Sequoia National Park-Ash Mountain, Bakersfield-California Avenue, Maricopa, Sequoia National Park-Lower Kaweah, Shafter
2020-08-20	Fresno-Garland, Modesto-14th Street, Merced-Coffee Road
2020-08-21	Fresno-Drummond, Fresno-Garland, Parlier, Clovis-N Villa Avenue, Hanford-S Irwin Street, Arvin-Di Giorgio, Visalia, Bakersfield-Municipal Airport, Edison, Sequoia National Park-Ash Mountain, Bakersfield-California Avenue, Maricopa, Oildale, Porterville, Sequoia National Park-Lower Kaweah, Shafter
2020-08-22	Fresno-Garland, Clovis-N Villa Avenue, Arvin-Di Giorgio, Bakersfield-Municipal Airport, Edison, Sequoia National Park-Ash Mountain, Bakersfield-California Avenue, Maricopa, Oildale, Porterville, Sequoia National Park-Lower Kaweah, Shafter
2020-08-23	Sequoia National Park-Ash Mountain, Sequoia National Park-Lower Kaweah
2020-08-24	Fresno-Drummond, Fresno-Garland, Fresno-Skypark, Parlier, Clovis-N Villa Avenue, Madera City, Hanford-S Irwin Street, Arvin-Di Giorgio, Visalia, Edison, Sequoia National Park-Ash Mountain, Bakersfield-California Avenue, Porterville, Shafter
2020-08-28	Modesto-14th Street, Turlock-S Minaret Street
2020-08-29	Fresno-Garland, Hanford-S Irwin Street, Shafter
2020-08-31	Fresno-Garland, Hanford-S Irwin Street, Bakersfield-California Avenue, Shafter
2020-09-01	Fresno-Garland, Arvin-Di Giorgio, Edison, Sequoia National Park-Ash Mountain, Bakersfield-California Avenue, Shafter
2020-09-02	Arvin-Di Giorgio, Edison, Sequoia National Park-Ash Mountain, Bakersfield-California Avenue, Shafter
2020-09-03	Arvin-Di Giorgio, Edison, Bakersfield-California Avenue
2020-09-04	Hanford-S Irwin Street, Edison, Bakersfield-California Avenue
2020-09-05	Fresno-Drummond, Fresno-Garland, Parlier, Clovis-N Villa Avenue, Hanford-S Irwin Street, Arvin-Di Giorgio, Visalia, Bakersfield-Municipal Airport, Edison, Bakersfield-California Avenue, Maricopa, Oildale, Porterville, Shafter
2020-09-06	Fresno-Skypark, Madera City, Madera-Pump Yard, Modesto-14th Street, Merced-Coffee Road, Arvin-Di Giorgio, Bakersfield-Municipal Airport, Edison, Sequoia National Park-Ash Mountain, Bakersfield-California Avenue, Maricopa, Shafter
2020-09-07	Fresno-Drummond, Fresno-Garland, Parlier, Clovis-N Villa Avenue, Madera City, Hanford-S Irwin Street, Modesto-14th Street
2020-09-12	Edison, Bakersfield-California Avenue, Shafter
2020-09-13	Arvin-Di Giorgio, Bakersfield-Municipal Airport, Edison, Bakersfield-California Avenue, Shafter
2020-09-14	Fresno-Drummond, Fresno-Garland, Madera City, Hanford-S Irwin Street, Arvin-Di Giorgio, Bakersfield-California Avenue, Maricopa, Shafter
2020-09-15	Edison, Bakersfield-California Avenue, Maricopa, Shafter
2020-09-16	Fresno-Garland, Arvin-Di Giorgio, Edison, Bakersfield-California Avenue, Maricopa, Shafter
2020-09-17	Arvin-Di Giorgio, Edison, Bakersfield-California Avenue
2020-09-21	Edison, Shafter
2020-09-29	Hanford-S Irwin Street, Modesto-14th Street
2020-09-30	Modesto-14th Street, Shafter
2020-10-01	Fresno-Garland, Hanford-S Irwin Street, Edison, Bakersfield-California Avenue, Shafter

Date	Site(s)
2020-10-02	Fresno-Drummond, Fresno-Garland, Hanford-S Irwin Street, Edison, Bakersfield-California Avenue, Shafter
2020-10-03	Fresno-Drummond, Fresno-Garland, Fresno-Skypark, Madera City, Madera-Pump Yard, Hanford-S Irwin Street, Bakersfield-California Avenue, Porterville, Shafter
2020-10-04	Fresno-Garland, Parlier, Hanford-S Irwin Street, Bakersfield-California Avenue, Shafter
2020-10-05	Edison, Bakersfield-California Avenue
2020-10-16	Clovis-N Villa Avenue

4.3 $PM_{2.5}$

Evidence of ground-level impacts of smoke on the monitor can also be indicated through analysis of fine particulate matter ($PM_{2.5}$). Figure 27 through Figure 33 shows that there was elevated $PM_{2.5}$ concentrations across the Valley during the time of the events listed in Table 7, the event periods are highlighted within the black box in each figure.

Due to the surrounding mountains and meteorological conditions, air flow in and out of the Valley can be limited. Resulting in poor dispersion and stagnation allowing the wildfire ozone precursors to linger which is conducive to the formation of elevated ozone concentrations.

Figure 27. Daily PM2.5 Data for July 2016

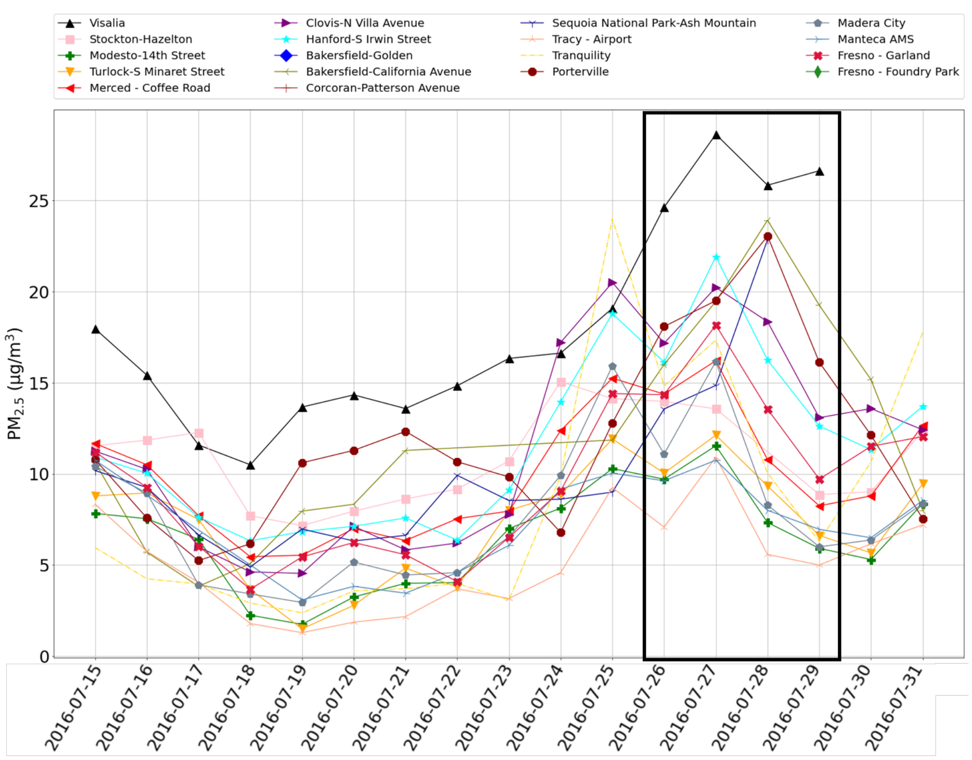


Figure 28. Daily PM2.5 Data for August 2016

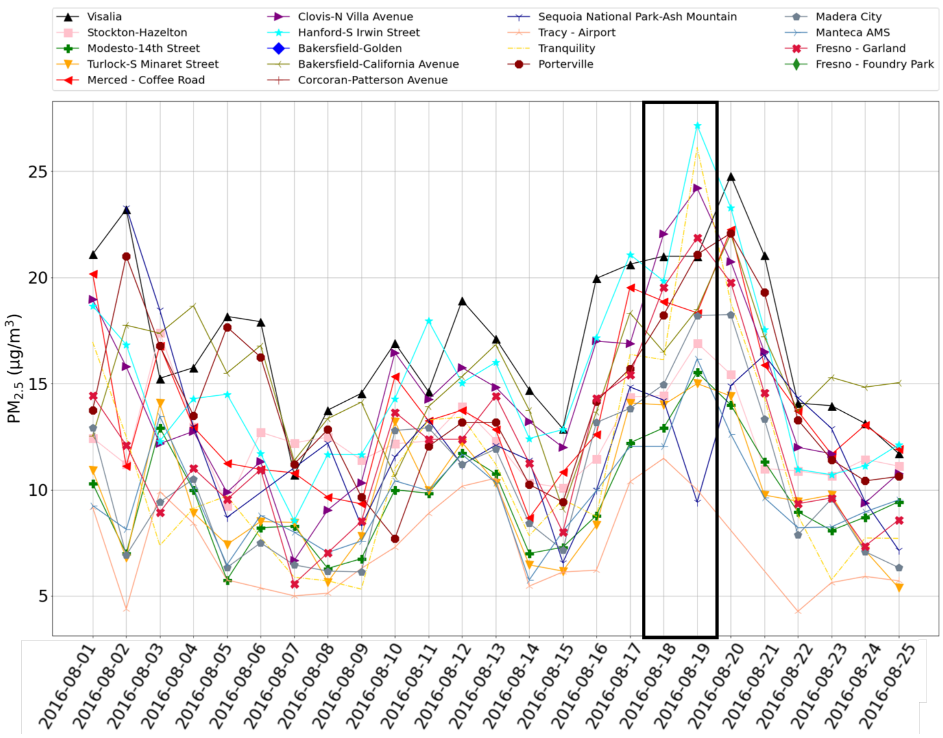


Figure 29. Daily PM2.5 Data for August and September 2017

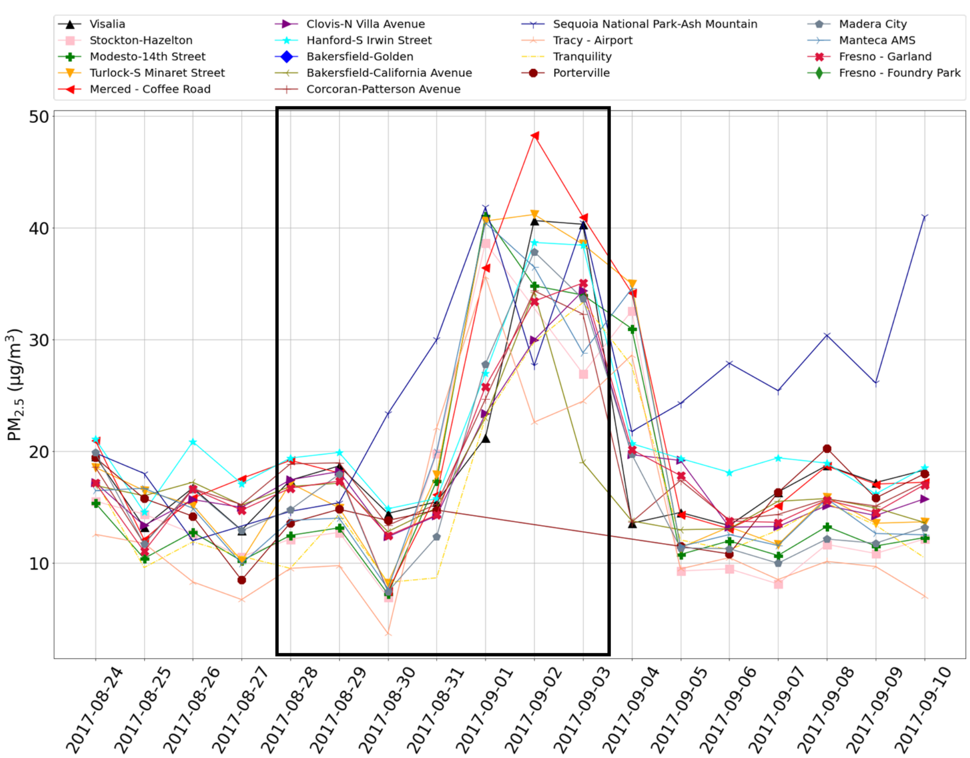


Figure 30. Daily PM2.5 Data for July and August 2018

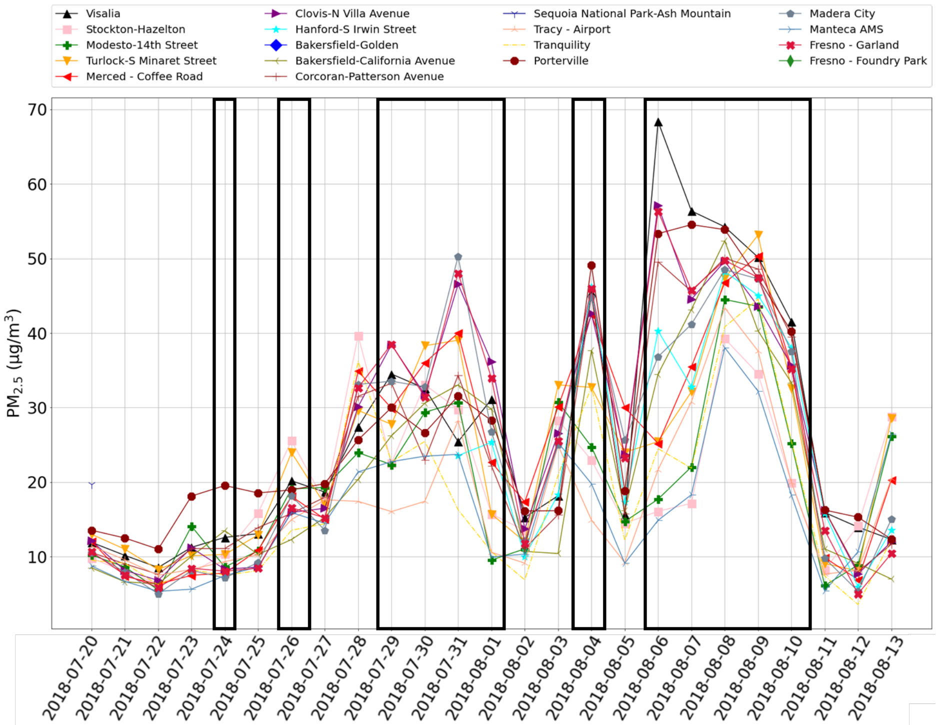


Figure 31. Daily PM2.5 Data for September 2018

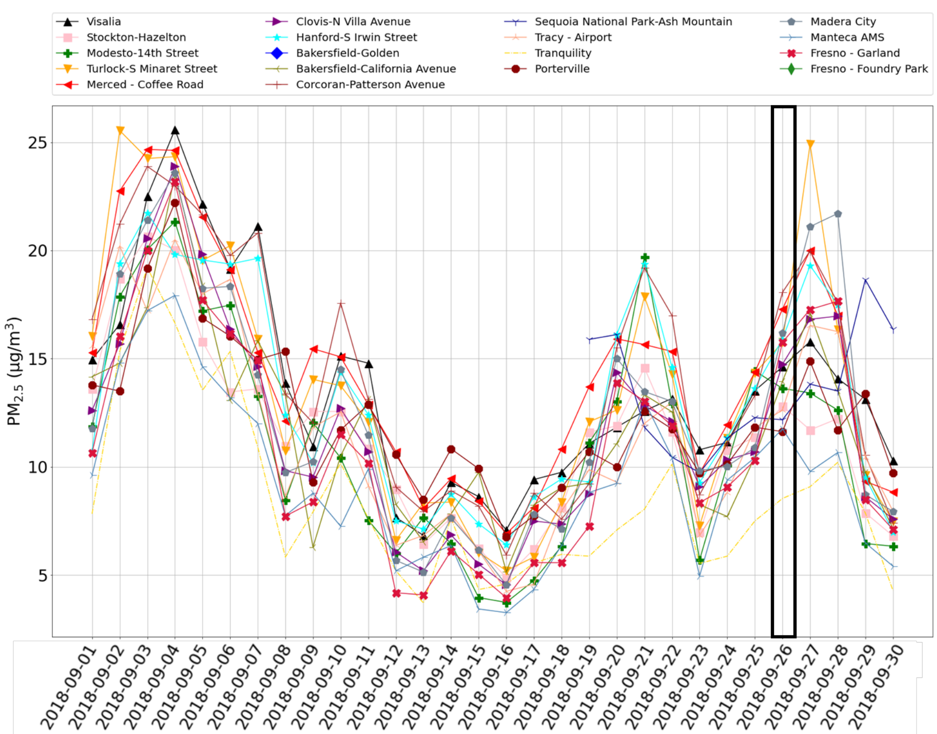


Figure 32. Daily PM2.5 Data for August and early September 2020

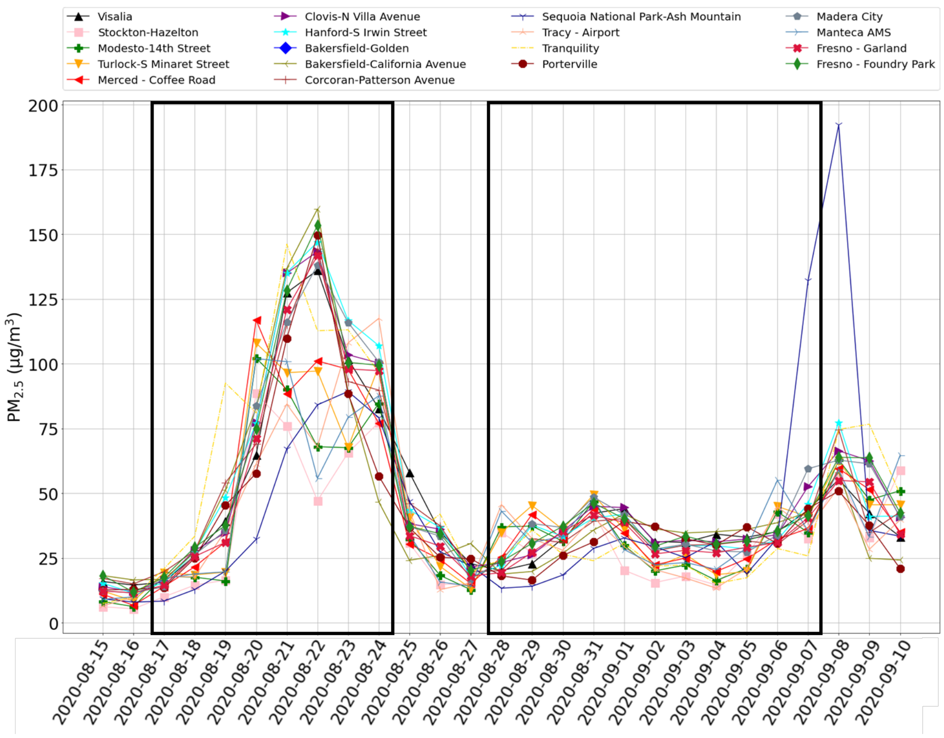
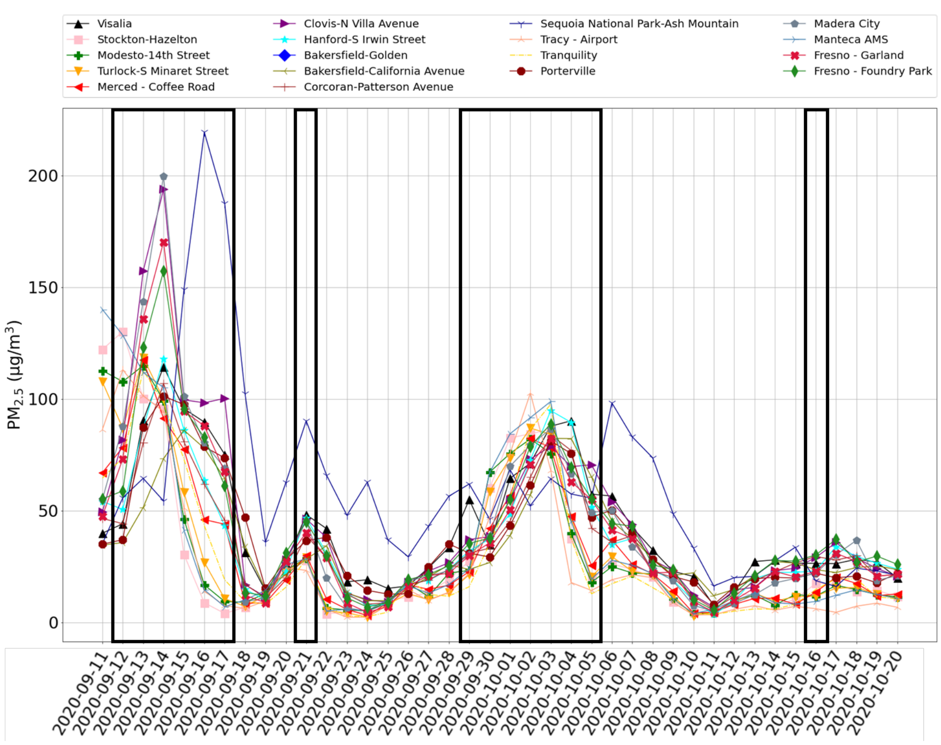


Figure 33. Daily PM2.5 Data for mid-September and October 2020



4.4 Adjusted Design Values

Table 8 shows the highest current operational sites in the Valley and their most recent design values alongside the adjusted design value. The adjusted design value was calculated from average of the adjusted 4th high value for the past three years for each of the sites, after the potential wildfire impacted dates were removed (Table 7).

The increase in the DV seen between 2019 and 2020 is likely due to the increased number and intensity of wildfires seen throughout California during the past five years. When the potential wildfire impact days are removed the adjusted DV no longer shows that increase for 2020 (Figure 34). A downward trend in DVs can be seen basin wide (Figure 34) and for all sites (Figure 35 – Figure 47) once the potential wildfire impact days are removed and the adjusted DV is calculated and used.

Figure 34. Official and Adjusted Design Value Trends for the San Joaquin Valley Air Basin

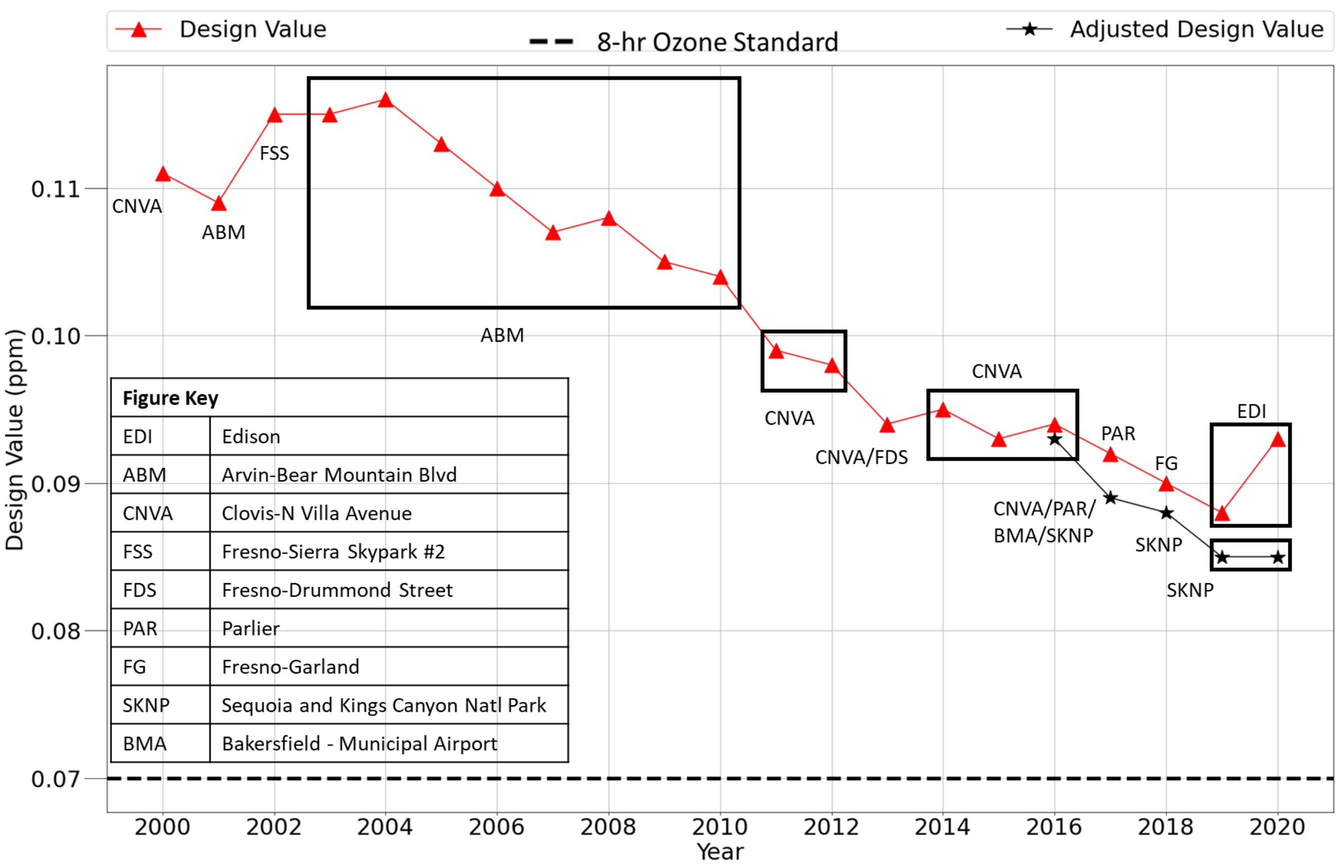


Table 8. Adjusted Design Values Compared to the Official Design Values for the High Sites Currently Operating in the SJV (in ppb)

	County	Site	2018 Official DV	2018 Adjusted DV	2019 Official DV	2019 Adjusted DV	2020 Official DV	2020 Adjusted DV
Northern	Merced	Merced-S Coffee Avenue	79	79	76	76	76	75
Northern	San Joaquin	Stockton-Hazelton Street	66	66	66	66	66	66
Northern	San Joaquin	Tracy-Airport	76	76	73	73	70	70
Northern	Stanislaus	Modesto-14th Street	80	77	80	76	79	76
Northern	Stanislaus	Turlock-S Minaret Street	84	81	82	79	80	78
Central	Fresno	Clovis-N Villa Avenue	89	85	84	80	84	79
Central	Fresno	Fresno-Drummond Street	86	81	82	77	80	77
Central	Fresno	Fresno-Garland	90	85	86	81	84	76
Central	Fresno	Fresno-Sierra Skypark #2	83	82	80	79	79	77
Central	Fresno	Parlier	88	85	84	82	81	79
Central	Fresno	Tranquility- 32650 West Adams Avenue	75	75	72	72	70	70
Central	Kings	Hanford-S Irwin Street	82	81	80	79	80	76
Central	Madera	Madera-28261 Avenue 14	81	80	78	77	78	77
Central	Madera	Madera-Pump Yard	78	77	76	75	76	75
Southern	Kern	Arvin-Di Giorgio	89	85	87	83	89	83
Southern	Kern	Bakersfield - 5558 California Avenue	88	82	87	82	85	77
Southern	Kern	Bakersfield - Municipal Airport	88	84	84	81	85	80
Southern	Kern	Edison	89	84	88	84	93	84
Southern	Kern	Maricopa-Stanislaus Street	85	81	83	79	85	80
Southern	Kern	Oildale-3311 Manor Street	82	78	84	80	83	78
Southern	Kern	Shafter-Walker Street	81	80	79	78	82	79
Southern	Tulare	Porterville - 1839 Newcomb Street	83	83	77	77	80	77
Southern	Tulare	Sequoia and Kings Canyon Natl Park	89	88	86	85	88	85

	County	Site	2018 Official DV	2018 Adjusted DV	2019 Official DV	2019 Adjusted DV	2020 Official DV	2020 Adjusted DV
	Tulare	Sequoia Natl Park - Lower Kaweah	86	85	82	81	83	79
	Tulare	Visalia-N Church Street	85	80	84	80	83	79

Figure 35 through Figure 47 shows trends of the highest sites in the northern, central, and southern regions over the past two decades along with the adjusted design values for 2016 to 2020.

4.4.1 Northern Region

Figure 35. 2016-2020 Adjusted DV for Turlock – S Minaret Street Monitoring Station (2000–2020)

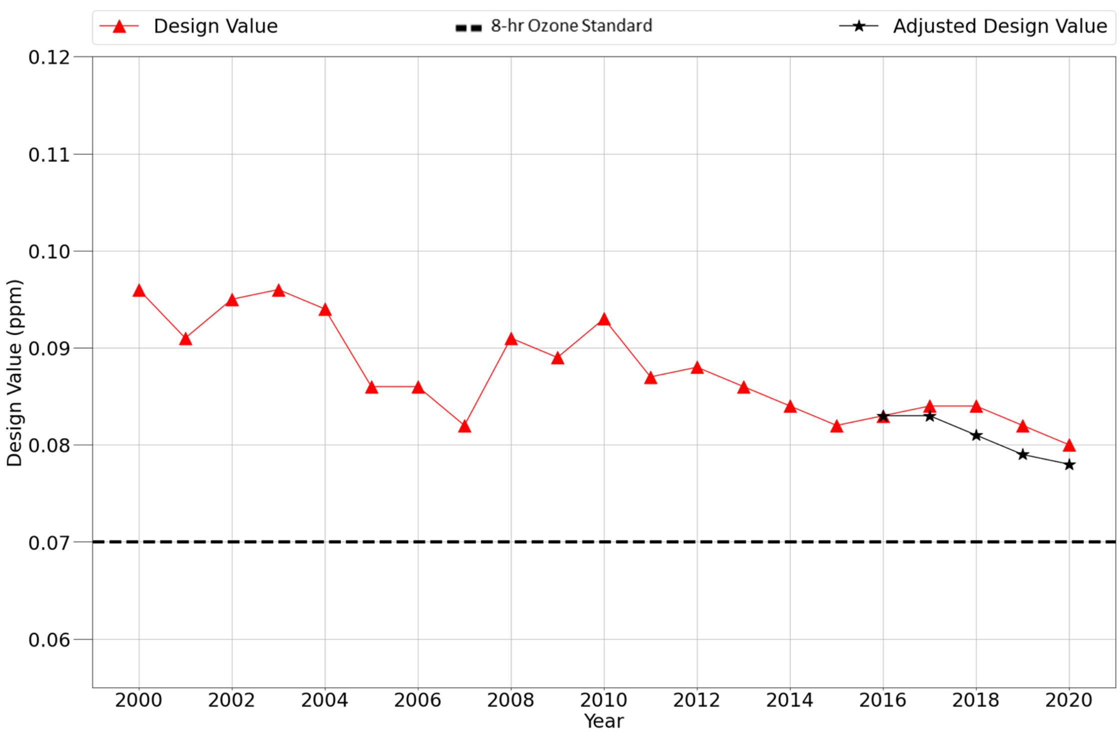
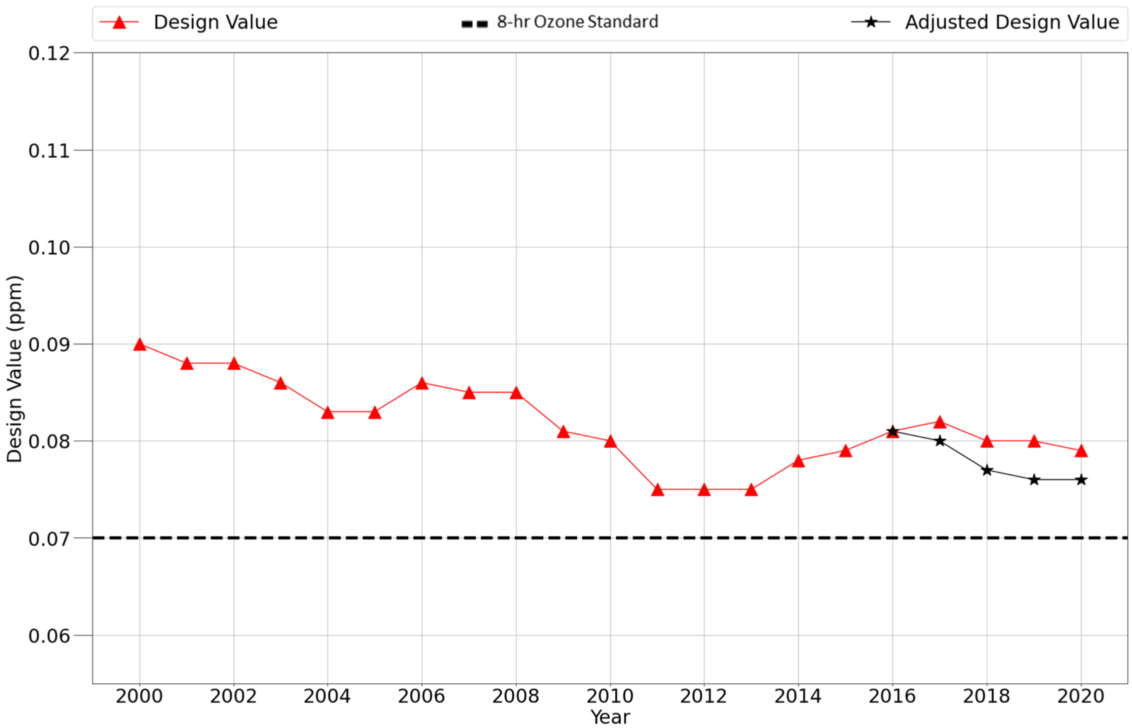


Figure 36. 2016-2020 Adjusted DV for Modesto -14th Street Monitoring Station (2000–2020)



4.4.2 Central Region

Figure 37. 2016-2020 Adjusted DV for Clovis – N Villa Avenue Monitoring Station (2000-2020)

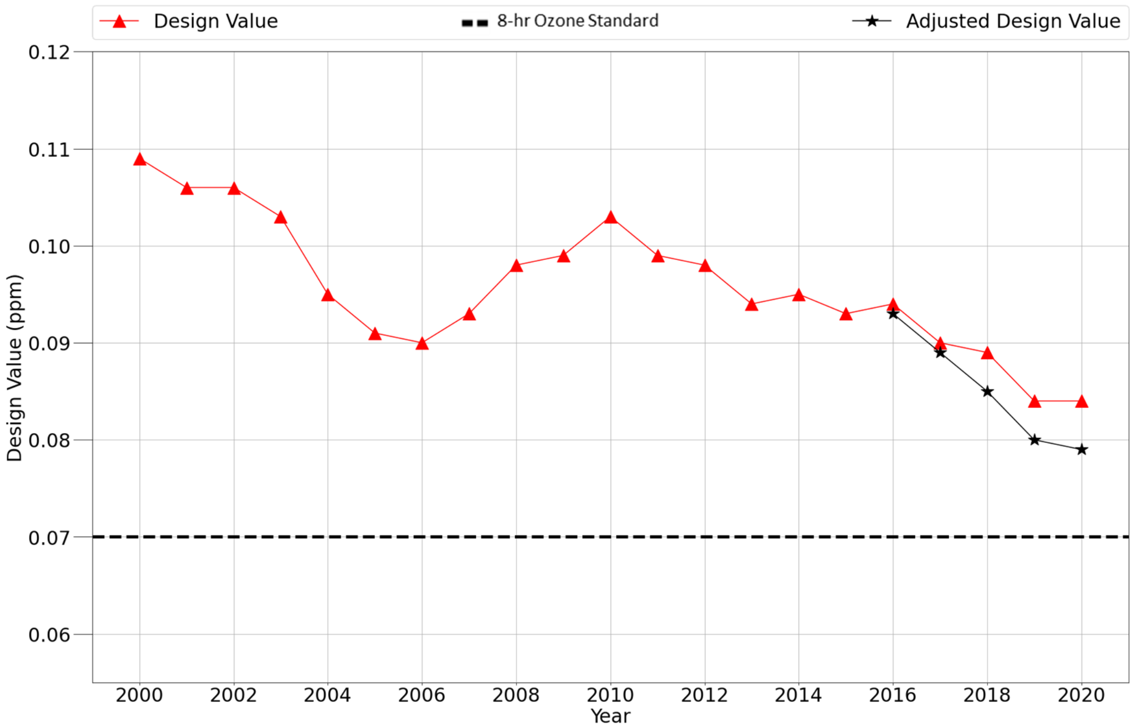


Figure 38. 2016-2020 Adjusted DV for Fresno – 1st street and Garland Street Monitoring Station (2000-2020)

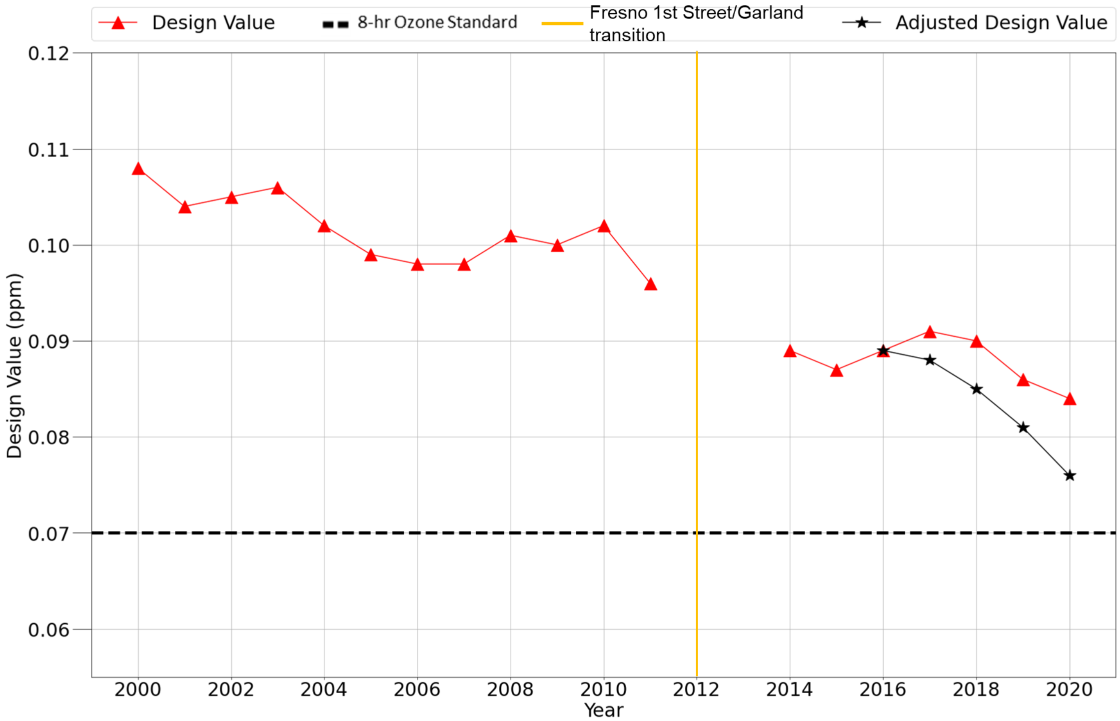


Figure 39. 2016-2020 Adjusted DV for Parlier Street Monitoring Station (2000-2020)

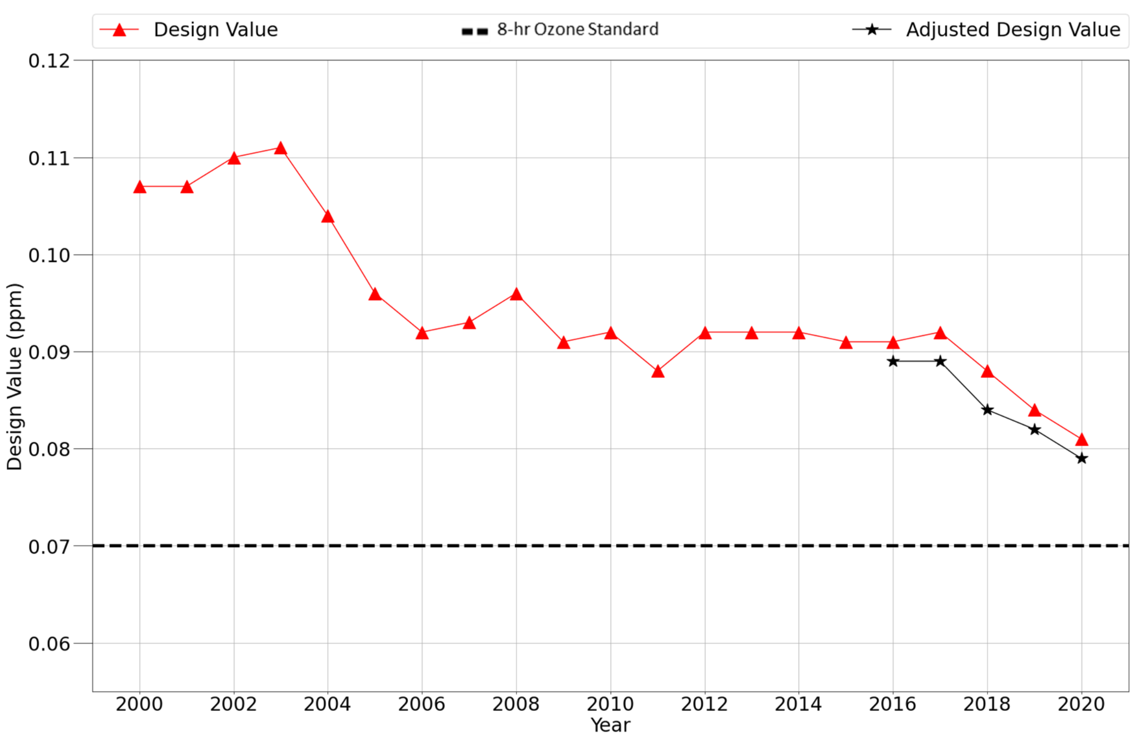


Figure 40. 2016-2020 Adjusted DV for Fresno - Drummond Monitoring Station (2000-2020)

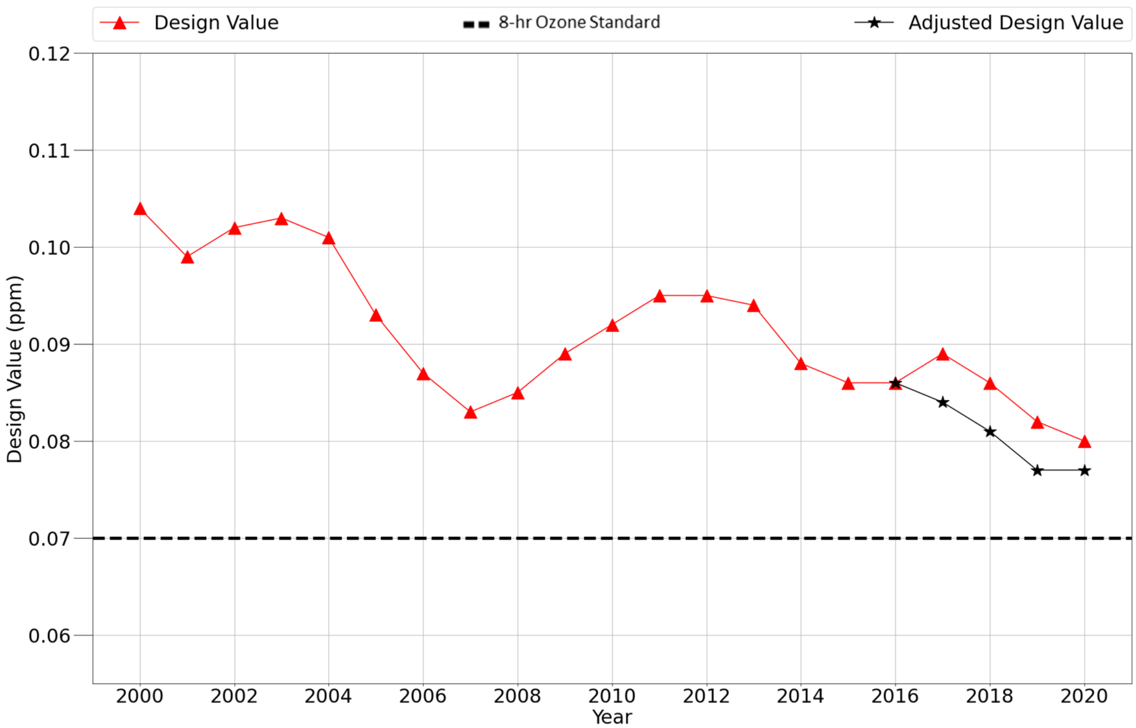
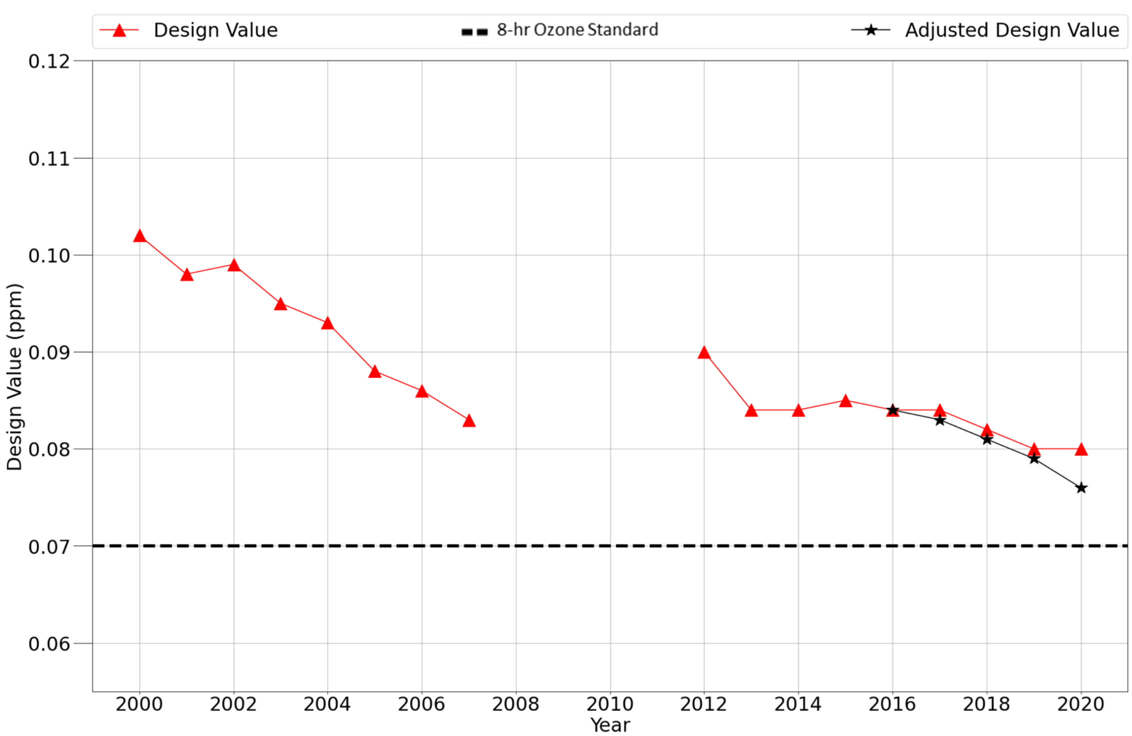


Figure 41. 2016-2020 Adjusted DV for Hanford – S Irwin Street Monitoring Station (2000-2020)



4.4.3 Southern Region

Figure 42. 2016-2020 Adjusted DV for Edison Monitoring Station (2000-2020)

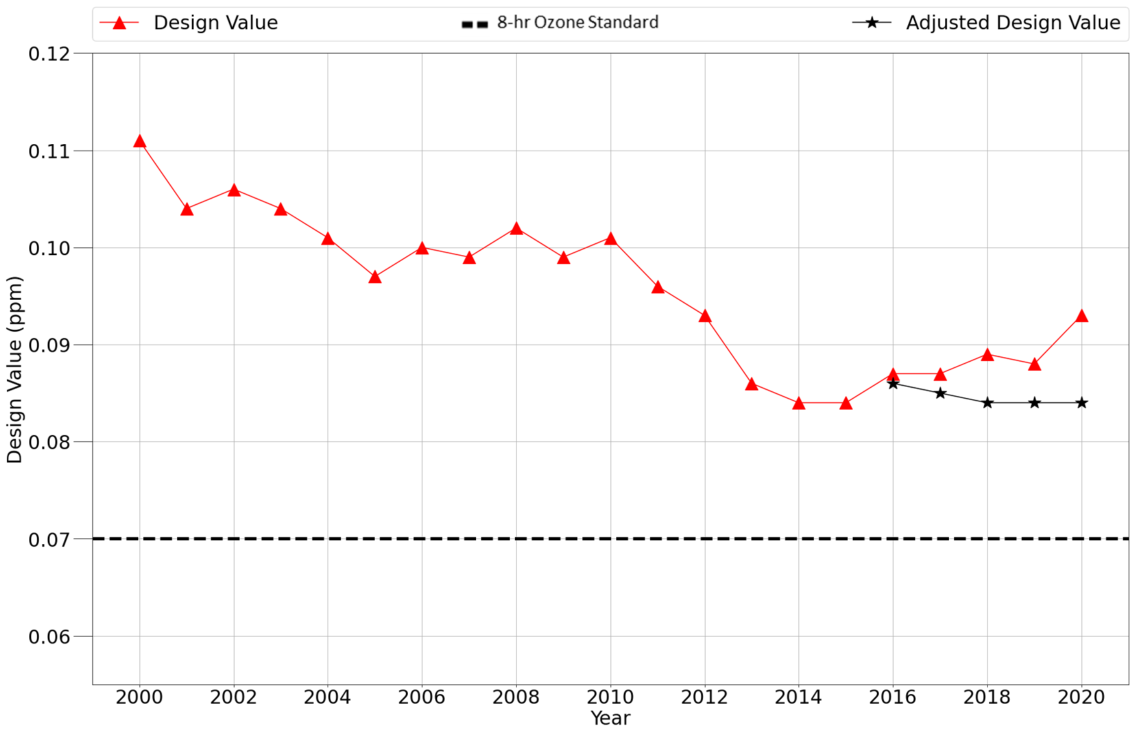


Figure 43. 2016-2020 Adjusted DV for Arvin – Di Giorgio Monitoring Station (2012-2020)

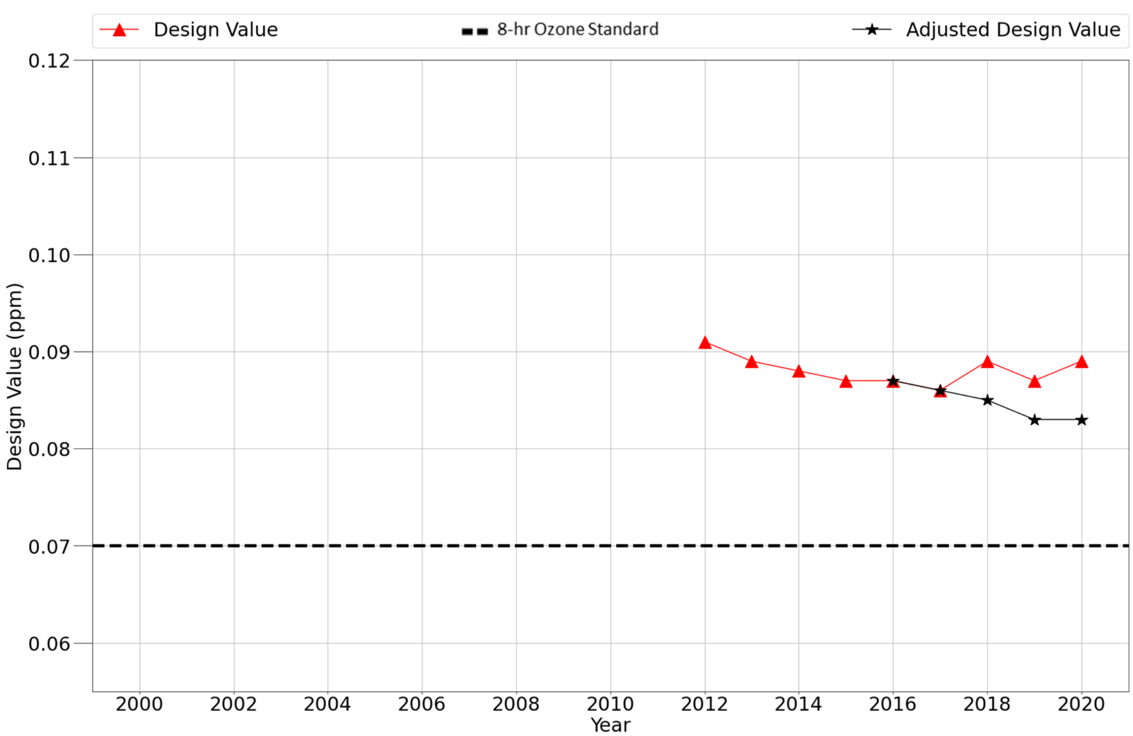


Figure 44. 2016-2020 Adjusted DV for Bakersfield – California Avenue Monitoring Station (2000-2020)

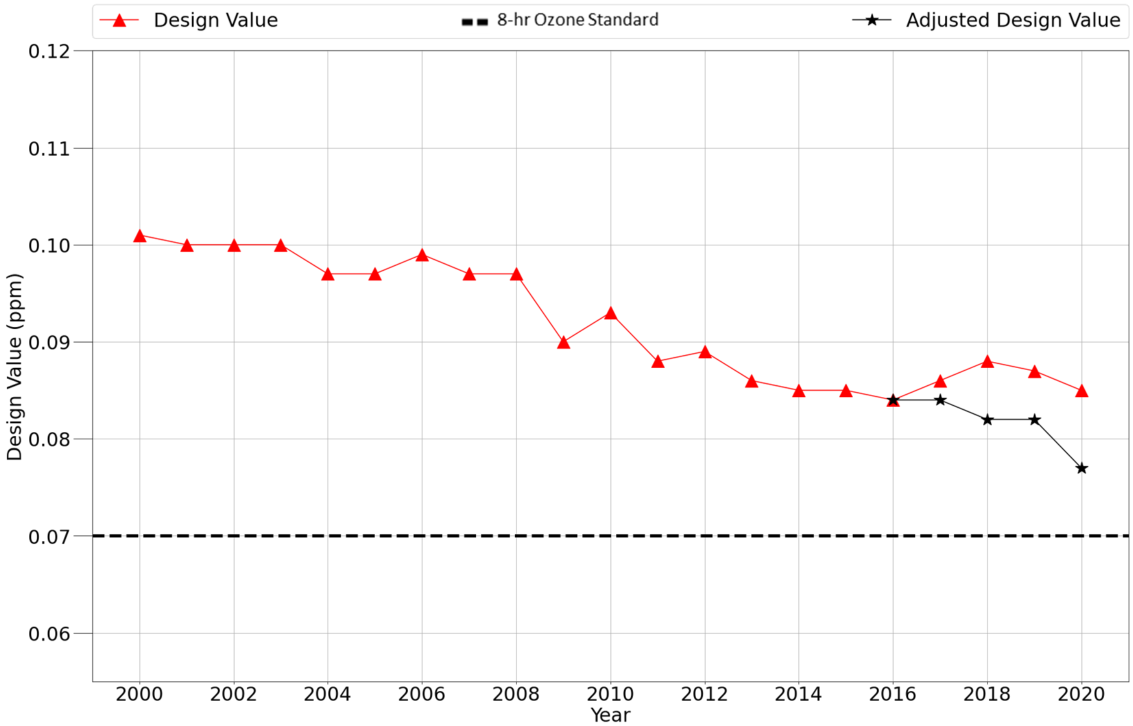


Figure 45. 2016-2020 Adjusted DV for Maricopa Monitoring Station (2001-2020)

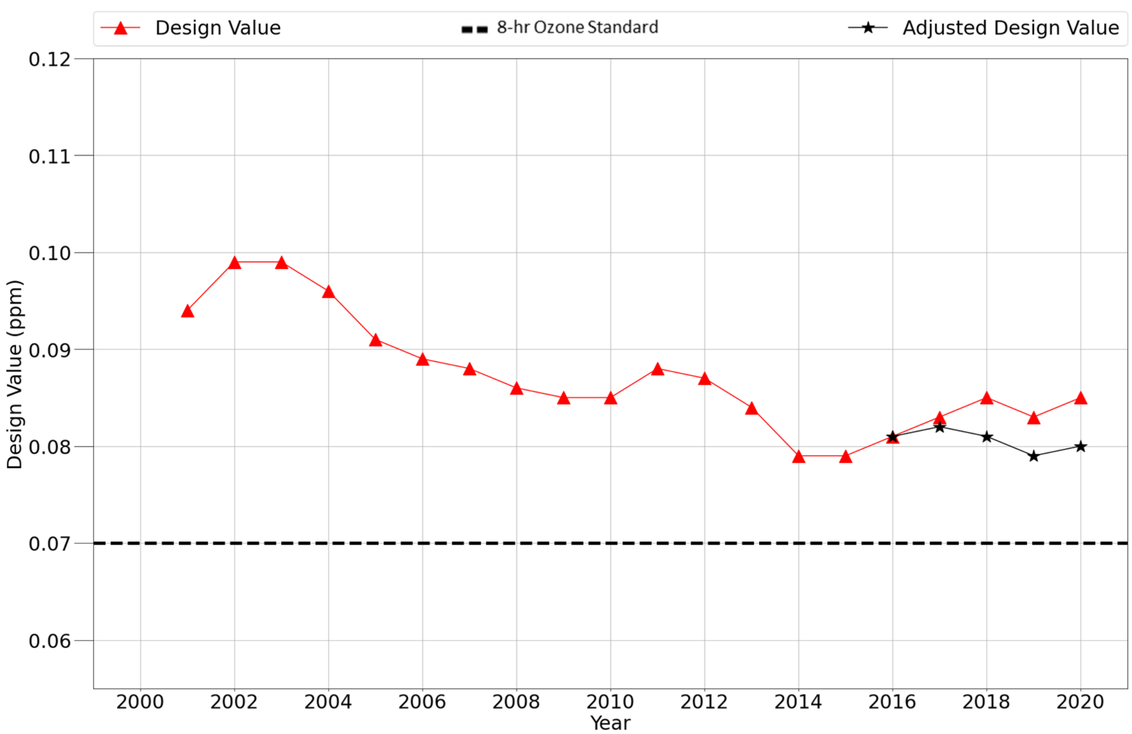


Figure 46. 2016-2020 Adjusted DV for Bakersfield – Municipal Airport Monitoring Station (2014-2020)

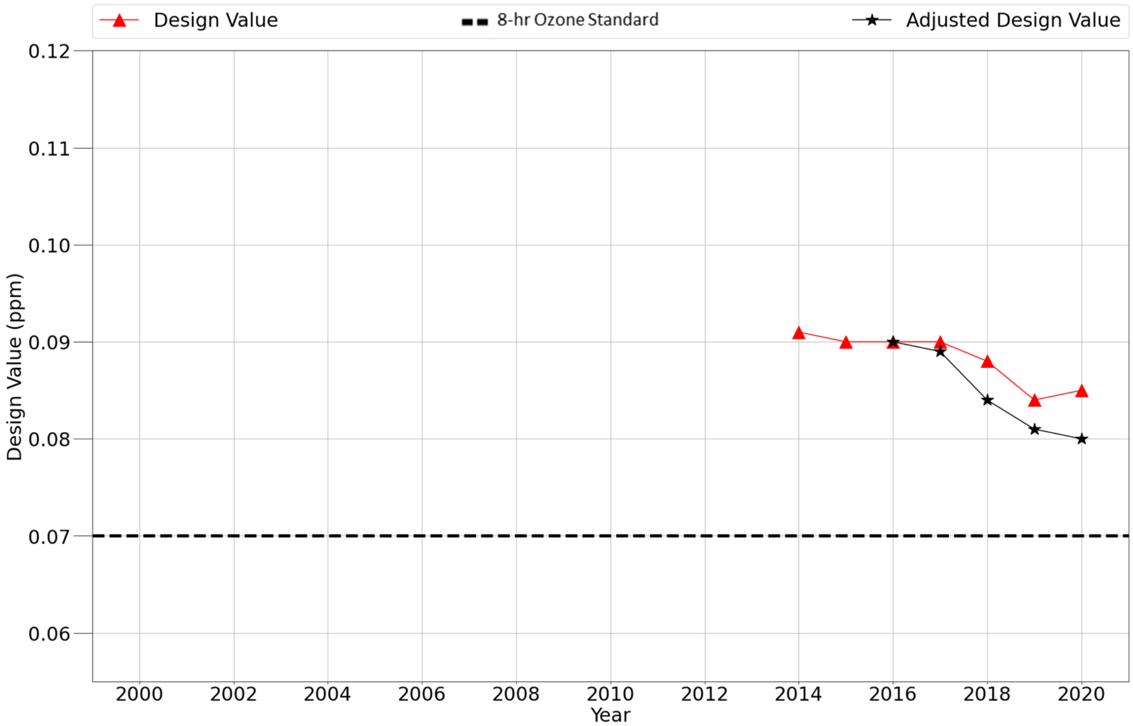
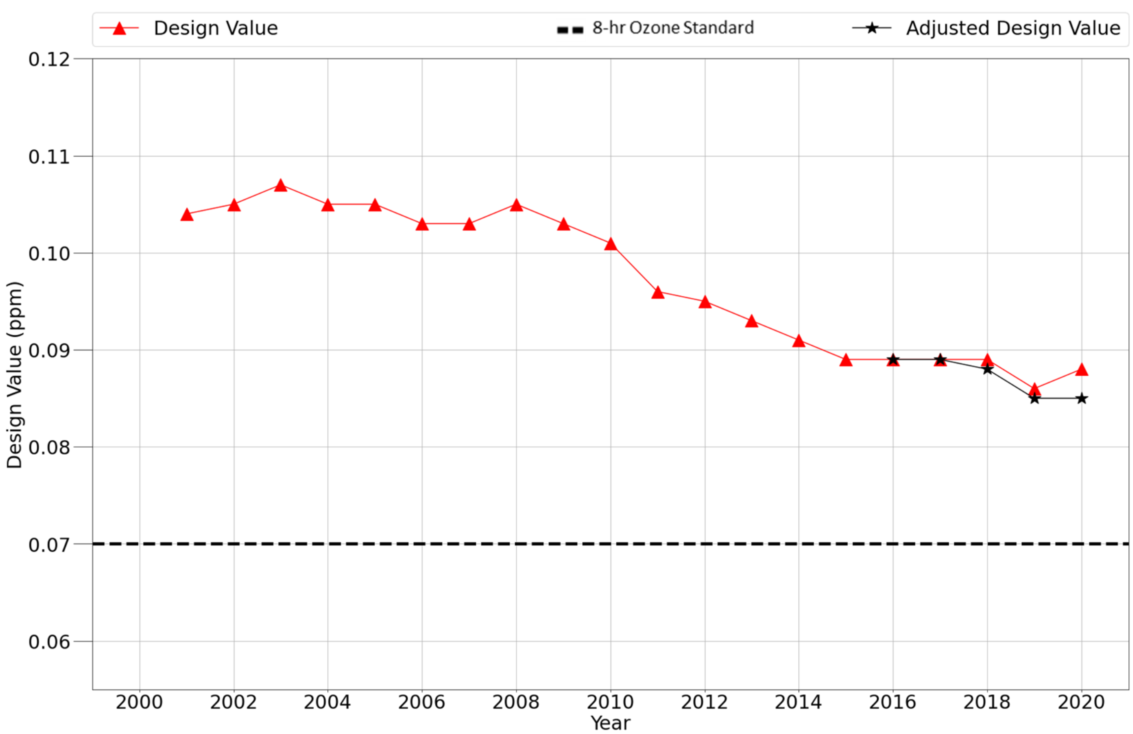


Figure 47. 2016-2020 Adjusted DV for Sequoia National Park – Ash Mountain Monitoring Station (2001-2020)



5. Meteorology and Air Quality Trends

The meteorological and photochemical processes leading to ozone formation are complex involving interactions both at the surface and in the upper air. The previous trends discussion looked at air quality as measured at ambient monitoring sites, without any consideration of or adjustment for meteorological variability.

The following discussions characterize the general meteorological conditions to evaluate the aptness of using 2018 as a base year for modeling, as well as analyzing long-term ozone trends having been "adjusted" for meteorological variability. These analyses are an effort to better understand the impact of meteorology on air quality and thereby track improvements attributable to emissions reductions. For this section of the document the potential wildfire dates (Table 7) were removed and the adjusted design values were used.

5.1 Suitability of 2018 as a Base Year for Modeling

Two analyses of meteorological conditions during recent ozone seasons are presented below. The first is a statistical analysis of annual ozone forming potential (OFP) using Python sklearn Random Forest[8], and the second is a simple comparison of the frequencies of relevant meteorological conditions by month and year.

Python sklearn Random Forest[8] was used to model the influences of changing weather conditions on ozone trends in all three regions of the SJV. The random forest predicts the ozone concentration using meteorology parameters and was built by using 25 estimators ("trees") and a max depth of 10 for each tree. 2016-2018 was selected as the base years with the assumption that the emissions did not change significantly during this time period and that any changes in ozone during the base years were due to changes in meteorology.

Datasets containing daily maximum 8-hour ozone and a variety of meteorological variables were prepared for the northern, central, and southern regions of the Valley. Each data set included the meteorological variables shown in Table 9.

Table 9. List of Observed variables used in Python sklearn Random Forest[8]

Variable	Description	Unit
Wind Speed	Midday 6-hour (10 a.m.- 4 p.m.) average	m/s
Wind Direction	Midday 6-hour (10 a.m.- 4 p.m.) average	Degrees
Temperature	Midday 6-hour (10 a.m.- 4 p.m.) average	^oC

[8]Python sklearn Random Forest. https://scikit-learn.org/stable/modules/generated/sklearn.ensemble.RandomForestRegressor.html

5.1.1 Ozone-Forming Potential

Within an ozone season (May-October), day to day differences in meteorological conditions strongly affect the ambient daily maximum 8-hour ozone concentrations, thus days differ in their OFP. These variations are affected by factors in addition to meteorology, such as variations in emissions, but for this discussion OFP is limited to meteorological effects represented by the meteorological data used in this analysis. Annual OFP is an aggregate summary of daily OFP values within each year. Annual OFP differs from year to year because meteorological conditions that favor higher or lower daily OFP differ in their frequencies from year to year. The year-to-year fluctuations can sometimes mask the extent to which the ozone air quality trends represent changes in emissions.

In April 2007, U.S. EPA expanded the scope of photochemical modeling required for ozone attainment demonstrations. Previously, attainment modeling was based on a few multi-day episodes when ozone levels were unusually high, especially at the design site(s). Now, however, attainment modeling must address a wider range of conditions and locations when and where ozone levels exceed the daily maximum 8-hour standard for ozone.

The U.S. EPA's current modeling guidance[9], released in 2018, includes the following: (1) "it is recommended to use a relatively recent base period" and (2) the base year period should include "time periods in which observed concentrations are close to the appropriate base year design value … and ensure there are a sufficient number of days so that the modeled test applied at each monitor is based on multiple days." The first guideline concerning "recent base period" focused attention on evaluating the years 2016 to 2020. The second guideline concerning "sufficient days" to support for the modeled attainment test led to an OFP summary based on the 40 days with the highest meteorologically based OFP.

Each ozone season from 2010 through 2020 was summarized based on daily OFP values within the season. Three different summaries – a whole season view, a Top 40 view, and a Top 8 view – were considered. The whole season includes a mixture of high and low OFP values. The Top 8 view includes the highest OFP conditions but lacks the additional breadth that the U.S. EPA guidance recommends. Therefore, the Top 40 view was selected as a practical approach with respect to the new scope for attainment modeling. The average of the 40 highest daily OFP values is used to rank each year with respect to the other years.

For the northern region of the Valley, the overall relationship between daily OFP (predicted daily max 8-hour ozone based on meteorology) and the observed daily max 8-hour ozone for 2016-2018, the selected baseline period for this analysis, shown in Figure 48, exhibits an excellent linear fit (R^2 = 0.873). The relationship for the central region and southern regions, shown in Figure 49 and Figure 50, also exhibit excellent linear fits R^2 of 0.854 and 0.876, respectfully.

[9] U.S. EPA Modeling Guidance for Demonstrating Air Quality Goals for Ozone, PM2.5 and Regional Haze. https://www.epa.gov/sites/default/files/2020-10/documents/o3-pm-rh-modeling_guidance-2018.pdf

Figure 48. OFP vs Observed Daily Max 8-Hour Ozone in Northern SJV

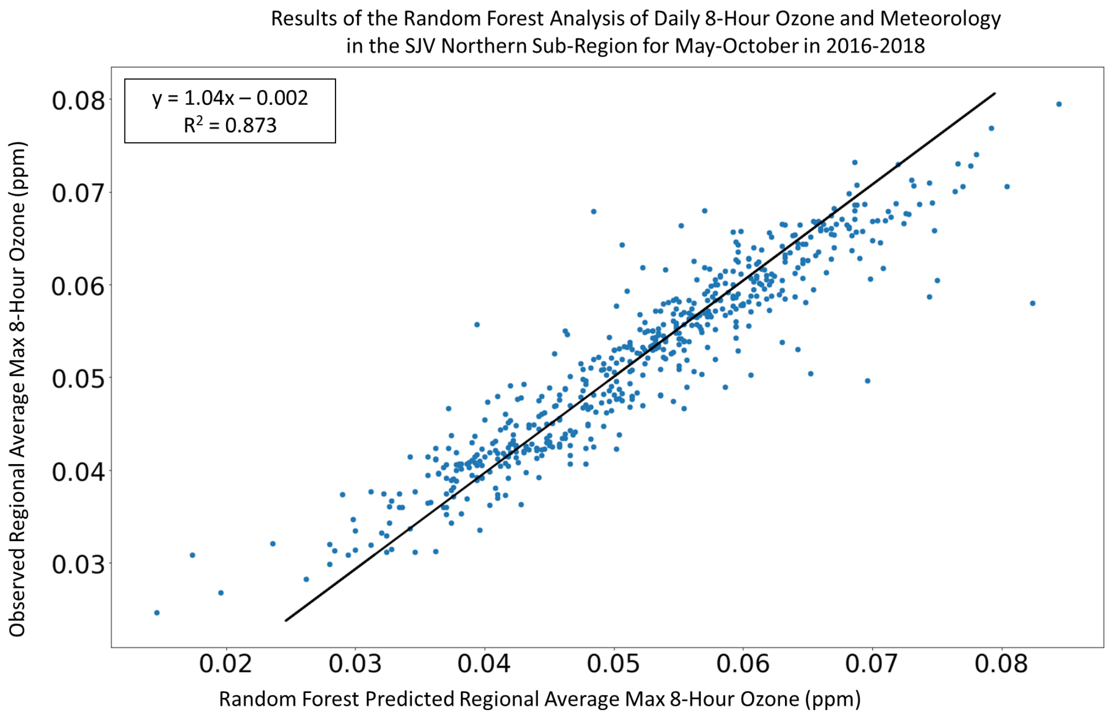


Figure 49. OFP vs Observed Daily Max 8-Hour Ozone in Central SJV

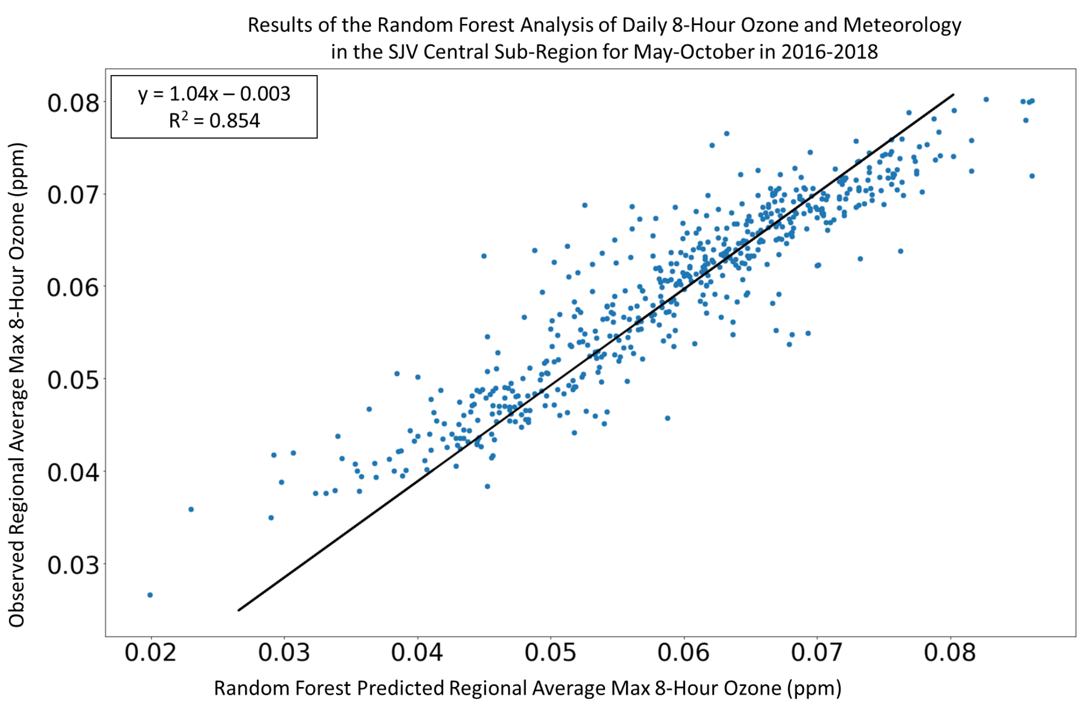
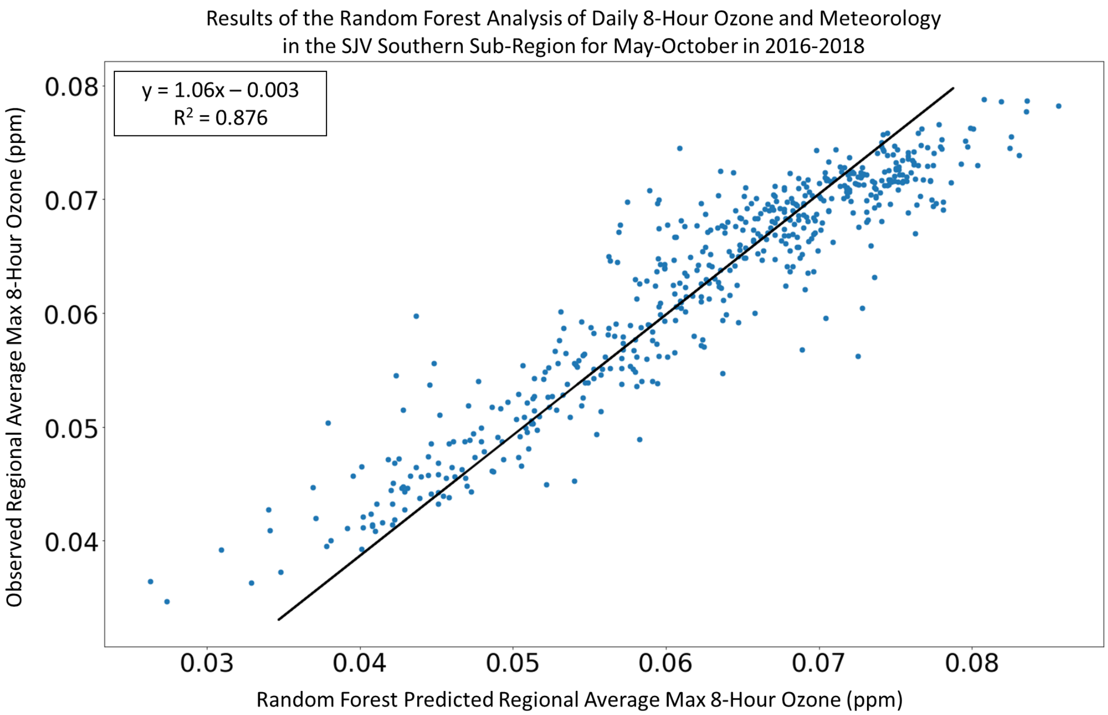


Figure 50. OFP vs Observed Daily Max 8-Hour Ozone in Southern SJV



This document shows the results of the most recent annual OFP analysis for all three regions of the San Joaquin Valley air basin. Figure 51 through Figure 53 shows the average top 40 predicted (from the model developed above) and the corresponding average observed ozone concentrations for each year. The predicted ozone (red) line shows the year-to-year variations of OFPs from 2010-2020, which indicates that in 2018, southern SJV had the highest OFP while the OFPs in northern and central SJV were at the average levels.

The difference between the observed and predicted lines indicates the difference of ozone precursor emissions between a given year and the base years (2016-2018). In the early years (2010-2014) the observed average ozone is higher than the predicted average ozone, suggesting that ozone precursor emissions are higher than the base year period. As the year progresses towards the base-years (2016-2018) the predicted and observed average ozone become similar. Subsequently, after 2018 the observed average ozone shifts to being lower than the predicted average ozone due to lower ozone precursor emissions in recent years.

Figure 51. OFP in Northern SJV

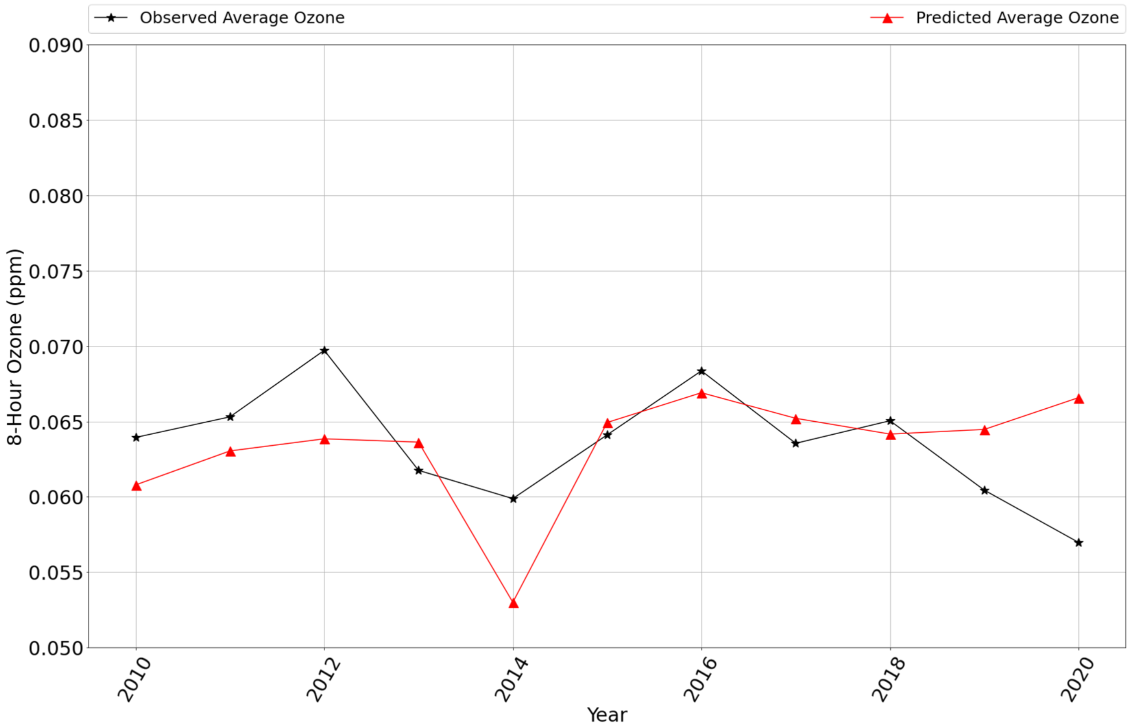


Figure 52. OFP in Central SJV

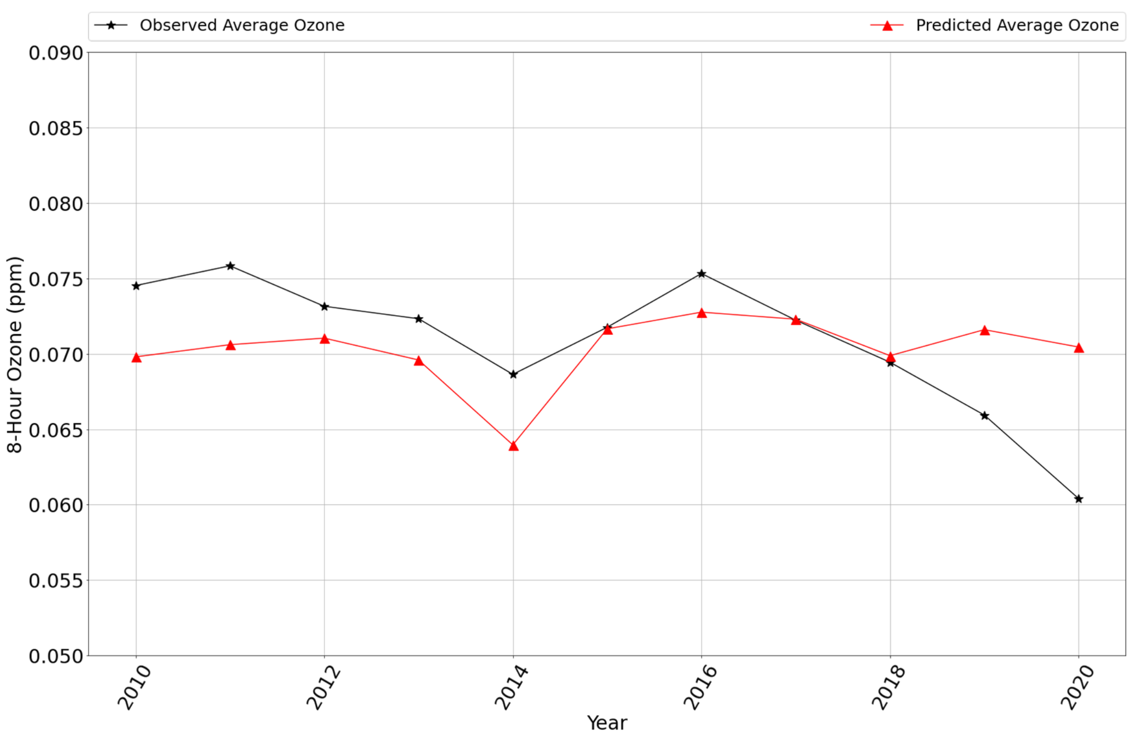
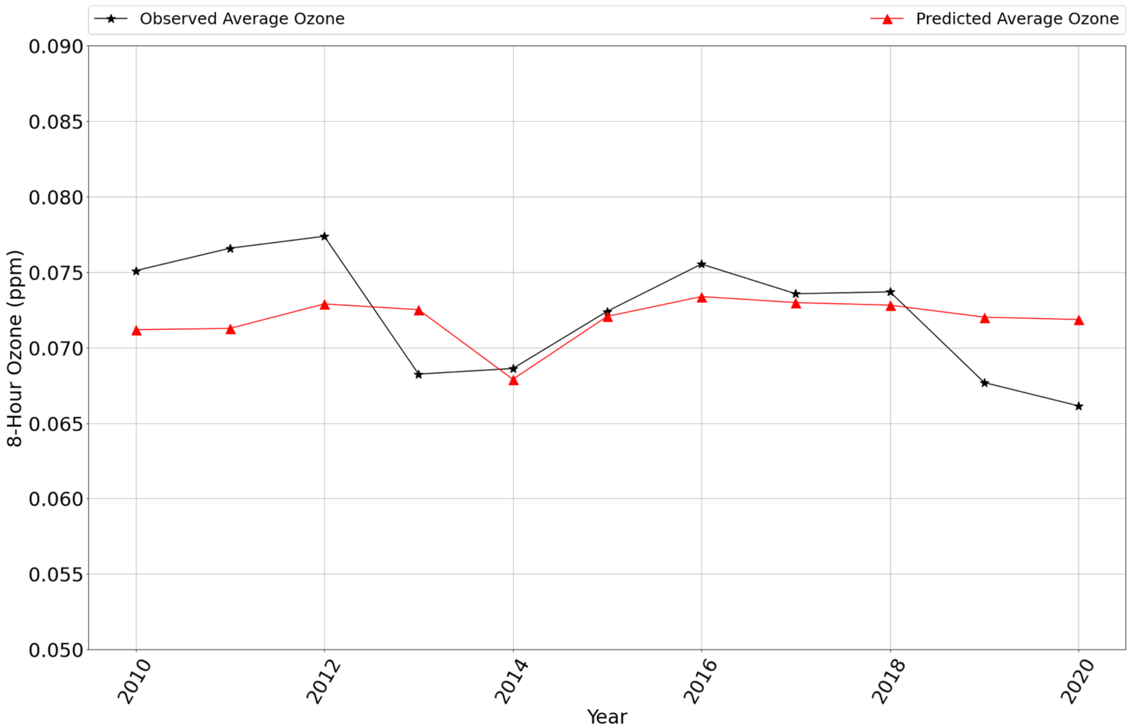


Figure 53. OFP in Southern SJV



5.1.2 Ozone related Meteorological Conditions by Month and Year

Relationships between meteorological conditions and ozone have been studied for more than three decades. Though many different statistical methods have been used to study ozone and meteorology, several categories of meteorological variables have repeatedly provided predictive power. High ozone levels typically occur on days with strong sunlight, high temperatures, trapping inversions, and light recirculating winds. Ozone seasons in which these types of conditions occur frequently are most suitable for use as a base case in SIP modeling needed to demonstrate future attainment of an ozone standard.

Figure 54 through Figure 59, offer a broad view of meteorological conditions in the Valley that favor different ozone levels. Each figure addresses one meteorological variable for 2010 to 2020 by month (May through October) broken down by sub-region. In each figure, monthly quintiles are used, the observed values in a month for all the years together were used to determine that month's quintiles, the 5th, 50th, and 95th percentiles. This allows the distribution of values for one year to be compared to the distributions for all the other years. In each figure, 2018 is highlighted to facilitate comparisons to the other years.

Strong sunlight is present on almost all days from May to October in the Valley. Surface temperature is represented by the midday (10 a.m. to 4 p.m.) average temperature in the northern region (Figure 54), central region (Figure 56) and the southern region (Figure 58). Winds are represented by the midday (10 a.m. 4 p.m.) average wind speed in the northern region (Figure 55), central region (Figure 57) and the southern region (Figure 59).

With respect to temperature and wind speed (Figure 55 through Figure 59), 2018 was ranked neither highest nor lowest.

Figure 54. Percentiles for Midday (10 a.m. to 4 p.m.) Average Temperature in the Northern SJV

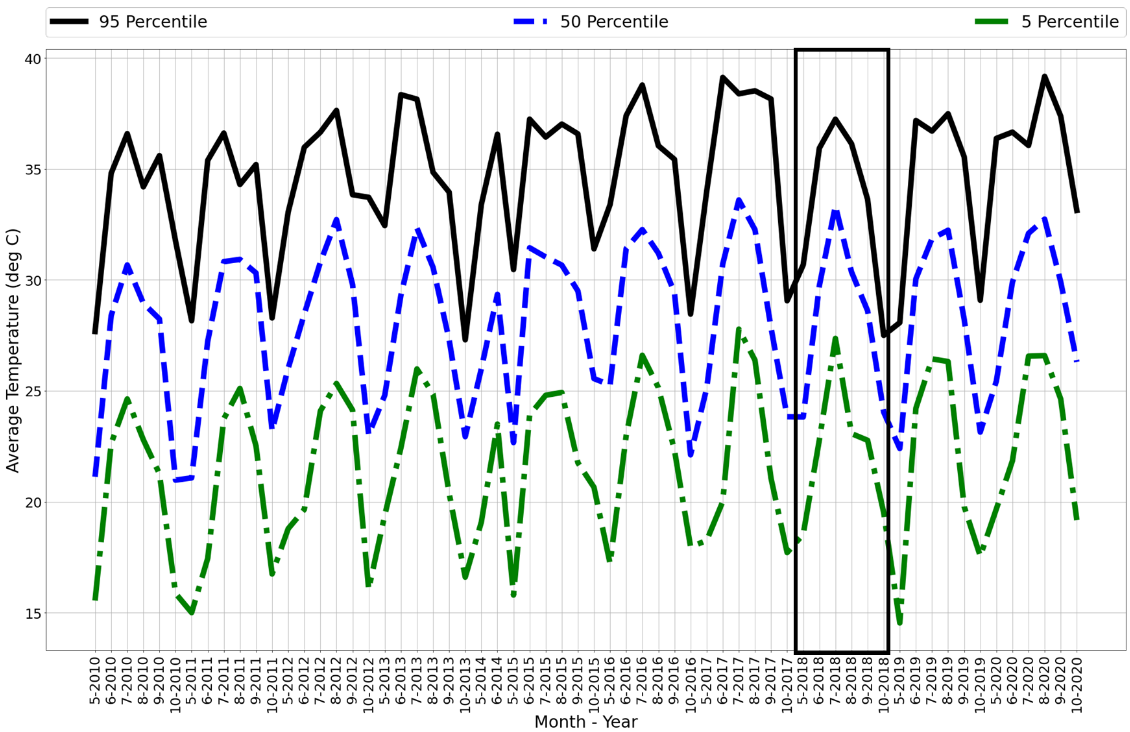


Figure 55. Percentiles for Midday (10 a.m. to 4 p.m.) Average Wind Speed in the Northern SJV

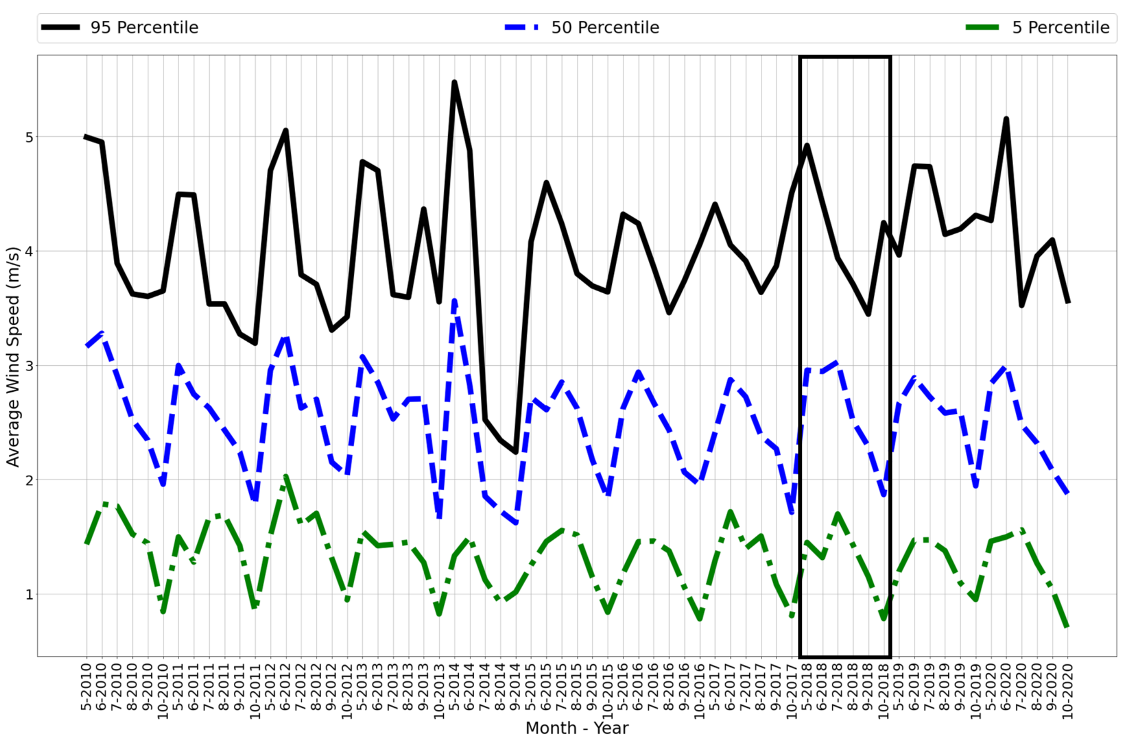


Figure 56. Percentiles for Midday (10 a.m. to 4 p.m.) Average Temperature in the Central SJV

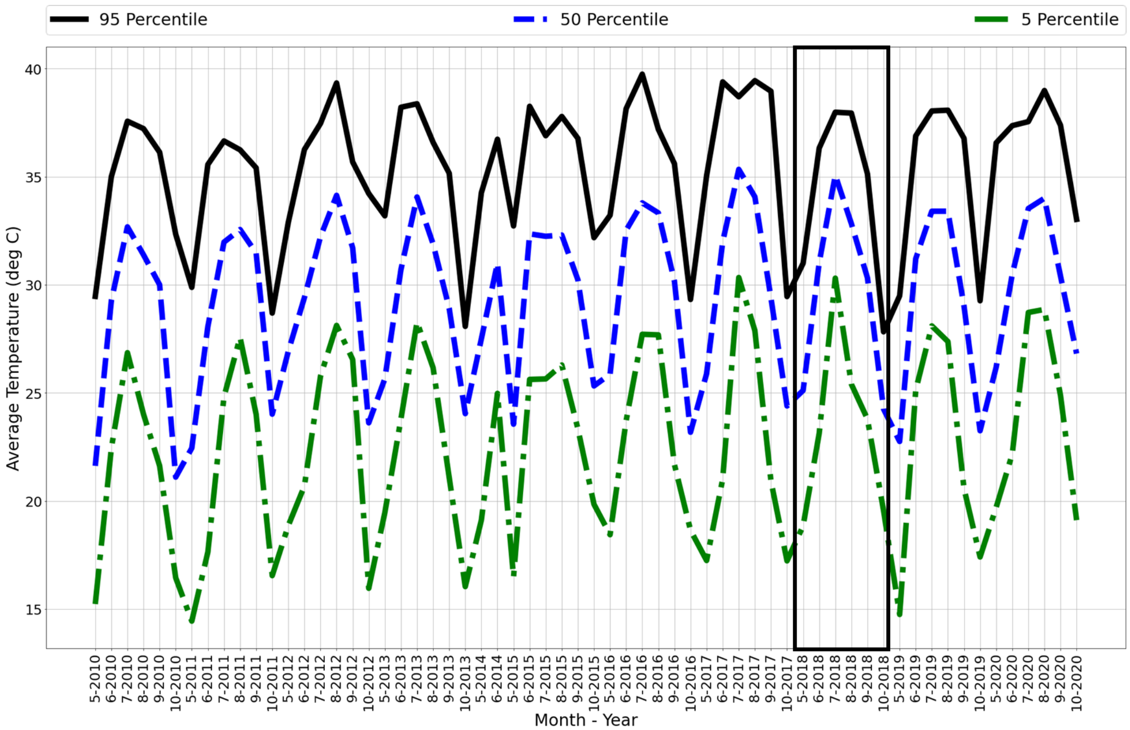


Figure 57. Percentiles for Midday (10 a.m. to 4 p.m.) Average Wind Speed in the Central SJV

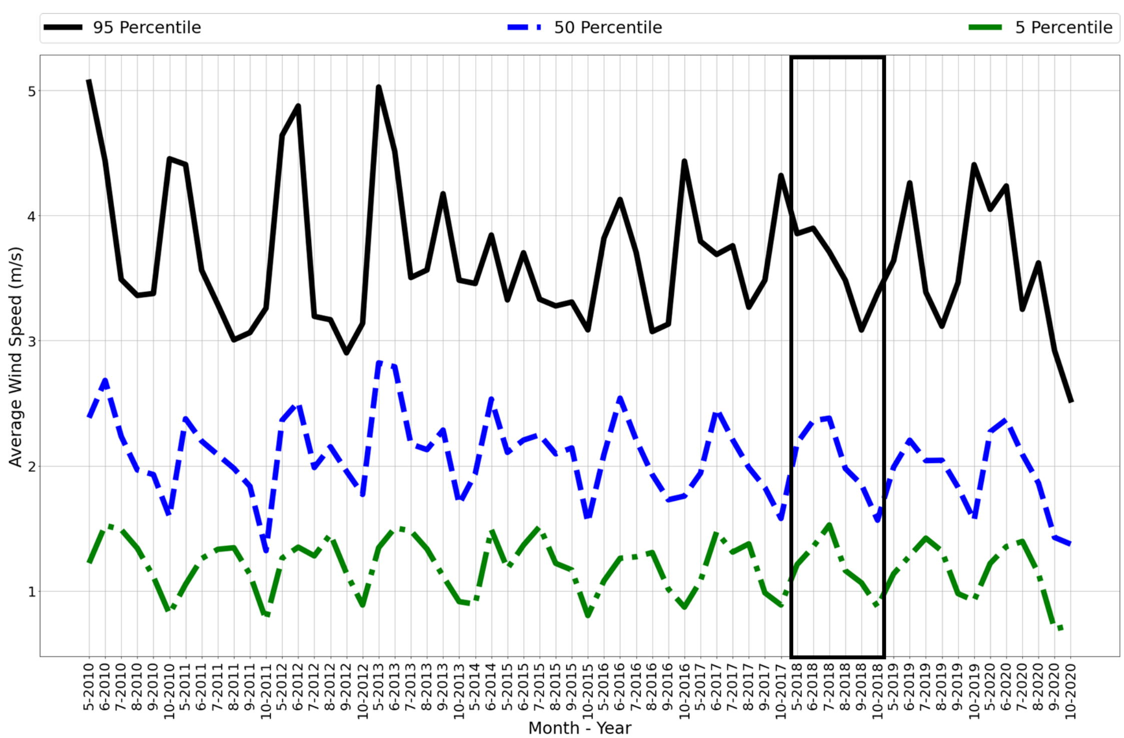


Figure 58. Percentiles for Midday (10 a.m. to 4 p.m.) Average Temperature in the Southern SJV

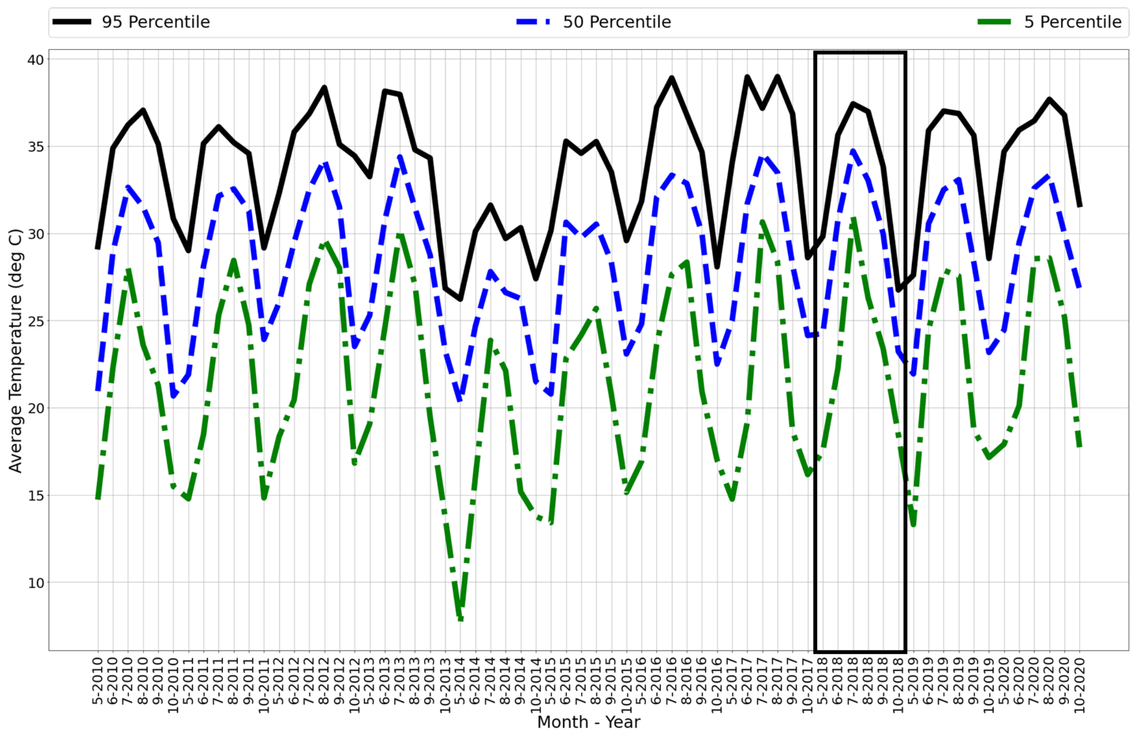
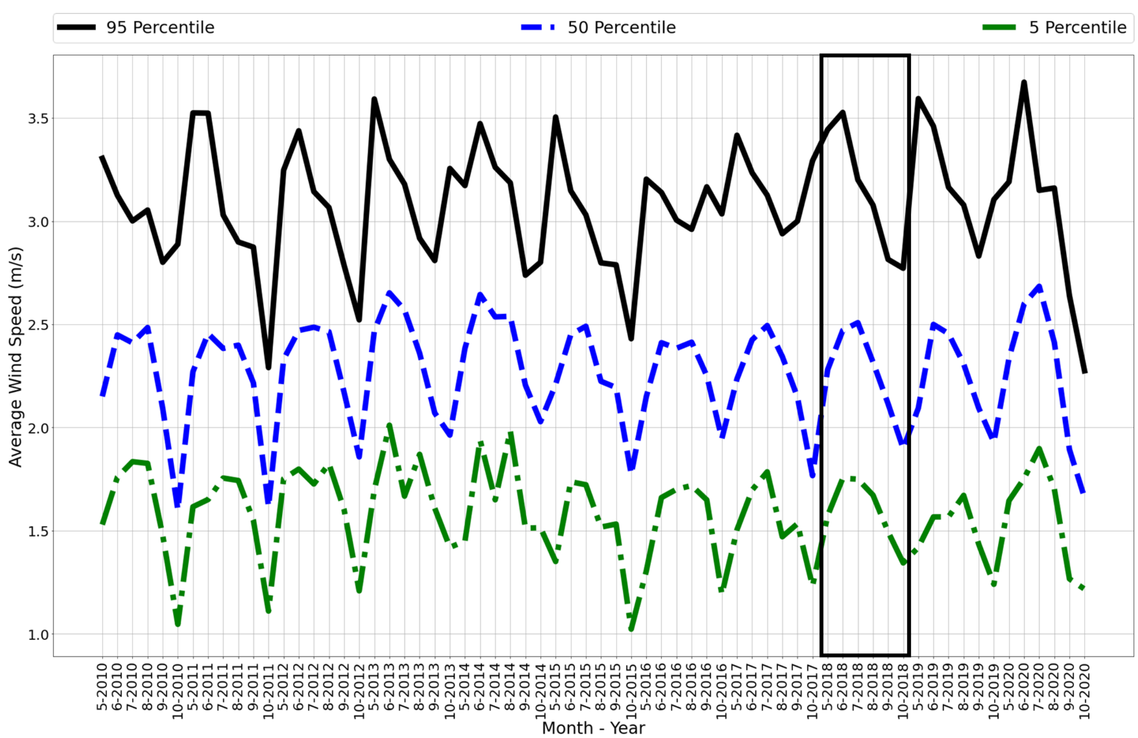


Figure 59. Percentiles for Midday (10 a.m. to 4 p.m.) Average Wind Speed in the Southern SJV



The combined figures from Figure 54 through Figure 59 indicates that the meteorological conditions present in the 2018 ozone season make it a typical meteorological year in terms of ozone formation, and therefore it is a good choice among recent years (2016-2020) as a base period for SIP modeling of ozone in the San Joaquin Valley. This conclusion is based on two different evaluations of meteorological conditions in the Valley during the ozone seasons of 2010-2020.

5.2 Meteorology-Adjusted Ozone Trends – Seasonal Averages by Region

In addition to an evaluation of trends in OFP and variations in meteorological variables, when observed trends are adjusted to compensate for periods of atypical meteorology, the "meteorology adjusted" trends reveal more clearly the impact of emissions reductions.

This section presents observed and meteorology adjusted trends for the season (May-October) average of daily maximum 8-hour ozone in three regions of the Valley from 2010-2020. Although these trends do not relate directly to attainment of the 2015 national 8-hour ozone standard, they do offer a broad-based perspective on the response of ambient ozone levels to strategic reductions in emissions of NO_x and volatile organic compounds (VOC).

5.2.1 Meteorology-Adjusted Trends for Season Average Daily-Max 8-Hour Ozone

In this analysis, the predicted highest 40 daily maximum 8-hour ozone value were averaged over the ozone season, within each region, from 2010-2020. These season average trends may differ from trends for other indicators, such as design values, that highlight changes in the higher end of the distribution of ozone concentrations.

For each year, the meteorology adjusted ozone concentrations were calculated using the following equation:

$$Ozone_{met} = Ozone_{obs} - (Ozone_{pre} - Ozone_{cal})$$

Where $Ozone_{met}$ is the "meteorology adjusted" ozone concentrations for each year; $Ozone_{obs}$ is the averaged observed daily maximum 8-hour ozone (corresponding to the predicted 40 daily maximum 8-hour ozone days); $Ozone_{pre}$ is the average predicted highest 40 daily maximum 8-hour ozone; and $Ozone_{cal}$ is the ozone averages for the calibration period (2016-2018).

Figure 48 through Figure 50 shows the annual average 8-hour ozone concentrations based on observations and the meteorologically adjusted concentrations for all three regions of the Valley. The meteorology adjusted ozone (red) lines shows the ozone trends after removing the meteorological effects, and the linear trend represents the best available general assessment of the response of season average 8-hour ozone to emissions of NO_x and VOC.

- For the northern region, the linear fit to the meteorology adjusted data in Figure 48 shows a downward trend of 0.99 ppb per year
- For the central region, the linear fit to the meteorology adjusted data in Figure 49 shows a substantial overall decline of 1.21 ppb per year
- For the southern region, the linear fit to the meteorology adjusted data in Figure 50 shows a mild downward trend of 0.79 ppb per year

These season average trends are generally similar to the patterns observed in the other metrics. Additional discussion on how these relate to the response to emission reductions based on the ozone chemistry of the region is provided in subsequent sections.

Figure 60. Meteorology-adjusted Season Average of Daily Maximum 8-Hour Ozone Concentrations for Northern SJV

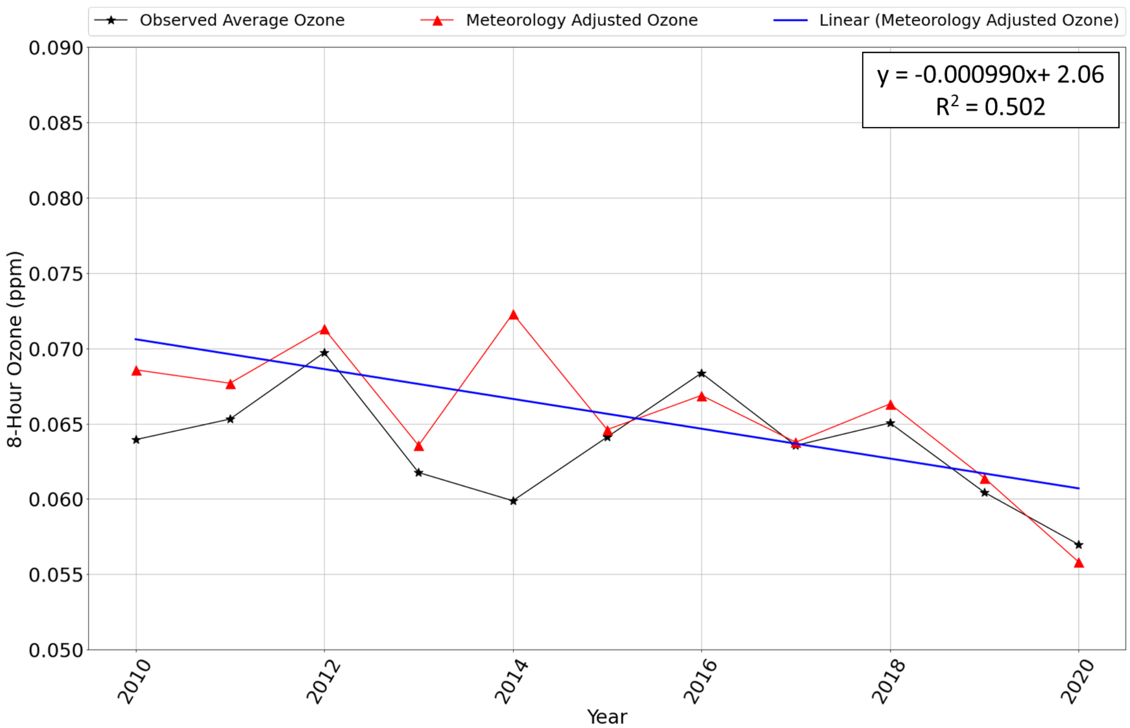


Figure 61. Meteorology-adjusted Season Average of Daily Maximum 8-Hour Ozone Concentrations for Central SJV

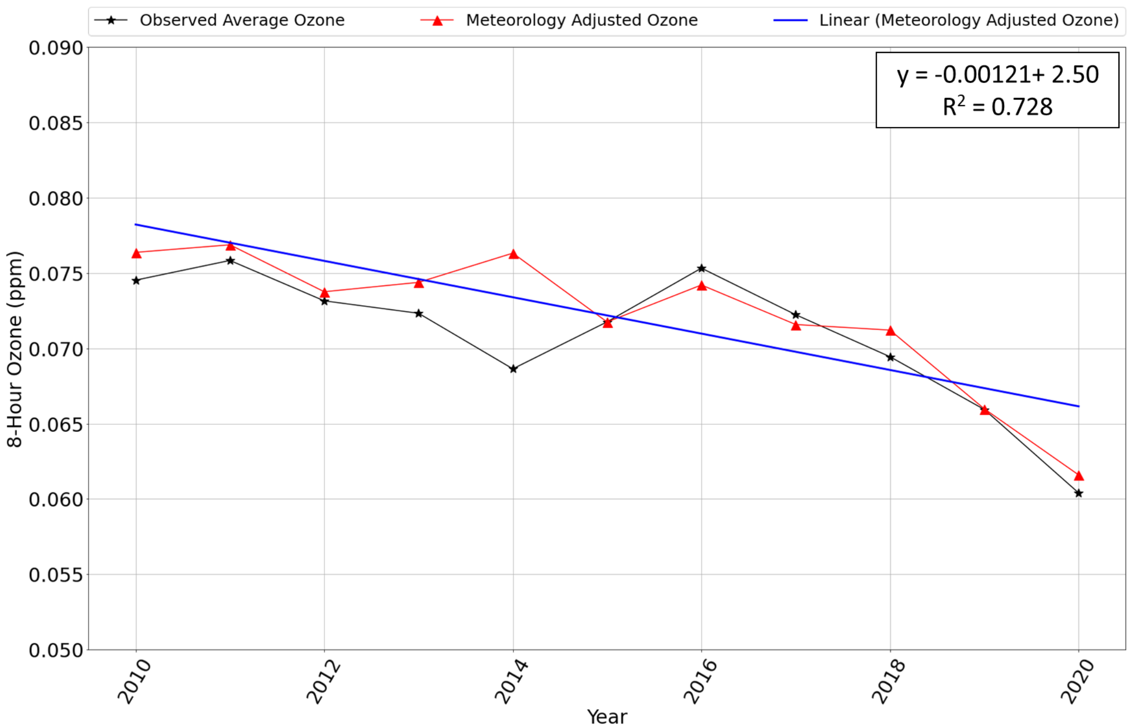
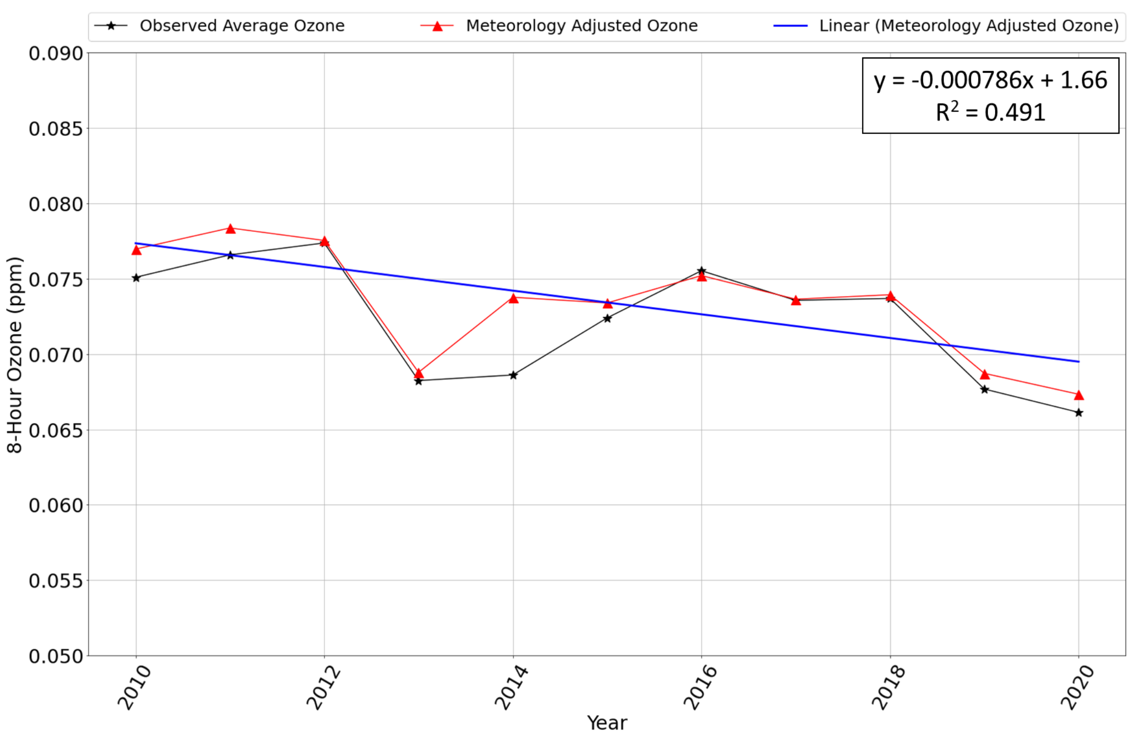


Figure 62. Meteorology-adjusted Season Average of Daily Maximum 8-Hour Ozone Concentrations for Southern SJV

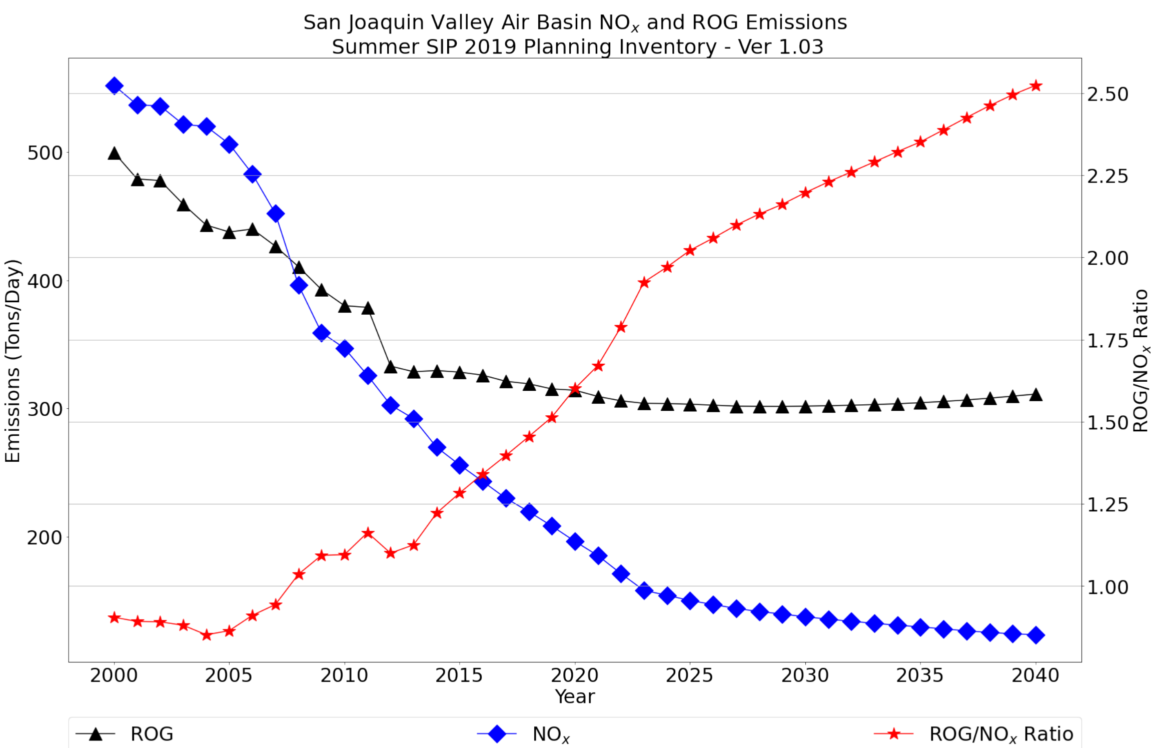


6. Trends in Precursor Emissions

Tropospheric (ground-level) ozone is a secondary pollutant that is formed by NO_x and VOCs through complex non-linear photochemical reactions. VOCs are also referred to as Reactive Organic Gases (ROG) and these two terms are used interchangeably in this document. Anthropogenic emissions from mobile sources, industrial facilities and electric utilities, gasoline vapors, and chemical solvents are some of the major sources of NO_x and ROG. Vegetation is also a major source of ROG emissions.

Emissions control programs have substantially reduced the amounts of both NO_x and ROG emitted by various sources throughout the Valley. Emissions trends, excluding emissions from natural sources, for NO_x and ROG in the Valley are shown in Figure 63. All emission inventory values are baseline values and are based on the California Air Resources Board's (CARB) California Emission Projection Analysis Model (CEPAM) for the 2019 Ozone SIP version 1.03 with external adjustments, using 2017 as the base year. Figure 63 shows that from 2000-2040, anthropogenic NO_x is forecasted to decrease by 78 percent and ROG by 38 percent.

Figure 63. Overall Anthropogenic NO_x and ROG Emission Trends for the San Joaquin Valley



The relative amount of ROG emissions compared to NO_x, or ROG/NO_x ratio, is an important consideration when planning emissions reduction strategies. For higher ROG/NO_x ratios, ROG emissions reductions will generally be less effective in lowering ozone while NO_x emissions reductions will be more effective. This is known as a NO_x-limited regime. A ROG-limited regime occurs when the ROG/NO_x ratios are lower, indicating higher NO_x emissions. In this regime, ROG emissions reductions will be more effective than NO_x emissions in reducing ozone concentrations.

Looking forward from 2015, the 2037 emissions represent approximately a 40 percent decrease in NO_x and a 7 percent decrease in ROG. Accordingly, the ROG/NO_x ratio for anthropogenic emissions in 2037 is expected to be about twice the ratio that prevailed in 2015. The ratio of ambient ROG to ambient NO_x would be greater than the ROG/NO_x ratio based upon anthropogenic emissions. This is because biogenic ROG (494.91 tons/day for the 2018 May-October average) is the majority of the total ROG inventory in the Valley for most of the ozone season, while biogenic NO_x is a tiny fraction of the total NO_x inventory. The trend towards higher ROG/NO_x ratios in the Valley indicates that the area will become more NO_x-limited, thus NO_x controls will become increasingly more effective for lowering ozone concentrations.

Trends in summer emissions of anthropogenic NO_x and ROG for the northern region are shown in Figure 64, central region in Figure 65 and the southern region in Figure 66. These trends show similarities that reflect the valley wide implementation of significant control programs for both NO_x and ROG. Similar to the Valley as a whole, in the northern, central, and southern regions of the Valley, the inventory shows greater reductions in NO_x (an average of 63 percent in the three regions) than ROG (an average of 37 percent in the three regions) from 2000 through 2020, with that pattern continuing through 2040.

Figure 64. Anthropogenic NO_x and ROG Emission Trends for the Northern San Joaquin Valley

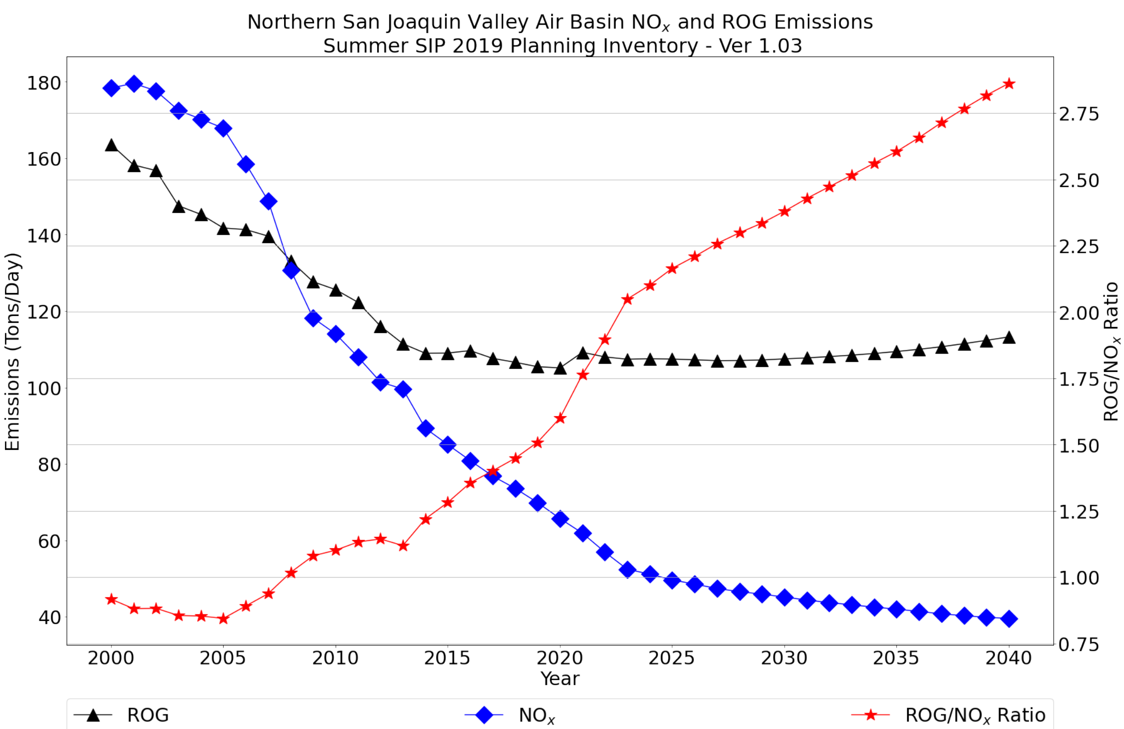


Figure 65. Anthropogenic NO_x and ROG Emission Trends for the Central San Joaquin Valley

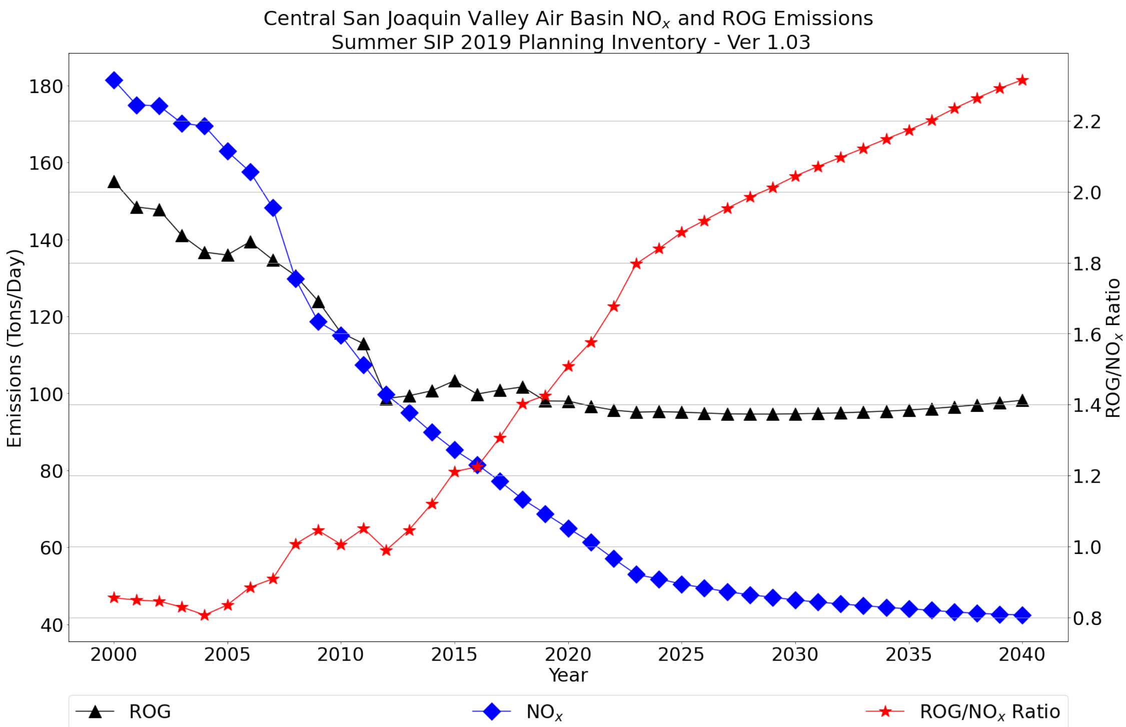
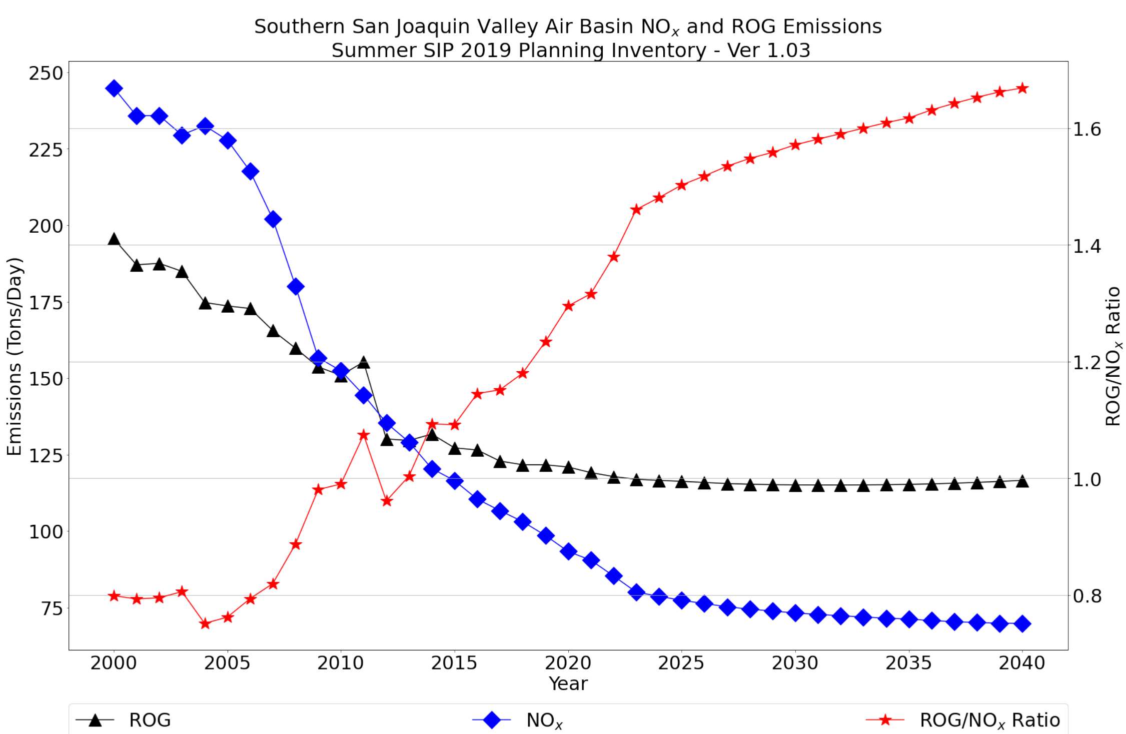


Figure 66. Anthropogenic NO_x and ROG Emission Trends for the Southern San Joaquin Valley



The county-by-county trends in Figure 67 (ROG emissions) and Figure 68 (NO_x emission) have largely similar shapes but differ in the magnitude of the emissions, with the highest NO_x and ROG emissions in Kern and Fresno counties.

The trends shown in Figure 63 – Figure 67 and Figure 68 are using baseline NO_x reductions based on current emissions reductions programs. Recently adopted CARB and District NO_x emissions reduction measures and CARB's new NO_x reduction commitments will drive the NO_x emission reductions even further for the future years.

Figure 67. Summer ROG Emissions by County in the San Joaquin Valley

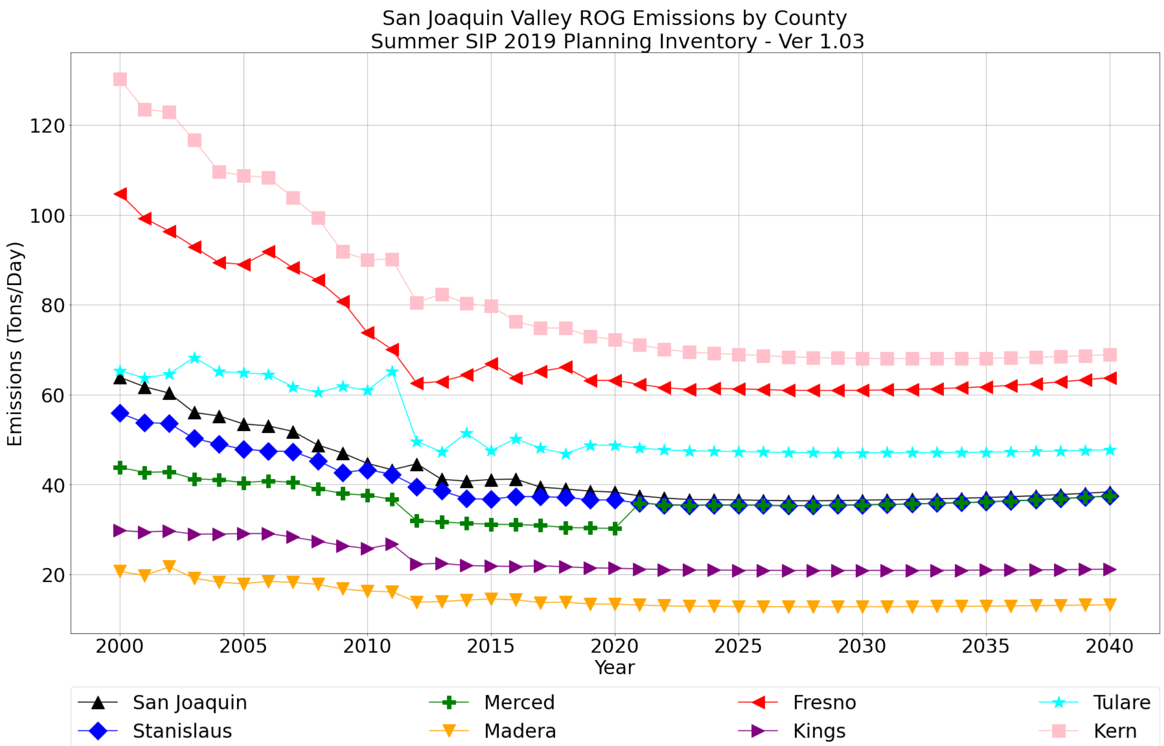
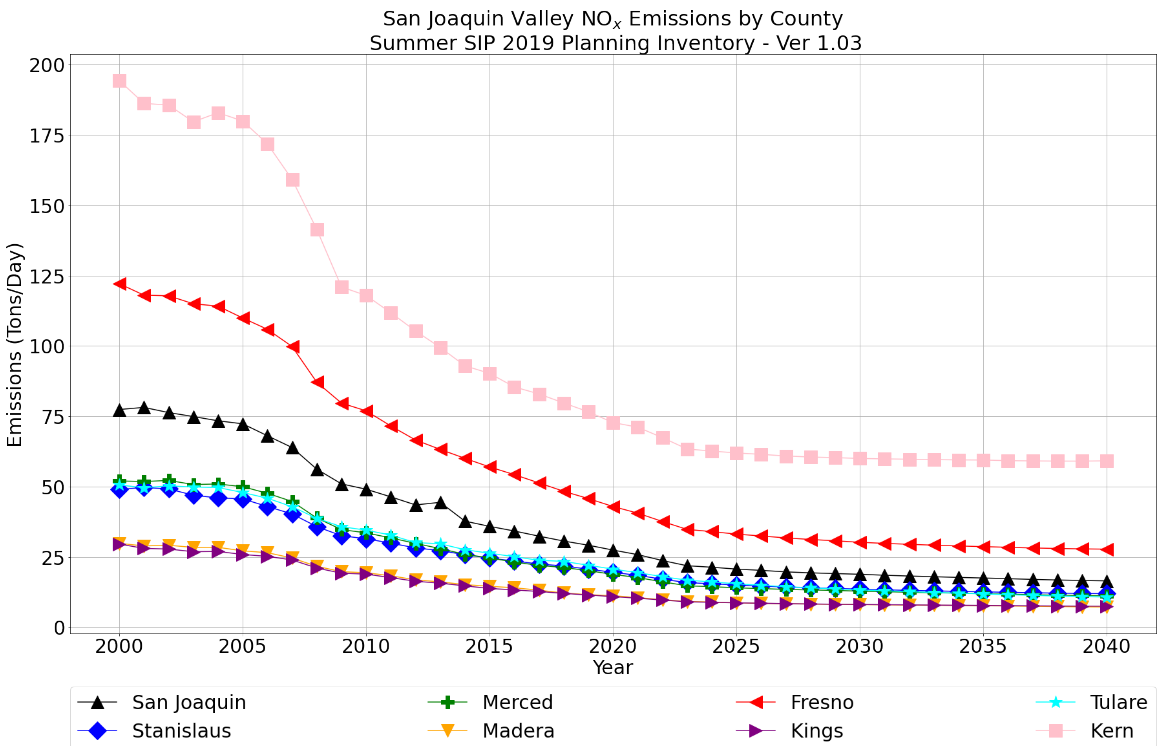


Figure 68. Summer NO_x Emissions by County in the San Joaquin Valley



7. Trends for Ozone Precursor Concentrations

This section presents trends in the primary ozone precursors, NO_x and VOC. The data are from a special purpose network of Photochemical Assessment Monitoring Stations (PAMS) where both NO_x and VOC are measured side by side. The PAMS network operates during the summer ozone season and collects VOC samples that represent different parts of the day. The work done for this WOE was focused on the morning hours between 5:00 a.m. and 8:00 a.m. in July and August, when the ambient concentrations of ozone precursor emissions are highest, during the morning commute hours.

The VOC data discussed here are the sum of 55 chemical species, sometimes called Non-Methane Organic Compounds (NMOC), a subset of VOC. These data are known to be lower than total VOC by percentages that differ by location.

The PAMS reactivity metric quantifies the relative impacts of each species on ozone formation. Using the maximum incremental reactivity (MIR) scale, this reactivity weighted metric is a more meaningful measurement for how ambient VOC plays a role in forming ozone.

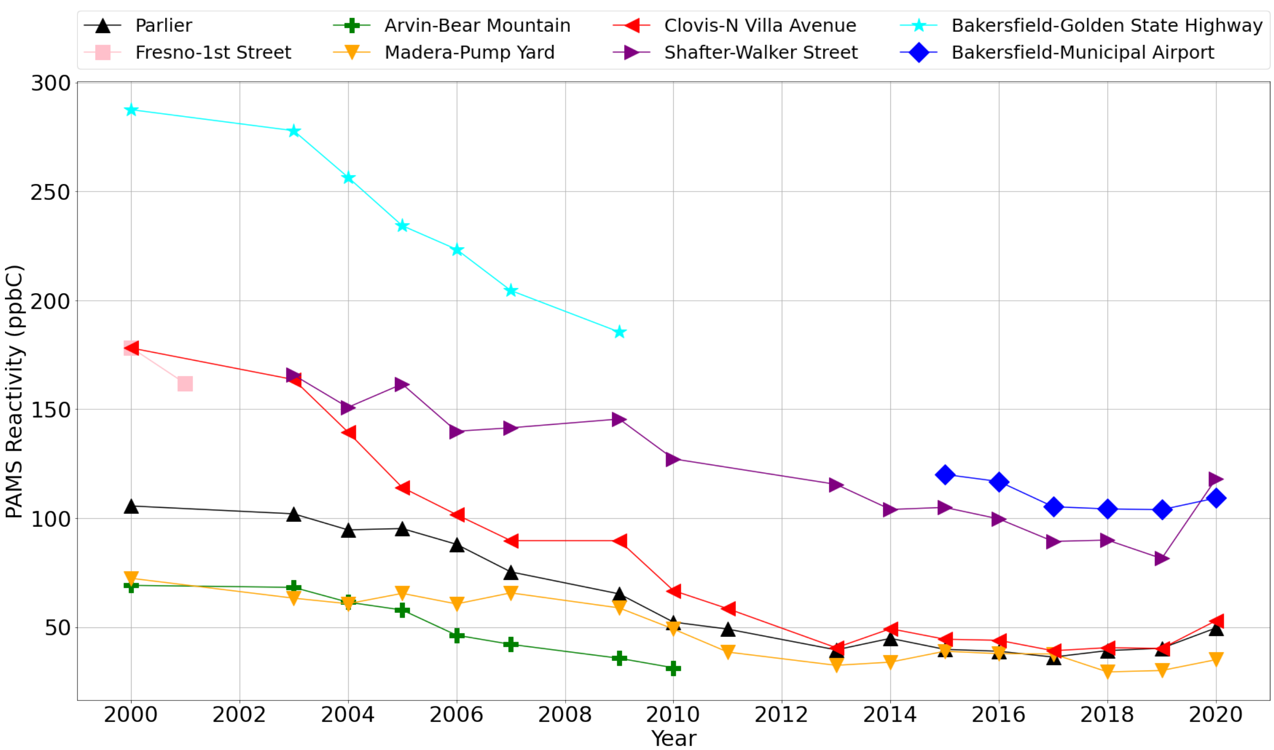
VOC are not measured at many of the monitors in the routine ambient network. The routine network of NO_x monitors, however, is extensive, and is discussed in a subsequent section.

7.1 Analysis of PAMS Data

The data were collected and filtered for the months of July and August because these two months tend to be during the peak of the ozone season. In addition, NMOC data were not consistently available for other months in the PAMS network. PAMS data is measured and collected periodically throughout the day, and most observations tend to represent a three-hour period. As such, it was important also to filter for a certain time of the day. Data from the 5:00 a.m.- 7:00 a.m. PDT and 6:00 a.m.- 8:00 a.m. PDT periods were selected. This time was chosen because it represents the hours before photochemistry (and therefore ozone formation) is triggered, and at a time when ozone precursor is at higher levels.

From 2000 to 2020, ambient VOC concentrations decreased significantly throughout the Valley. Trends for each site shown in Figure 69 show a long-term downward trend towards lower VOC levels in every region. The ambient VOC levels are consistent with the emissions inventory trends, with the southern region (Bakersfield Golden State Highway, Bakersfield – Municipal Airport and Shafter Walker Street) having higher levels than the central region (Fresno-1st Street, Clovis N Villa Avenue, and Parlier). Due to the sites in the southern region have higher VOC levels, it would take comparatively fewer NO_x reductions for that region to transition to a NO_x-limited regime, and ultimately show a response with lower ozone levels.

Figure 69. July – August Means at all San Joaquin Valley PAMS Stations (5-7 a.m./6-8 a.m.)*



*3-hour NMOC/PAMS samples from 5-7 am or 6-8 am for a standard set of 55 compounds. Some samples with extreme mixing ratios for one or more compounds were identified and excluded. Data for 2008 and 2012 were not available for this area during the chosen months and hours.

7.2 Analysis of Routine Ambient NO_x Data

The trends in the previous section represent ambient ROG at sites in the limited PAMS network during July and August for the hours between 5:00 a.m. and 8:00 a.m. This section will focus on all sites in the Valley that measure NO_x, providing a broader basis for assessing trends. These concentrations are averages measured over the May-October season for all hours in the day, from 2000 to 2020.

Figure 70, Figure 71, Figure 72, and Figure 73 show NO_x trends for each site in the northern, central, southern regions and the whole SJV air basin, respectively. All figures use May-October annual averages to show the NO_x trends during the peak ozone season. Data was less than 25 percent complete and therefore removed for Hanford-S Irwin Street in 2008-2010 and Bakersfield-California Avenue in 2014. The May-October annual average in 2018 for Fresno-Drummond was also not included due to some questionable data.

Generally, ambient NO_x is on a steady decline in each of the regions. All sites, especially the ones with the highest concentrations, show substantial NO_x decreases over the past 20 years. On average, the sites in the northern, central, and southern regions had a decrease of about 66, 51 and 62 percent from 2000 to 2020, respectively. From 2000-2020, the ambient NO_x concentrations across the whole SJV air basin (Figure 73) have decreased by 61 percent. The overall trends in ambient NO_x measurements are consistent with the emissions inventory data. The recent increases in NO_x concentrations at some sites could be due to the increased NOx emissions from wildfires.[10]

[10]Lindaas, J., Pollack, I. B., Garofalo, L. A., Pothier, M. A., Farmer, D. K., Kreidenweis, S. M., et al. (2020). Emissions of reactive nitrogen from Western U.S. wildfires during summer 2018. Journal of Geophysical Research: Atmospheres, 125, e2020JD032657. https://doi.org/10.1029/2020JD032657

Figure 70. Northern San Joaquin Valley Trends for Ambient 24-hour NO_x from May – October

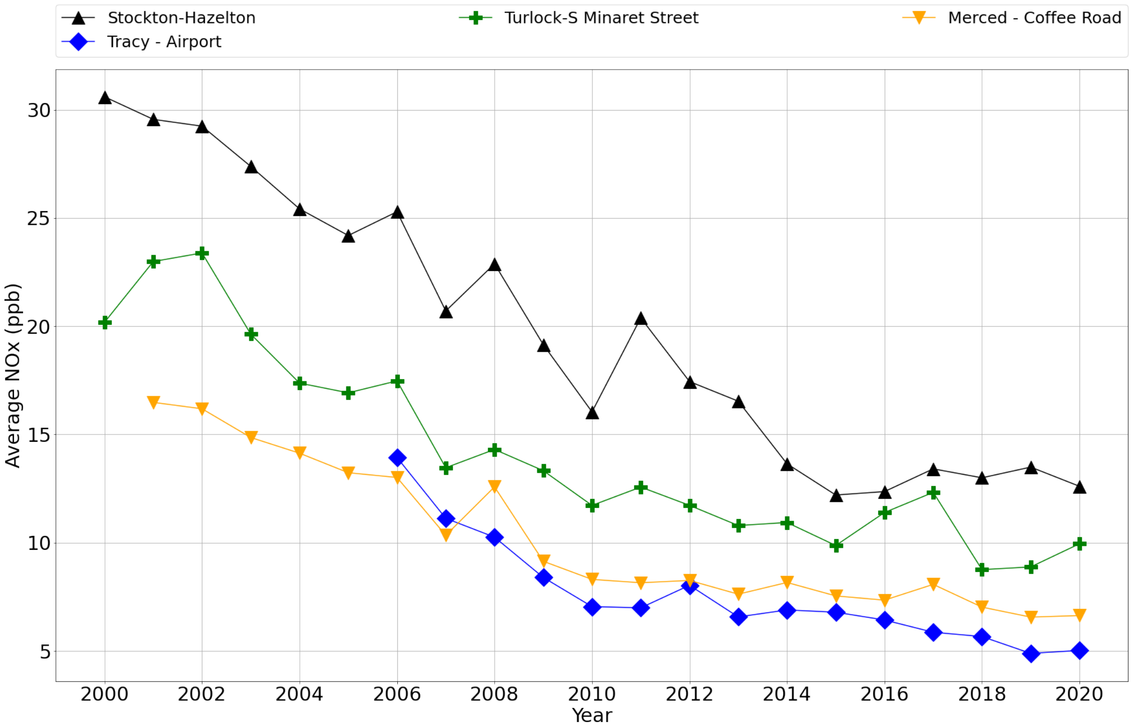


Figure 71. Central San Joaquin Valley Trends for Ambient 24-hour NO_x from May – October

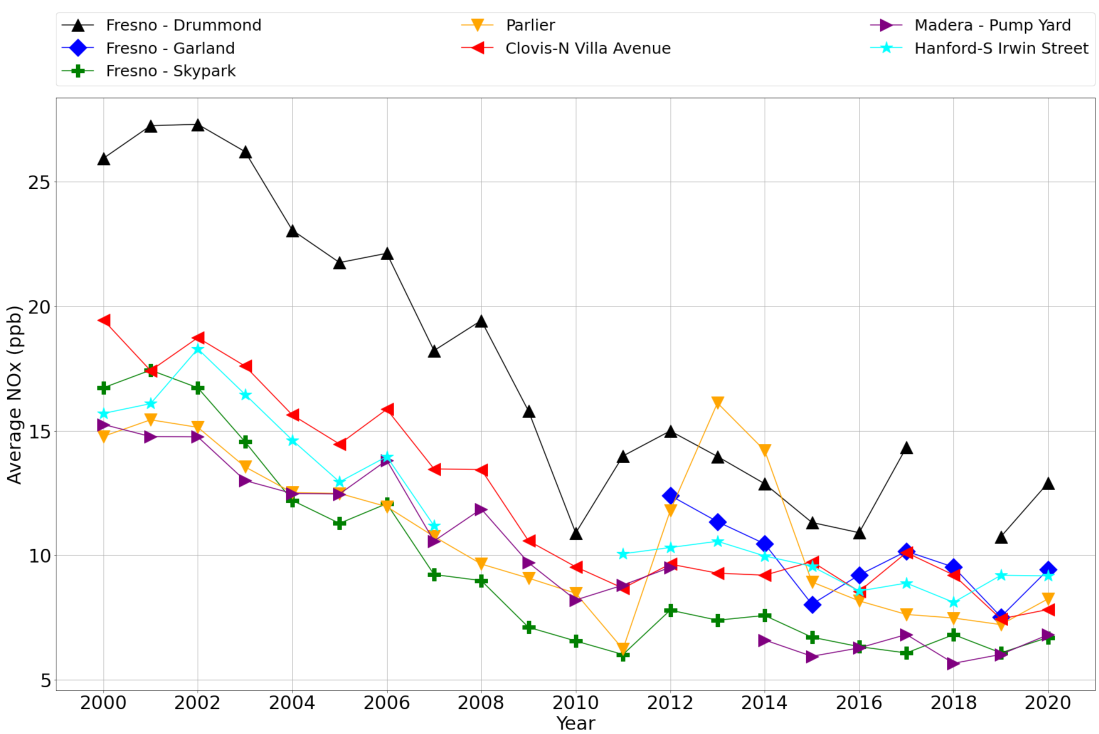


Figure 72. Southern San Joaquin Valley Trends for Ambient 24-hour NO_x from May – October

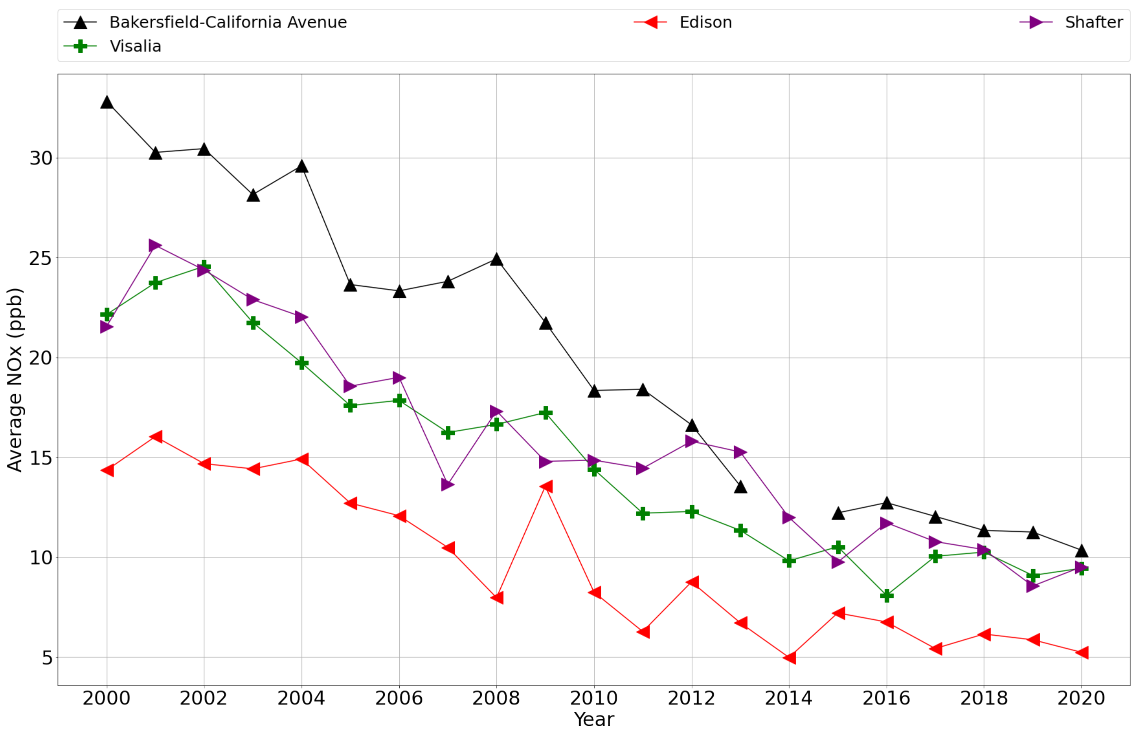
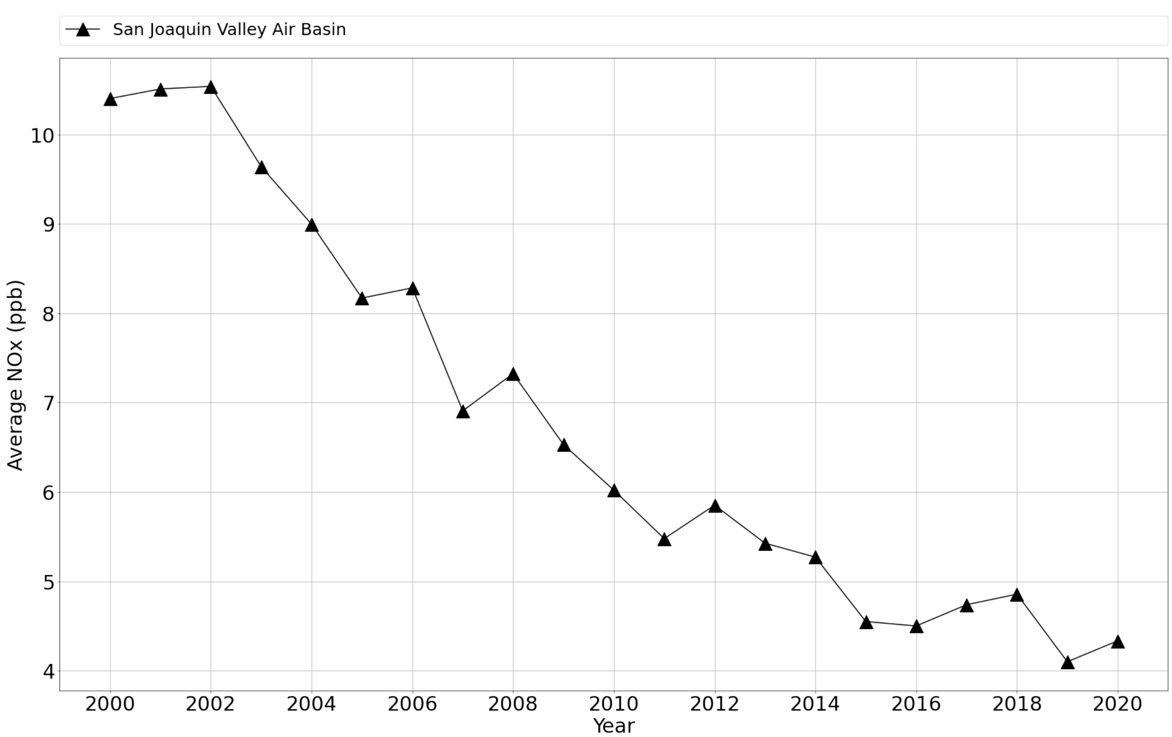


Figure 73. San Joaquin Valley Air Basin Trends for ambient NO_x from May – October



8. Weekend Effect in the San Joaquin Valley

Areas, such as the SJV, that have high NO_x emissions tend to show a day of the week ozone dependence, with ozone concentrations peaking on the weekends. [11] This is known as the "ozone weekend effect" (WE). The WE is a well-known phenomenon in many urbanized areas emissions of ozone precursors, especially NO_x, decrease substantially on weekends while the measured levels of ozone increase on weekends. The decrease in NO_x emissions is typically due to the reduced heavy-duty truck activity and emissions on weekends.[11]

The WE was calculated by taking the Weekend average/Weekday average. A WE value above one indicates a VOC-limited regime, while a WE value approximately or below one indicates a NO_x-limited regime.

In a NO_x-limited regime, reductions in NO_x emissions are expected to reduce ambient ozone levels. In a VOC-limited regime, reductions in NO_x emissions may have a counterproductive effect. These varying effects of NO_x reductions are due to the non-linear chemistry of ozone formation involving NO_x and VOC.

In many places within the SJV, NO_x emissions are substantially lower on weekends compared to weekdays. The average WE for the northern, central, and southern regions of the SJV along with the whole SJV air basin are shown in Figure 74 through Figure 77 and Table 10 on a site-by-site basis and a regional average basis. In some cases, a strong WE is present, while in others, a reverse WE is present, with weekend ozone being lower than weekday ozone. The WE values shown in Table 10 may indicate that regions of the Valley differ in their sensitivity to NO_x and VOC emissions.

In the northern region of the SJV (Figure 74 and Table 10), the average WE decreased from 1.12 in 2000-2004 to 1.01 in 2015-2020. The central region of the SJV (Figure 75 and Table 10), the average WE has stayed relatively constant around 1.00. The southern region of the SJV (Figure 76 and Table 10), the average WE decreased from 1.05 in 2000-2004 down to 1.00 in 2015-2020. The values from all three regions are consistent with scientific and modeling assessments[12] indicating that all regions are becoming more NO_x-limited although some areas may still be transitioning.

The Sequoia National Park has been in a NO_x-limited regime for the past 20 years, with the average WE staying around 0.96. These results indicate that reductions in anthropogenic NO_x emissions in the heavily populated regions of the SJV are be expected to reduce ozone at elevated down-wind sites, consistent with both recent air quality trends and modeling results.

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[11]Cai, C., Avise, J., Kaduwela, A., DaMassa, J., Warneke, C., Gilman, J. B., et al. (2019). Simulating the weekly cycle of NOx-VOC-HOx-O3 photochemical system in the South Coast of California during CalNex-2010 campaign. Journal of Geophysical Research: Atmospheres, 124, 3532–3555. https://doi.org/10.1029/2018JD029859

[12]California Air Resources Board - 2016 San Joaquin Valley 8-Hour Ozone Plan. https://ww2.arb.ca.gov/resources/documents/2016-san-joaquin-valley-8-hour-ozone-plan

Looking at the whole SJV air basin (Figure 77 and Table 10), the average WE decreased from 1.05 in 2000-2004 to 1.00 in 2015-2020. These results again indicate that the whole SJV air basin is transitioning to a NOx-limited regime. In particular, the WE in 2020 was significantly lower than 1.0 due to the additional NOx emission reductions caused by the pandemic. This suggests that NOx emission control strategies in SJV are expected to be effective in reducing ozone levels in future years.

Figure 74. Average Weekend Effect for the Northern Sub-Region of the SJV Basin

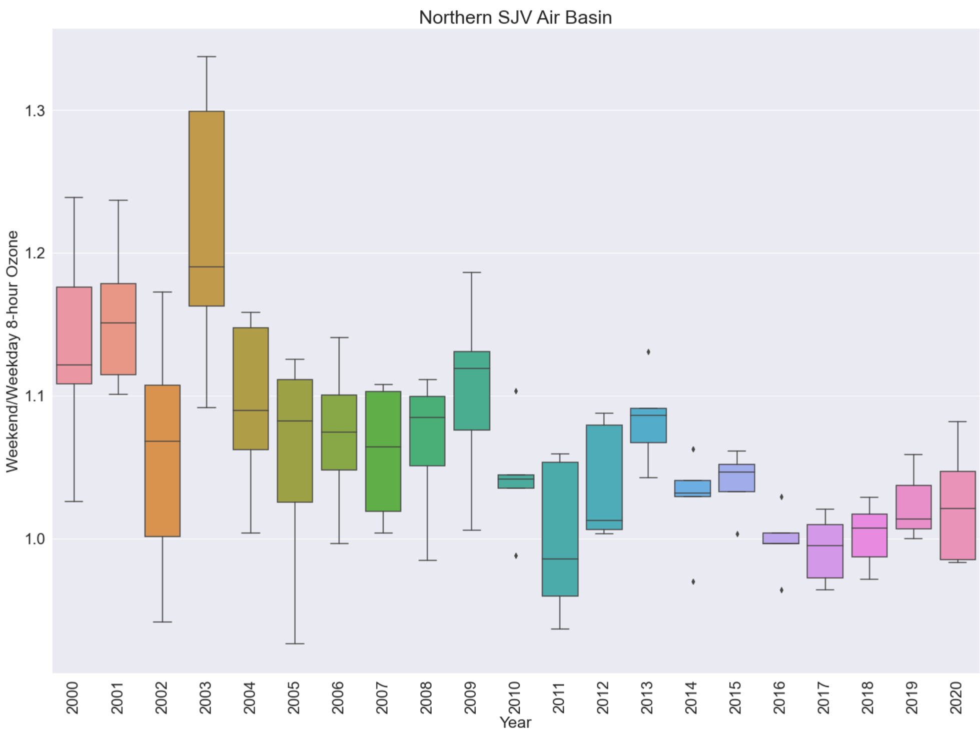


Figure 75. Average Weekend Effect for the Central Sub-Region of the SJV Basin

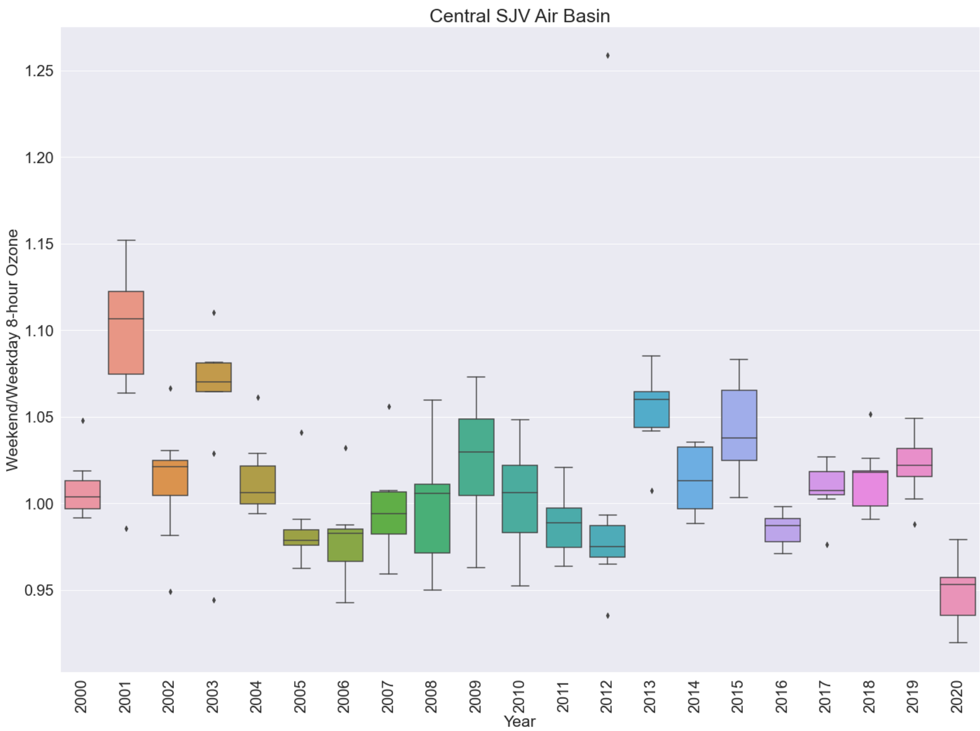


Figure 76. Average Weekend Effect for the Southern Sub-Region of the SJV Basin

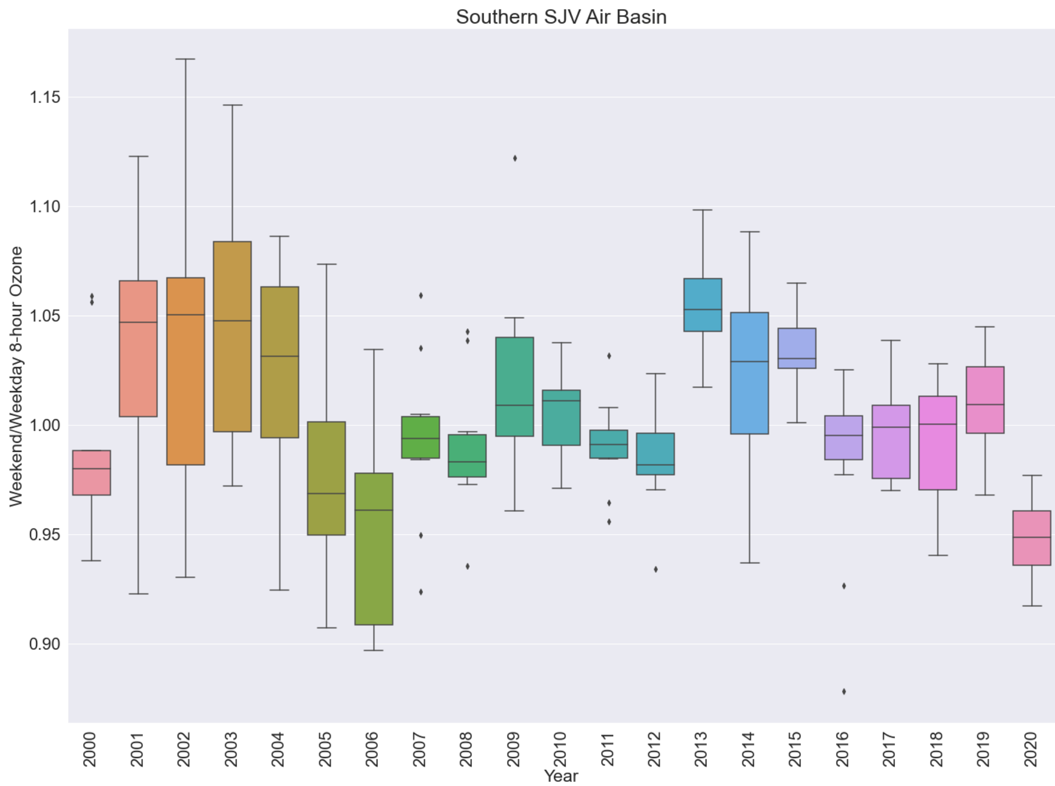


Figure 77. Average Weekend Effect for the whole SJV Basin

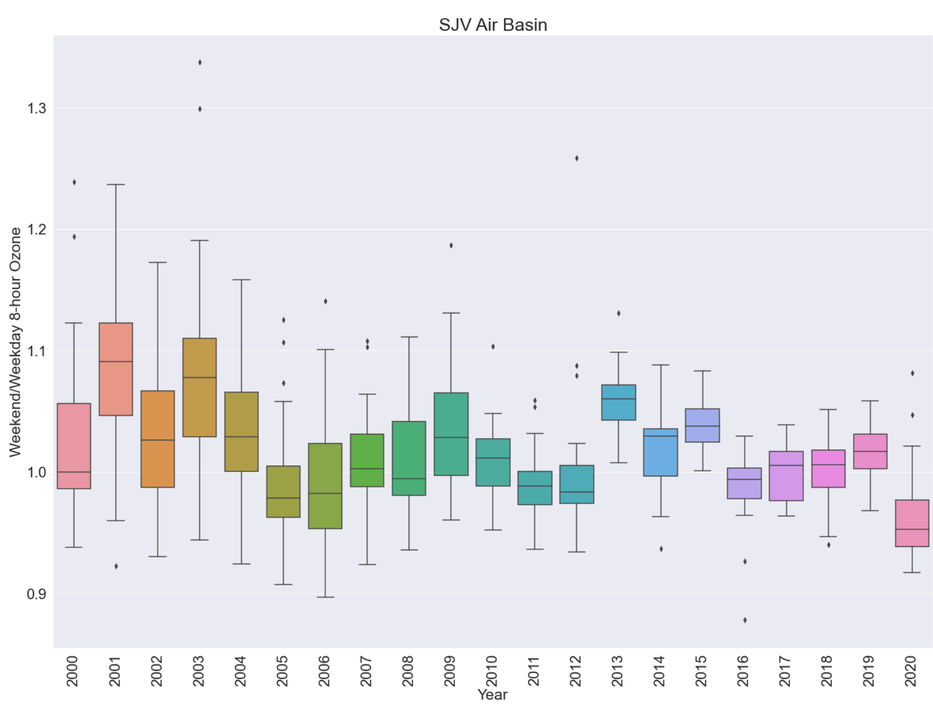


Table 10. Average Weekend Effect

Sub-region and Site		2000 to 2004	2005 to 2009	2010 to 2014	2015 to 2020
SJV - Northern					
	Stockton-Hazelton Street	1.21	1.13	1.07	1.04
	Modesto-14th Street	1.20	1.11	1.08	1.02
	Turlock-S Minaret Street	1.11	1.07	1.03	1.00
	Merced-S Coffee Avenue	1.04	0.98	0.99	0.99
	Tracy-Airport	N/A	1.07	1.02	1.01
	Stockton-E Mariposa	1.06	N/A	N/A	N/A
	Tracy-24371 Patterson Pass Road	1.12	N/A	N/A	N/A
	Average	**1.12**	**1.07**	**1.04**	**1.01**
SJV - Central					
	Fresno-Drummond Street	1.09	1.05	1.03	1.02
	Parlier	1.04	1.00	1.00	0.99
	Fresno-Sierra Skypark #2	1.03	1.00	1.01	1.00
	Clovis-N Villa Avenue	1.05	0.99	1.01	1.02
	Hanford-S Irwin Street	1.03	0.97	0.99	1.01
	Madera-Pump Yard	1.03	0.98	1.00	1.01
	Tranquility-32650 West Adams Avenue	N/A	N/A	0.98	0.99
	Madera-28261 Avenue 14	N/A	N/A	1.01	1.00
	Fresno-Garland	N/A	N/A	1.02	1.01

Sub-region and Site		2000 to 2004	2005 to 2009	2010 to 2014	2015 to 2020
	Fresno-1st Street	1.05	1.01	1.09	N/A
	Shaver Lake - Perimeter Road	0.98	N/A	N/A	N/A
	Corcoran-Patterson Avenue	N/A	0.98	N/A	N/A
	Fresno-Fremont School	1.03	N/A	N/A	N/A
	Fresno-Mobile	0.94	N/A	N/A	N/A
	Average	**1.03**	**1.00**	**1.02**	**1.00**
SJV - Southern					
	Visalia-N Church Street	1.10	1.02	1.03	1.00
	Edison	1.05	1.00	1.03	0.99
	Oildale-3311 Manor Street	1.03	0.99	1.02	1.00
	Maricopa-Stanislaus Street	1.01	0.94	0.98	1.00
	Shafter-Walker Street	1.04	0.97	1.01	1.01
	Bakersfield-5558 California Avenue	1.06	1.00	1.04	1.01
	Arvin-Di Giorgio	N/A	N/A	1.01	0.98
	Porterville-1839 Newcomb Street	N/A	N/A	1.01	0.99
	Bakersfield-Municipal Airport	N/A	N/A	1.03	1.02
	Arvin-Bear Mountain Blvd	1.01	0.96	0.98	N/A
	Bakersfield-Golden State Highway	1.11	1.05	N/A	N/A
	Average	**1.05**	**0.99**	**1.01**	**1.00**
Sequoia National Park					
	Sequoia Natl Park-Lower Kaweah	0.96	0.97	1.00	0.96
	Sequoia and Kings Canyon Natl Park	0.97	0.93	0.98	0.97
	Sequoia National Park-Lookout Point	0.94	N/A	N/A	N/A
	Average	**0.96**	**0.95**	**0.99**	**0.96**
Whole SJV Air Basin					
	Average	**1.05**	**1.01**	**1.02**	**1.00**

9. Preliminary Look: 2021 Ozone Data

While this WOE focuses on regulatory ozone data submitted through 2020, most of the data from 2021 are already submitted. For the data that have not been submitted yet, staff used the Air Quality and Meteorological Information System (AQMIS) for preliminary data. Using these two data sets, it is possible to look at preliminary numbers for trends continuing through 2021.

2021 was another extreme year for wildfires, with numerous wildfires active during the June through October. Leading to many potential wildfires impacted days in the SJV and higher ozone levels due to the wildfire smoke. Table 12 shows the preliminary 2021 DV and an adjusted 2021 DV with potential wildfire days being removed. The 2021 adjusted DV was calculated using the 2019 4th high, and adjusted 4th highs for 2020 and 2021 which were determined by removing the impacted wildfire dates (Table 7 and Table 11).

Table 11. 2021 List of Dates and Sites Affected by Wildfires.

Date	Site(s)
2021-06-17	Clovis-N Villa Avenue, Edison, Sequoia National Park-Ash Mountain, Porterville
2021-06-18	Fresno-Drummond, Parlier, Visalia, Edison, Sequoia National Park-Ash Mountain, Porterville
2021-06-19	Fresno-Drummond, Parlier, Clovis-N Villa Avenue, Visalia, Edison, Sequoia National Park-Ash Mountain, Porterville, Sequoia National Park-Lower Kaweah
2021-06-27	Visalia
2021-07-12	Edison, Sequoia National Park-Ash Mountain, Sequoia National Park-Lower Kaweah
2021-07-13	Sequoia National Park-Ash Mountain, Porterville, Sequoia National Park-Lower Kaweah
2021-08-03	Edison, Sequoia National Park-Ash Mountain, Sequoia National Park-Lower Kaweah
2021-08-04	Parlier, Arvin-Di Giorgio, Edison, Sequoia National Park-Ash Mountain, Oildale, Sequoia National Park-Lower Kaweah
2021-08-08	Edison, Sequoia National Park-Ash Mountain, Sequoia National Park-Lower Kaweah
2021-08-21	Sequoia National Park-Ash Mountain, Sequoia National Park-Lower Kaweah
2021-08-25	Edison, Sequoia National Park-Ash Mountain, Porterville, Sequoia National Park-Lower Kaweah
2021-08-26	Modesto-14th Street, Visalia, Sequoia National Park-Ash Mountain, Porterville, Sequoia National Park-Lower Kaweah
2021-08-27	Fresno-Drummond, Fresno-Garland, Fresno-Skypark, Parlier, Clovis-N Villa Avenue, Madera-Pump Yard, Hanford-S Irwin Street, Modesto-14th Street, Merced-Coffee Road
2021-08-28	Fresno-Drummond, Fresno-Garland, Fresno-Skypark, Parlier, Clovis-N Villa Avenue, Madera City, Madera-Pump Yard, Hanford-S Irwin Street, Tranquility, Modesto-14th Street, Turlock-S Minaret Street, Merced-Coffee Road, Arvin-Di Giorgio, Visalia, Bakersfield-Municipal Airport, Edison, Bakersfield-California Avenue, Oildale, Porterville, Shafter
2021-08-29	Fresno-Drummond, Fresno-Garland, Fresno-Skypark, Parlier, Clovis-N Villa Avenue, Madera City, Madera-Pump Yard, Hanford-S Irwin Street, Tranquility, Modesto-14th Street, Turlock-S Minaret Street, Arvin-Di Giorgio, Visalia, Bakersfield-Municipal Airport, Edison, Sequoia National Park-Ash Mountain, Bakersfield-California Avenue, Maricopa, Oildale, Porterville, Shafter
2021-08-30	Fresno-Drummond, Fresno-Garland, Fresno-Skypark, Parlier, Clovis-N Villa Avenue, Modesto-14th Street, Turlock-S Minaret Street, Merced-Coffee Road, Visalia, Edison, Porterville, Sequoia National Park-Lower Kaweah
2021-08-31	Sequoia National Park-Lower Kaweah
2021-09-05	Edison
2021-09-06	Edison
2021-09-07	Parlier, Clovis-N Villa Avenue, Visalia, Edison
2021-09-08	Clovis-N Villa Avenue
2021-09-09	Porterville
2021-09-14	Hanford-S Irwin Street
2021-09-22	Fresno-Garland, Fresno-Skypark, Madera City, Madera-Pump Yard, Edison
2021-10-02	Modesto-14th Street, Maricopa

Sequoia and Kings Canyon National Park and Edison are the sites that currently have the highest ozone concentrations in the Valley. The 2021 data for these two sites show a decrease in the design value. Sequoia and Kings Canyon National Park stayed constant in design value, while Edison's design value decreased by 1 ppb. As Table 12 shows below, almost all sites in the Valley show a decrease in design value, except for a few sites that showed a small increase of 1 ppb.

Table 12. Preliminary Look: 2019-2021 Design Values (in ppb)

	County	Site	2019 Official DV	2020 Official DV	2020 Adjusted DV	2021 Preliminary DV	2021 Adjusted DV
Northern	Merced	Merced-S Coffee Avenue	76	76	75	76	74
Northern	San Joaquin	Stockton-Hazelton Street	66	66	66	82	64
Northern	San Joaquin	Tracy-Airport	73	70	70	68	68
Northern	Stanislaus	Modesto-14th Street	80	79	76	78	75
Northern	Stanislaus	Turlock-S Minaret Street	82	80	78	80	78
Central	Fresno	Clovis-N Villa Avenue	84	84	79	83	79
Central	Fresno	Fresno-Drummond Street	82	80	77	82	77
Central	Fresno	Fresno-Garland	86	84	76	84	75
Central	Fresno	Fresno-Sierra Skypark #2	80	79	77	80	76
Central	Fresno	Parlier	84	81	79	84	78
Central	Fresno	Tranquility- 32650 West Adams Avenue	72	70	70	69	69
Central	Kings	Hanford-S Irwin Street	80	80	76	78	74
Central	Madera	Madera-28261 Avenue 14	78	78	77	81	78
Central	Madera	Madera-Pump Yard	76	76	75	79	75
Southern	Kern	Arvin-Di Giorgio	87	89	83	86	82
Southern	Kern	Bakersfield - 5558 California Avenue	87	85	77	80	75
Southern	Kern	Bakersfield - Municipal Airport	84	85	80	83	81
Southern	Kern	Edison	88	93	84	93	83
Southern	Kern	Maricopa-Stanislaus Street	83	85	80	80	77
Southern	Kern	Oildale-3311 Manor Street	84	83	78	81	79
Southern	Kern	Shafter-Walker Street	79	82	79	79	77
Southern	Tulare	Porterville - 1839 Newcomb Street	77	80	77	85	78

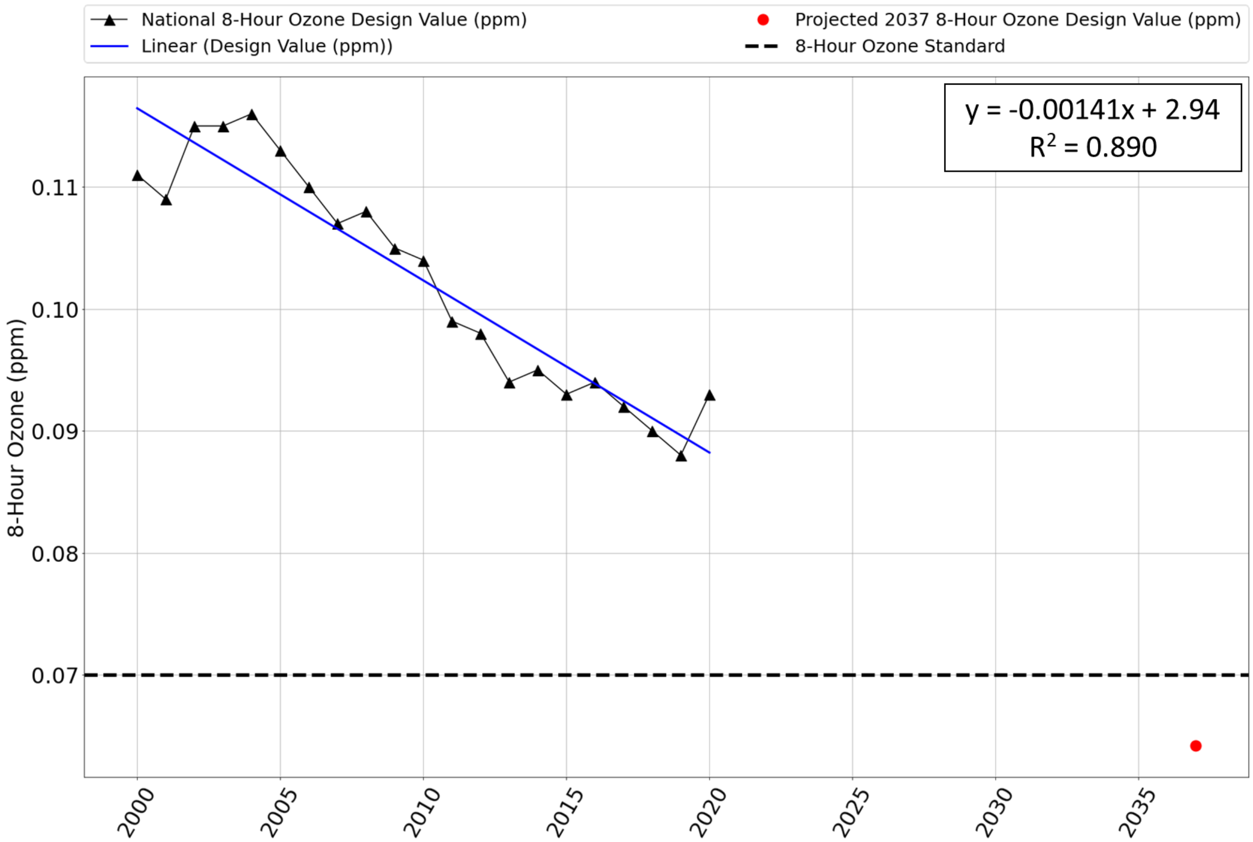
	County	Site	2019 Official DV	2020 Official DV	2020 Adjusted DV	2021 Preliminary DV	2021 Adjusted DV
	Tulare	Sequoia and Kings Canyon Natl Park	86	88	85	90	85
	Tulare	Sequoia Natl Park - Lower Kaweah	82	83	79	82	78
	Tulare	Visalia-N Church Street	84	83	79	84	80

The preliminary 2021 data are consistent with the conclusions of the WOE assessment demonstrating that the Valley continues to show a trend toward lower ozone.

10. Summary

Photochemical modeling performed in support of the Valley's 8-hour ozone attainment plan shows that with current and new emission reductions commitments, the San Joaquin Valley can be expected to attain the 2015 national 8-hour ozone standard by 2037, which is consistent with the projection based on the historical DV trend as shown in Figure 78. This is supported by additional analyses using observed ozone levels, meteorology, and precursor emissions.

Figure 78. Design Value Trend for the San Joaquin Valley Air Basin along with the 2037 Projected Design Value



This WOE package comprises a set of complementary analyses that supplement the SIP required modeling, providing additional support for the attainment demonstration based on the following factors:

- Trends for multiple indicators of ozone air quality have shown progress in the Valley, with a decrease in basin wide design value of 16 percent from 2000 to 2020, and a 24 percent reduction in design values when looking at the adjusted design values that removed wildfire impacts.
- From 2000-2020, ambient NO_x concentrations across the Valley have decreased by 61 percent.
- Exceedance days have decreased by 25 percent in the past two decades, and the severity of ozone has significantly decreased throughout the Valley.
- Two of the five sites in the northern region are already meeting the standard. The highest site in 2020, Turlock S Minaret Street, has shown a decrease in the official design value of 0.016 ppm (0.096 to 0.080 ppm) since 2000 and approximately 68 percent drop-in exceedance days in the past two decades.
- The central region has exhibited progress, with a declining trend in design values over the past two decades. The highest site, Clovis-N Villa Avenue, has shown a decrease in official design value of 0.025 ppm (0.109 to 0.084 ppm) since 2000 and approximately 56 percent drop-in exceedance days in the past two decades.

- Sites in the southern region have shown the progress over the past two decades. The design site, Edison, has shown a decrease in the official design value of 0.018 ppm (0.111 to 0.093 ppm) since 2000 and approximately 30 percent drop-in exceedance days in the past two decades.
- After wildfire impact days were removed, all the regions show a greater decrease in design values. Turlock S Minaret Street shows a decrease of 0.018 ppm (0.096 to 0.079 ppm), Clovis-N Villa Avenue shows a decrease of 0.030 ppm (0.109 to 0.079 ppm) and Edison shows a decrease of 0.027 ppm (0.111 to 0.084 ppm).
- Accounting for meteorological variability, season average ozone levels declined between 2010-2020 in all three regions of the Valley. Met-adjusted design value trends show a greater response to emission reductions and a faster decline rate throughout the Valley.
- From the emission inventory, there has been a basin wide baseline reduction of 64 percent (552 to 196 tons/day) in NO_x and a reduction of 37 percent (500 to 314 tons/day) in VOC from 2000 to 2020. These reductions have driven the VOC/NO_x ratio in the Valley towards and into the NO_x-limited regime.
- The ozone weekday-weekend analysis supports that the SJV is transitioning to a NO_x-limited regime.
- The weekday-weekend analysis in 2020 was significantly lower than other years due to the additional NO_x emission reductions caused by the pandemic. This suggests that NO_x emission control strategies in SJV are expected to be effective in reducing ozone levels in future years.
- Based on all available ambient precursor trends, emissions inventory, weekday-weekend analyses, and field-based studies, it is expected that the Valley will be increasingly responsive to NO_x reductions.
- Between 2020 and 2037, current control programs are expected to reduce NO_x emissions by approximately 36 percent (196 to 126 tons/day). However, recently adopted CARB and District NO_x emission control measures and CARB's new NO_x reduction commitments will drive the NO_x emission reductions even further.

Taken together, all these factors indicate that all sites in the San Joaquin Valley can be expected to attain the national 8-hour ozone standard by 2037 with current CARB and District control programs.