Exceptional Event Demonstration for PM_{10} Exceedances in Clark County, Nevada – May 8, 2022

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STi Sonoma Technology

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Exceptional Event Demonstration for PM_{10} Exceedances in Clark County, Nevada – May 8, 2023

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Cover graphic shows images from the M Resort Hotel in Las Vegas, Nevada, on May 8, 2022, at 13:00 PST.

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1. Narrative Conceptual Model

In early May 2022, a strong frontal passage traversed California, driving a windblown dust event that lofted and entrained dust from the Mojave Desert and increased particulate matter (PM) concentrations in Clark County, Nevada, on May 8, 2022. During this episode, the 2012 24-hour National Ambient Air Quality Standards (NAAQS) threshold was exceeded for particles with a diameter of less than 10 microns (PM_{10}) at ten monitoring sites in Clark County: Paul Meyer, Mountains Edge, Walter Johnson, Palo Verde, Joe Neal, Green Valley, Liberty High School, Jerome Mack, Sunrise Acres, and Walnut Community Center. Three additional sites experienced NAAQS exceedances, and all other sites throughout Clark County also experienced significantly enhanced hourly PM_{10} concentrations but were not regulatorily significant. The widespread impact on PM_{10} concentrations in Clark County indicates that this was a regional dust event. The exceedances at the ten regulatorily significant sites affect the PM_{10} attainment designation for Clark County during the 2021-2023 design value period.

Due to severe drought conditions in the Mojave Desert in southeastern California, strong winds created by the pressure gradient from the frontal passage lofted, entrained, and transported dust into Clark County, arriving late in the morning on May 8, 2022. The U.S. Environmental Protection Agency (EPA) Exceptional Event Rule (EER) (EPA, 2016) allows air agencies to omit air quality data from the design value calculation if it can be demonstrated that the measurement in question was caused by an exceptional event. In this case, enhanced wind speeds greater than 25 mph in the Mojave Desert source region and Clark County coincide with the frontal passage and increased PM_{10} concentrations along the transport path, which is consistent with a high-wind dust event as described in the EPA Guidance on High Wind Dust Events (EPA, 2019).

Overall, the May 8, 2022, PM_{10} events at the ten affected sites ranks above the 99th percentile for all 2018-2022 PM_{10} events in Clark County and is clearly exceptional compared to typical PM_{10} conditions. Windblown dust from the Mojave Desert is shown to be entirely from natural, undisturbed lands and can be considered a natural event that could not be mitigated by anthropogenic actions beyond public warnings. Overall, this report includes detailed analyses that establishes a clear causal relationship between the high-wind event in the Mojave Desert region of southeastern California with the enhanced PM_{10} concentrations measured at the ten affected sites in Clark County, Nevada – designating the May 8, 2022 event as a High-Wind Dust Exceptional Event.

Key narrative evidence and timeline elements are shown below and expanded on in this document:

Pre-Event Climatological Context

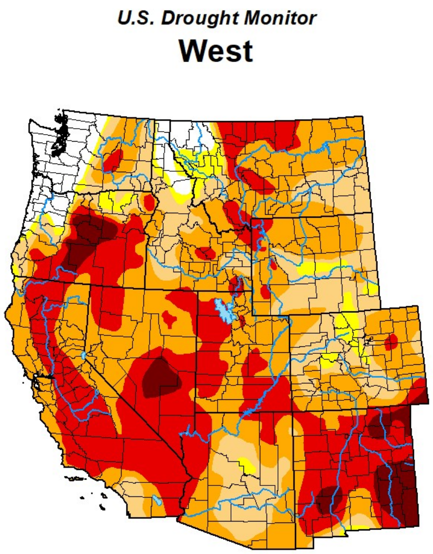

Figure 2.2-6

The Mojave Desert in southeastern California and Clark County, Nevada, was under extreme-to-exceptional drought conditions on and before the May 8, 2022, event. Temperatures were above normal and precipitation was below normal compared to climatology. The barren land cover, including the Mojave Desert source region, was primed for significant dust production during the high-wind event.

See Section 2.2

Inciting High-Wind Event

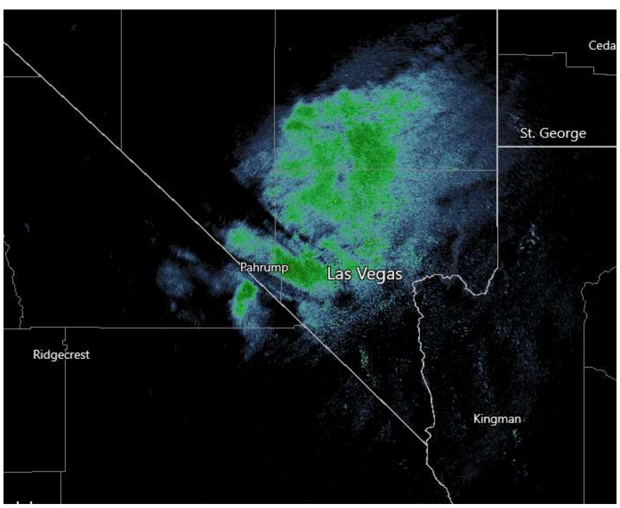

Figure 3.1-5

A frontal passage through California precipitated a large pressure gradient across Clark County and the Mojave Desert, culminating in high-wind speeds and gusts across the area between 10:00 and 20:00 PST on May 8, 2022. Meteorological analysis and radar images of this event show the frontal passage (and associated dust) entering Clark County, Nevada, at 11:00 PST on May 8. Wind speeds in the Mojave Desert well exceeded the 25-mph sustained wind threshold over natural undisturbed lands. This caused lofting, entrainment, and transport of PM_{10} from the source region into Clark County.

See Section 3.1

Transport of PM_{10} from the Source Region to Clark County

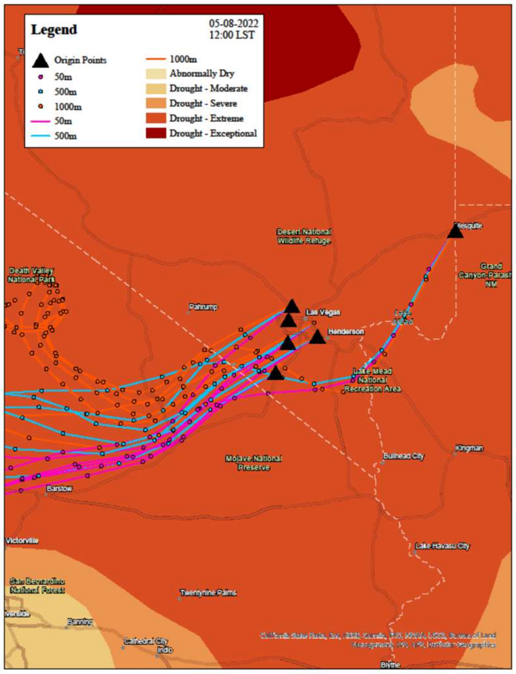

Figure 3.2-2

Back trajectories and meteorological data along the frontal passage confirm the Mojave Desert in southeastern California (located to the southwest of Clark County) as the source region for the high-wind dust event. The frontal passage pushed northeastward through the source region enroute to Clark County, Nevada, within two to six hours of the exceedance.

See Section 3.2

Enhanced PM_{10} Concentrations from High-Wind Dust Event Arrives in Clark County

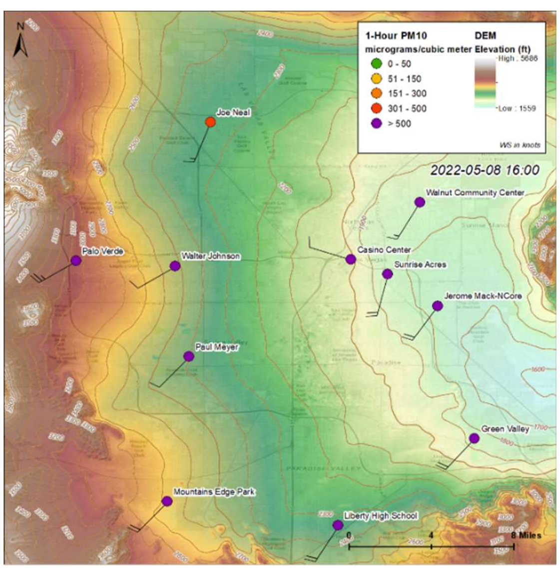

Figure 3.2-9

Enhanced PM_{10} concentrations arrived in Clark County beginning at 11:00 PST on May 8, 2022, with peak concentrations occurring between 13:00 and 18:00 PST. Concentrations remained enhanced through the remainder of the day. High PM_{10} concentrations at 13 sites across Clark County coincided with the frontal passage and occurred at the same time as the high-wind speed and gust measurements. Widespread high PM_{10} concentrations at all Clark County sites occurred simultaneously, indicating a regional high-wind event.

See Section 3.2

Effect of PM_{10} Concentrations in Clark County

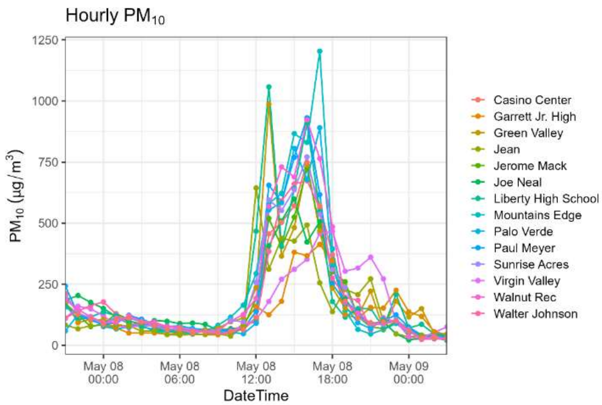

Figure 3.3-6

Thirteen PM_{10} monitoring sites exceeded the NAAQS on May 8, 2022; ten sites experienced exceedances that were regulatorily significant, while three experienced exceedances that were not. Almost all sites throughout Clark County showed peak hourly concentrations of PM_{10} well above 500 µg/m^3. The widespread high PM_{10} concentrations concur with a regional high-wind exceptional event. PM_{10} concentrations at all 13 sites exceeded the five-year 99th percentile on May 8, 2022.

See Section 3.3

High-Wind or PM_{10} Alerts Issued

News Release

County Commission:
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Justin Jones, Vice Chairman
Marilyn Kirkpatrick
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For Immediate Release — **Friday, May 6, 2022**

Air Quality Dust Advisory Issued for Sunday

The Clark County Department of Environment and Sustainability has issued a dust advisory for **Sunday, May 8,** to advise residents and local construction sites of the possibility of elevated levels of blowing dust due to the forecast of high winds in our area.

Airborne dust is a form of inhalable air pollution called particulate matter or PM, which aggravates respiratory diseases. Under windy conditions people with heart or lung disease, older adults, and children may feel better staying indoors as much as possible because they could be at greater risk from particulates, especially when they are physically active, according to the U.S. Environmental Protection Agency. Consult your physician if you have a medical condition that makes you sensitive to air pollution.

Figure 3.3-2

The National Weather Service issued a Dust Storm Warning for Clark County on May 8, 2022. Clark County, Nevada, issued a Dust Advisory in advance of the May 8 event due to forecasted high PM_{10} concentrations. They advised residents and local construction sites that enhanced levels of blowing dust was possible due to high winds. Multiple news outlets also reported on the high wind, low visibility, and extremely dusty conditions on May 8.

See Section 3.3

Comparison with Historical Data

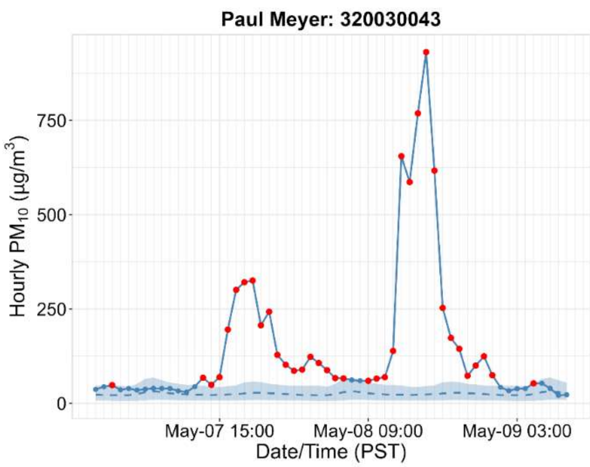


Figure 3.4-37

PM_{10} concentrations at the ten sites that had regulatorily significant exceedances were above the five-year 99th percentile and the NAAQS on May 8, 2022. These PM_{10} concentrations are also significantly outside typical seasonal and monthly ranges. 30-year climatology analyses show temperatures, wind speeds, and soil moisture in the Mojave Desert source region and Clark County were significantly outside of the historical normal on the event date.

See Section 3.4.

Not Reasonably Controllable or Preventable

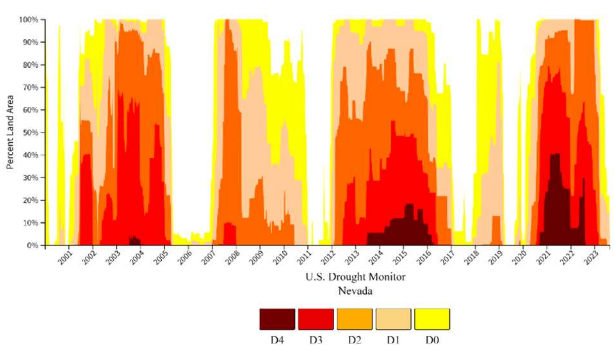


Figure 4.3-3

Based on the severe drought in the source region and the high-wind frontal passage, control measures for PM_{10} concentrations within Clark County were quickly overwhelmed and unable to prevent an exceedance event. Significant evidence shows high winds lofted, entrained, and transported PM_{10} from natural undisturbed lands, and indicates that this event was natural and not reasonably controllable or preventable.

See Section 4 and 5.

2. Background

2.1 Demonstration Description

2.1.1 PM_{10} Exceptional Event Rule Summary

The U.S. EPA EER (EPA, 2016) allows air agencies to omit air quality data from the design value calculation if it can be demonstrated that the measurement in question was caused by an exceptional event. According to EER, exceptional events such as high-wind dust events that affect PM_{10} concentrations can be subject to exclusion from calculations of the NAAQS attainment (i.e., design values) if a clear causal relationship can be established between a specific event and the monitoring exceedance (EPA, 2016). The EER states that an exceptional event demonstration must meet the following six statutory elements:

1. A narrative conceptual model that describes the event(s) causing the exceedance or violation and a discussion of how emissions from the event(s) led to the exceedance or violation at the affected monitor(s),
2. A demonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance or violation,
3. Analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times,
4. A demonstration that the event was both not reasonably controllable and not reasonably preventable,
5. A demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event, and
6. Documentation that the air agency followed the public comment process.

Specifically, a high-wind dust demonstration must show that the dust event is a "natural event," where windblown dust is from natural sources or all significant anthropogenic sources of windblown dust have been reasonably controlled using best available control measures (BACM) (EPA, 2016). Further, air agencies must show that the event met the high-wind threshold of a sustained wind speed of 25 mph or more, or an alternative area-specific high-wind threshold. The high-wind threshold is the minimum wind speed capable of causing PM emissions from natural undisturbed lands. If the 25-mph wind speed threshold was not met, a more detailed analysis is necessary to support the "not reasonably controlled or preventable" criterion. The winds causing the PM_{10} exceedance on May 8, 2022, met the 25-mph sustained wind speed threshold in Clark County and the Mojave Desert dust source region.

2.1.2 Requirements for Demonstration Based on Tier

The EPA "Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Influenced by High Wind Dust Events Under the 2016 Exceptional Events Rule" (U.S. Environmental Protection Agency, 2016) describes a three-tier analysis approach to determine a "clear causal relationship" for exceptional events demonstrations from an air agency. A summary of analysis requirements for each tier is listed in **Table 2.1-1**.

- Tier 1 analysis is applicable when the exceptional event is associated with a large-scale dust storm where recorded visibility is ≤ 0.5 miles, sustained winds are ≥ 40 mph, and is a focus of a Dust Storm Warning.

- Tier 2 analysis is applicable when the impacts of the dust event on PM_{10} levels are less clear and require more supportive documentation than Tier 1 analysis. Tier 2 analysis is warranted when sustained winds during the exceptional event are ≥ 25 mph but does not meet the other thresholds required in Tier 1 analysis.

- Tier 3 analysis is necessary when the impacts of the dust event on PM_{10} levels are more complicated than conditions described in the first two Tiers. Tier 3 analysis is needed when sustained winds during the exceptional event do not meet the 25-mph threshold; events categorized as Tier 3 may require additional analysis such as Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) trajectories from the source area or source-specific emissions inventories.

Table 2.1-1. High-wind PM_{10} exception event guidance requirements by tier

Tier	Requirements

1	• Referred to as "Large-Scale, High-Energy High Wind Dust Events."
	• Does not need justification to support the "not reasonably controllable or preventable" (nRCP) criterion.
	• To satisfy the nRCP criterion, the exceedance(s) must be associated with:
	  - A dust storm that is the focus of a Dust Storm Warning,
	  - Sustained winds that are ≥ 40 mph,
	  - Reduced visibility ≤ 0.5 miles.
	• Must occur over a "large geographic area."

2	• Referred to as "High Wind Dust Events with Sustained Winds at or above the High Wind Threshold."
	• Does not meet criterion of Tier 1 high-wind dust events.
	• High-wind threshold:
	  - Default of ≥ 25 mph for certain states,
	  - Measured as "at least one full hour in which the hourly average wind speed was at or above the area specific high wind threshold;" EPA will consider shorter averaging times as part of the weight-of-evidence demonstration, even if the hourly average was not above the threshold.
	• Must conduct a controls analysis for events where the dust source was anthropogenic:
	  - Identify anthropogenic and natural sources,
	  - Document whether a SIP, FIP, or other control measures addresses the event-related pollutant and all sources,
	  - Confirm effective implementation of control measures.

3	• Referred to as "High Wind Dust Events with Sustained Winds less than the High Wind Threshold."
	• Sustained winds did not meet the threshold (i.e., sustained winds ≤ 25 mph).
	• Requirements same as Tier 2, except with the addition of the following possible analyses:
	  - HYSPLIT trajectories of source area,
	  - Source-specific emissions inventories,
	  - Meteorological and chemical transport modeling,
	  - PM filter chemical speciation analysis where filter-based monitors are used.

2.1.3 Demonstration Outline

The PM_{10} exceedance on May 8, 2022, qualifies for Tier 2 analysis and may be referred to as a high-wind dust event with sustained winds at or above the high-wind threshold of 25 mph. On May 8, a resultant hourly average wind speed greater than the 25-mph threshold was observed within the Las Vegas metropolitan region. Additionally, two-minute Automated Surface Observing Systems (ASOS) data from the Harry Reid International Airport (LAS) shows wind speeds greater than 25 mph throughout the day and sustained wind speeds in the Mojave Desert source region were significantly higher than the 25-mph threshold.

Table 2.1-2 provides a breakdown by section of all required analyses for the high-wind exceptional event. Sections 3.1-3.3 discuss the high-wind event in detail, including a meteorological analysis (Section 3.1), the timeline of the high-wind dust event (Section 3.2), and evidence of the high-wind dust event observed at the surface (Section 3.3). This includes media coverage of (Sections 3.3.2) and ground images during the event (Section 3.3.5). Guidance for a Tier 2 analysis recommends a controls analysis when the dust source is not anthropogenic. Section 2.2 identifies anthropogenic and natural sources of dust. Sections 2.2.1 and 2.2.2 discuss the dust source for the event on May 8, which are natural, undisturbed lands southwest of Las Vegas; these sections also include an analysis of climatological factors that fostered prime conditions for lofted dust. Sections 2.2.3 and 4.1 identify regional emissions and other sources of PM_{10}, and Section 4 identifies control measures against PM_{10} emissions that exist in Clark County.

Table 2.1-2. Analysis elements required for a Tier 2 and 3 high-wind exceptional event by section in this report.

Tier	Elements	Section of This Report (Analysis Type)
2	High-wind dust event	Section 3 (Clear Causal Relationship)
	Sustained wind threshold	Section 3.1.1 (Meteorological Analysis) and 3.2.2 (High-Wind Event Timeline)
	Controls analysis for dust source	Section 2.2.3 (Regional Emissions of PM_{10}), Section 4.1 (Other Possible Source of PM_{10} in Clark County), Section 4.2 (PM_{10} Control Measures in Clark County), Section 4.3 (Reasonableness of Control Measures), and Section 4.4 (Effective Implementation of Control Measures)
3	HYSPLIT trajectories of source area	Section 3.2 (Transport to Clark County)
	Source-specific emissions inventories	Section 2.2.3 (Regional Emissions of PM_{10})
	Meteorological and chemical transport modeling	Section 3.1.1 (Meteorological Analysis)
	PM filter chemical speciation analysis where filter-based monitors are used	Section 3.3.4 (Particulate Matter Analysis)

Following the EPA's exceptional event guidance, we performed Tier 2 and Tier 3 analyses to show the "clear causal relationship" between the high-wind dust event and the PM_{10} exceedance event in Clark County, Nevada, on May 8, 2022. Focusing on the characterization of the meteorology, source region terrain and climatology, transport, and air quality on the days leading up to the event, we conducted the following specific analyses, the results of which are presented in **Section 3**:

- Performed a top-down meteorological analysis to trace the conditions between the surface and 250 millibars (mb) that led to the high-wind event in southern Nevada,
- Compiled maps and imagery of aerosol optical depth (AOD) and regional wind speed from satellite data,
- Showed the transport patterns via HYSPLIT modeling, and identified where the back trajectory air mass intersected with dust sources,
- Compared the timeline of meteorological events, high-wind speeds, and enhanced PM_{10} concentrations,
- Tracked surface meteorological conditions along the transport path between the source region and Clark County,
- Compiled media coverage of the high-wind dust event and ground-based visibility imagery during the event,
- Examined speciated PM concentrations during the event,
- Compared diurnal patterns of PM_{10} during the event to historical measurements,
- Performed meteorologically similar day analysis to assess PM_{10} concentrations on days with comparable wind conditions.

2.1.4 Regulatory Significance

The high-wind dust event that occurred on May 8, 2022, caused 24-hour PM_{10} NAAQS exceedances with regulatory significance at the Paul Meyer (Monitor AQS ID 32-003-0043, POC 1), Walter Johnson (Monitor AQS ID 32-003-0071, POC 1), Palo Verde (Monitor AQS ID 32-003-0073, POC 1), Joe Neal (Monitor AQS ID 32-003-0075, POC 1), Green Valley (Monitor AQS ID 32-003-0298, POC 1), Jerome Mack (Monitor AQS ID 32-003-0540, POC 1), Sunrise Acres (Monitor AQS ID 32-003-0561 POC 1), Liberty High School (Monitor AQS ID 32-003-0299 POC 1), Mountains Edge (Monitor AQS ID 32-003-0044 POC 1), and Walnut Community Center (Monitor AQS ID 32-003-2003 POC 1) monitoring sites. 24-hour PM_{10} exceedance values are listed in **Table 2.1-3**.

Table 2.1-3. 24-hour PM_{10} concentrations recorded at the sites that experienced an exceedance of the NAAQS on May 8, 2022.

Monitor AQS ID – POC	Site Name	24-hour PM_{10} Exceedance Concentration (µg/m^3)
32-003-0043-1	Paul Meyer	229
32-003-0044-1	Mountains Edge	258
32-003-0071-1	Walter Johnson	204
32-003-0073-1	Palo Verde	220
32-003-0075-1	Joe Neal	188
32-003-0298-1	Green Valley	215
32-003-0299-1	Liberty High School	242
32-003-0540-1	Jerome Mack	196
32-003-0561-1	Sunrise Acres	219
32-003-2003-1	Walnut Community Center	249

A NAAQS exceedance that is approved by the EPA as an exceptional event may be excluded from regulatory examination under the Exceptional Events Rule. Seven additional suspected wind-blown dust events occurred in Clark County between 2021 and 2023. Table 2.1-4 shows the 2021-2023 design values at each of these 10 monitoring sites with and without EPA concurrence on proposed exceptional PM_{10} events between 2021 and 2023.

Table 2.1-4. 2021-2023 design values at monitoring sites in the Las Vegas Valley without and with EPA concurrence that the May 8, 2022, and other suspected events qualify as exceptional events.

Monitor Site Name	Design Value Without EPA Concurrence	Design Value With EPA Concurrence
Paul Meyer	2.0	0.0
Walter Johnson	2.3	0.3
Palo Verde	1.7	0.0
Joe Neal	2.3	0.3
Green Valley	2.7	0.0
Jerome Mack	3.7	0.3
Sunrise Acres	3.0	0.3
Liberty High School	3.0	0.3
Walnut Community Center	4.0	1.0
Mountains Edge	1.7	0.3

Further details on the design values with and without concurrence, as well as data completeness, may be found in the Initial Notification Summary Information (INI) submitted by Clark County, DES to EPA Region 9 on February 12, 2024.

We request that the EPA evaluate the following assessment of the wind-blown dust event that occurred in Clark County on May 8, 2022, and agree to exclude the event from regulatory decisions regarding PM_{10} attainment.

2.2 Historical Non-Event Model

2.2.1 Land Type for Source Region and Clark County

Land use and cover type data from both 2019 National Land Cover Database (NLCD) (Dewitz, 2021) and Sentinel-2 satellite are shown for the approximate source region of Mojave Desert in southeastern California (Figure 2.2-1). The primary land classifications in this region, shown by the Sentinel-2 Land Use/Land Cover map, are bare ground and rangeland, with small pockets of forest and built area. Bare ground is defined as "areas of rock or soil with very sparse to no vegetation for the entire year; large areas of sand and deserts with no to little vegetation." Rangeland is defined as "open areas covered in homogenous grasses with little to no taller vegetation; wild cereals and grasses with no obvious human plotting." The primary classifications shown by the 2019 NLCD map are mostly shrub/scrub, grasslands/herbaceous, and barren land (rock/sand/clay). Classifications from both maps indicate that the source region is primarily land with little to no vegetation cover with natural sources of dust that are predisposed to high-wind events.

Figure 2.2-2 shows the land use and cover of Clark County and the surrounding area. The dominant land cover type in Clark County and the surrounding area is rangeland with pockets of bare ground and built area. Built area is defined as "human made structures; major road and rail networks; large homogenous impervious surfaces including parking structures, office buildings, and residential housing." Central Clark County (i.e., Las Vegas and surrounding communities) is mostly classified as built area with some small areas of bare ground, surrounded by rangeland.

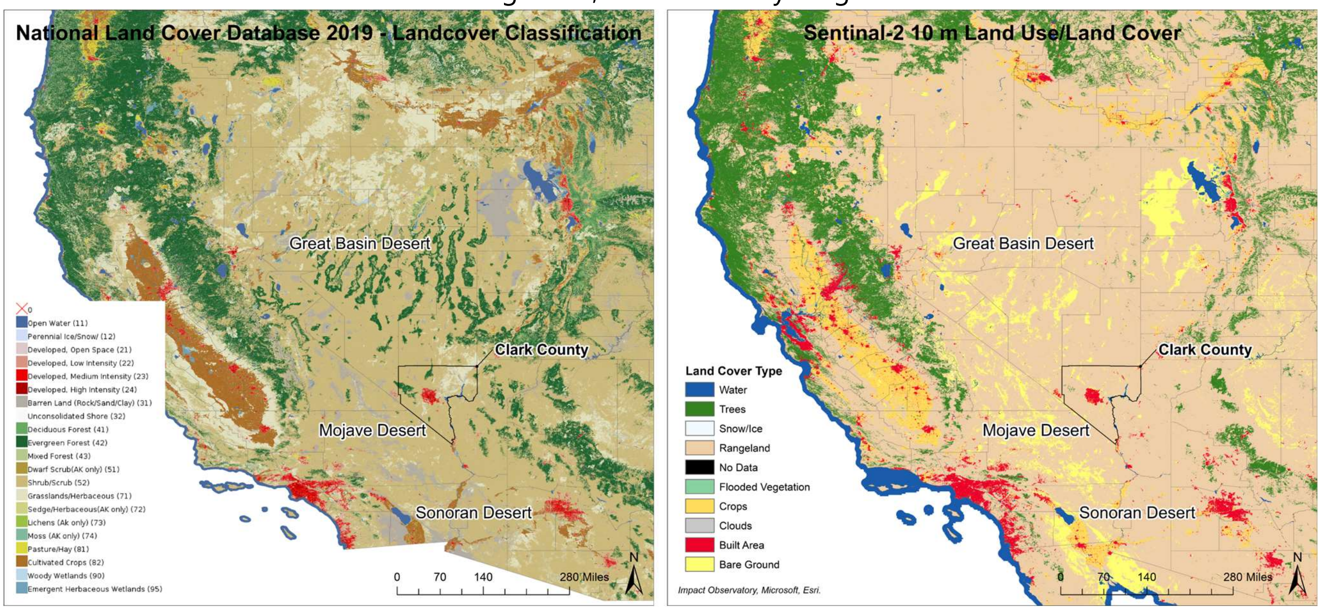


Figure 2.2-1. Land cover type for the western U.S. from (left) the National Land Cover Database-2019 and (right) Sentinel-2 satellite.

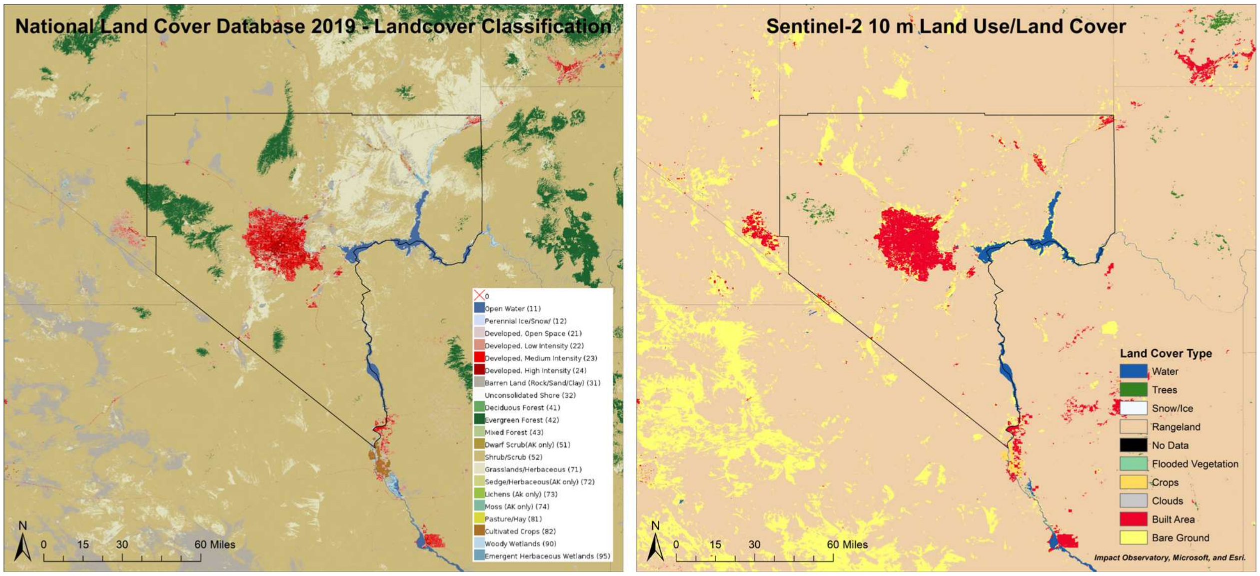


Figure 2.2-2. Land cover type for Clark County, Nevada, and surrounding area from the (left) the National Land Cover Database-2019 and (right) Sentinel-2 satellite.

2.2.2 Climatology for Source Region and Clark County

The source region is the Mojave Desert in southeastern California. The Mojave Desert is part of the Mojave Basin and Range Ecoregion, which is located primarily in southern California and southern Nevada (including Clark County), with smaller portions in Arizona and Utah (Sleeter and Raumann, 2012). In general, the roughly 130,000 km^2 ecoregion is composed of broad basins and scattered mountains that are generally lower, warmer, and drier than those of the Central Basin and Range (which border the ecoregion to the north and covers the majority of Nevada). The ecoregion climate is characterized by high temperatures during summer months and very little annual precipitation (50–250 mm in the valleys). In addition to the Mojave Desert, the ecoregion includes other desert areas in southeastern California and southern Nevada. The Mojave Desert is the driest of the deserts that comprise the greater North American Desert. This is due in part to the presence of the Sierra Nevada Mountain ranges to the west, which produce a rain shadow effect that inhibits significant moisture from reaching the Desert. Additionally, heavy use of off-road vehicles and motorcycles in some areas has made the soils susceptible to wind and water erosion (Griffith et al. 2016).

Clark County is located in the southern portion of Nevada and borders California and Arizona. Clark County includes the City of Las Vegas, one of the fastest growing metropolitan areas in the United States with a population of approximately 2.2 million (U.S. Census Bureau, 2020). Las Vegas is located in a 1,600 km^2 desert valley basin at 500 to 900 m above sea level (Langford et al., 2015). It is surrounded by the Spring Mountains to the west (3,000 m elevation) and the Sheep Mountain Range to the north (2,500 m elevation). Three mountain ranges comprise the southern end of the valley. The valley floor slopes downward from west to east, which influences surface wind, temperature, precipitation, and runoff patterns. The Cajon Pass and I-15 corridor to the east is an important atmospheric transport pathway from the Los Angeles Basin into the Las Vegas Valley (Langford et al., 2015).

The Las Vegas Valley climatology features abundant sunshine and hot summertime temperatures (average summer month high temperatures of 34 °C to 40 °C). Because of the mountain barriers to moisture inflow, the region experiences dry conditions year-round (~107 mm annual precipitation, 22% of which occurs during the summer monsoon season from July through September). The urban heat island effect in Las Vegas during summer leads to large temperature gradients within the valley, with generally cooler temperatures on the eastern side. During the summer season, monsoon moisture brings high humidity and thunderstorms to the region, typically in July and August (National Weather Service Forecast Office, 2020). Winds in the Las Vegas basin tend to be out of the southwest during spring and summer (Los Angeles is upwind), while winds in the fall and winter tend to be out of the northwest, with air transported between the neighboring mountain ranges and along the valley.

Compared to the long-term climate record in the Las Vegas Area, the days leading up to the May 8, 2022, exceedance experienced normal to above-normal maximum daily temperatures. Concurrently, precipitation accumulation for the Las Vegas Area was below normal for early May (**Figure 2.2-3** and **Figure 2.2-4**).

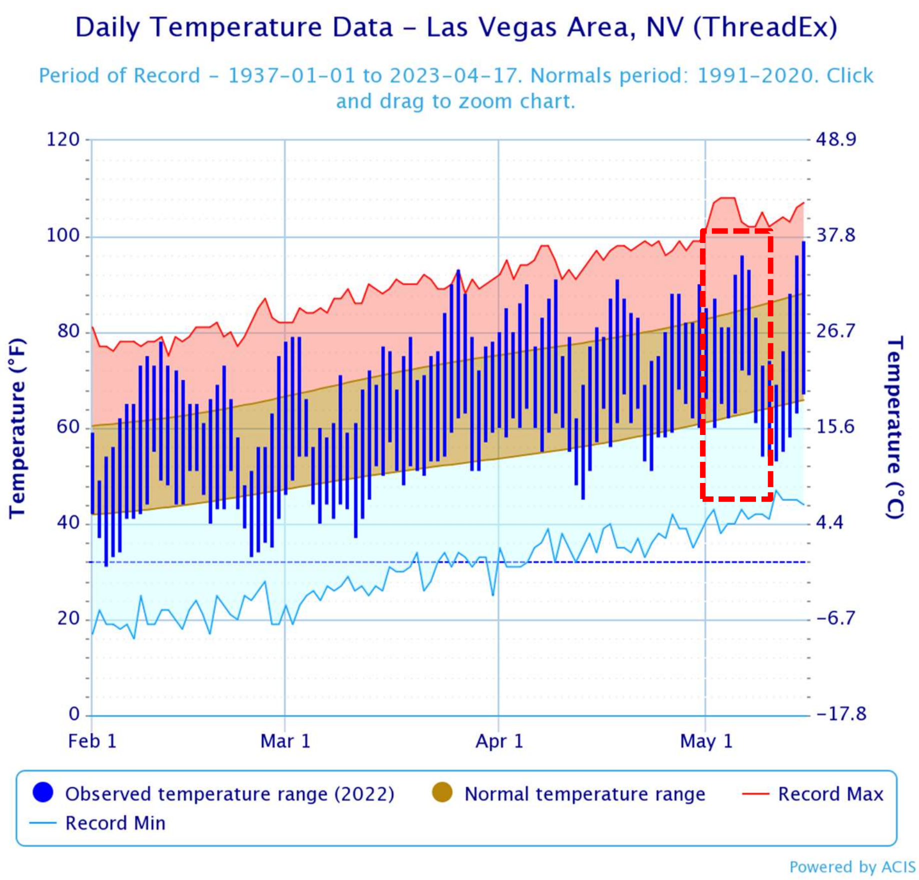


Figure 2.2-3. The temperature records for the Las Vegas area in Nevada from January 1, 1937, through December 26, 2022, by day, including (dark blue) observed temperature range 2022, (brown) normal temperature range, (red) record maximum, and (light blue) record minimum. The red box indicates the dates of above normal heat before the May 8, 2022, event. Data from the National Weather Service (NWS): https://www.weather.gov/wrh/Climate?wfo=vef.

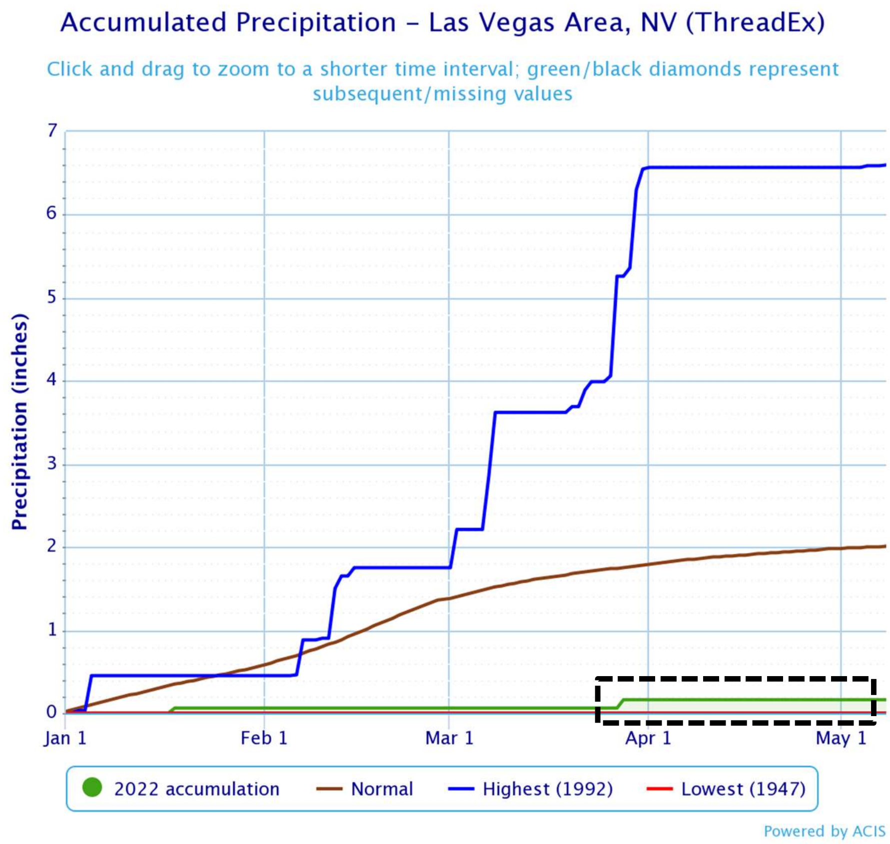


Figure 2.2-4. The precipitation records the Las Vegas area in Nevada by day, including (green) accumulation in 2022, (brown) normal, (blue) record maximum, and (red) record minimum. The black box indicates the period of low accumulated precipitation before the May 8, 2022, event. Data from NWS: https://www.weather.gov/wrh/Climate?wfo=vef.

The extreme hot and dry conditions in 2022 are also highlighted by the Palmer Drought Severity Index (PDSI) produced by the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Protection (NCEP). The areas of the western U.S. that experienced "extreme drought" conditions progressively increased in size and severity in the months before the PM_{10} exceedance (Figure 2.2-5). By May 8, 2022, all counties in Nevada were classified as in a severe-to-extreme drought.

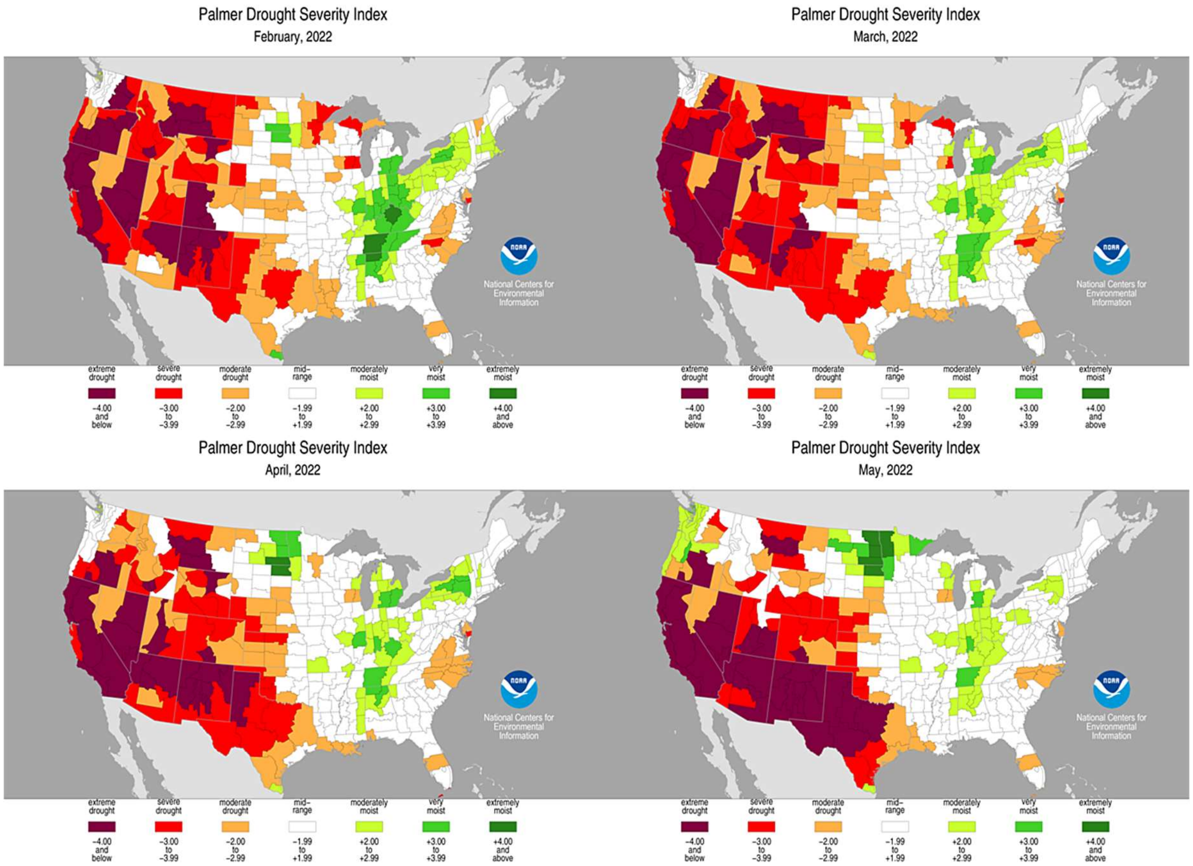
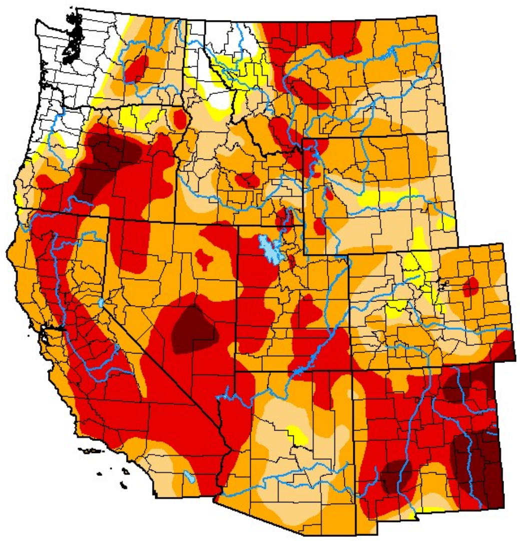


Figure 2.2-5. Palmer Drought Severity Index for February to May 2022.

On May 10, 2022, the western U.S. was under widespread drought conditions (**Figure 2.2-6**). The source region for this event was under severe-to-extreme drought (D2 - D4). By May 10, 2022, all (100%) of Nevada was included in the drought (**Figure 2.2-7**).

U.S. Drought Monitor
West



May 10, 2022
(Released Thursday, May. 12, 2022)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	5.28	94.72	90.85	72.57	34.31	4.58
Last Week 05-03-2022	4.68	95.32	91.33	72.86	30.69	4.63
3 Months Ago 02-08-2022	3.89	96.11	87.92	64.07	19.29	3.23
Start of Calendar Year 01-04-2022	3.68	96.32	89.29	64.90	23.85	3.94
Start of Water Year 09-28-2021	2.21	97.79	89.60	75.38	52.46	18.40
One Year Ago 05-11-2021	5.13	94.87	84.94	66.25	46.87	22.42

Intensity:
None
D0 Abnormally Dry
D1 Moderate Drought
D2 Severe Drought
D3 Extreme Drought
D4 Exceptional Drought

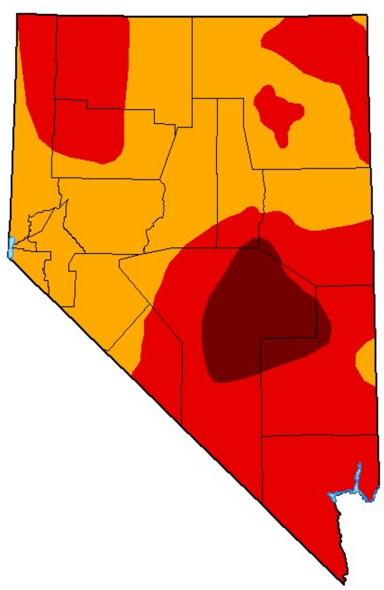
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:
David Simeral
Western Regional Climate Center

droughtmonitor.unl.edu

Figure 2.2-6. U.S. Drought Monitor values for the western U.S. on May 10, 2022.

U.S. Drought Monitor
Nevada



May 10, 2022
(Released Thursday, May. 12, 2022)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	100.00	54.87	8.27
Last Week 05-03-2022	0.00	100.00	100.00	100.00	51.65	8.27
3 Months Ago 02-08-2022	0.00	100.00	100.00	66.86	21.84	7.50
Start of Calendar Year 01-04-2022	0.00	100.00	100.00	68.07	24.21	7.50
Start of Water Year 09-28-2021	0.00	100.00	100.00	95.18	67.60	25.02
One Year Ago 05-11-2021	0.00	100.00	100.00	94.53	75.45	40.58

Intensity:
None
D0 Abnormally Dry
D1 Moderate Drought
D2 Severe Drought
D3 Extreme Drought
D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:
David Simeral
Western Regional Climate Center

droughtmonitor.unl.edu

Figure 2.2-7. U.S. Drought Monitor values for the Nevada on May 10, 2022.

There are several Automated Surface Observing Systems (ASOS) weather measurement sites in the wind-blown dust source region with data spanning multiple decades (Figure 2.2-8). Figure 2.2-9 shows the distribution of the maximum daily temperatures at several sites in the wind-blown dust source region on May 7 and 8 (from 1991 through 2021). The median maximum daily temperature varies in the source region, but range from approximately 65 °F to 84 °F.

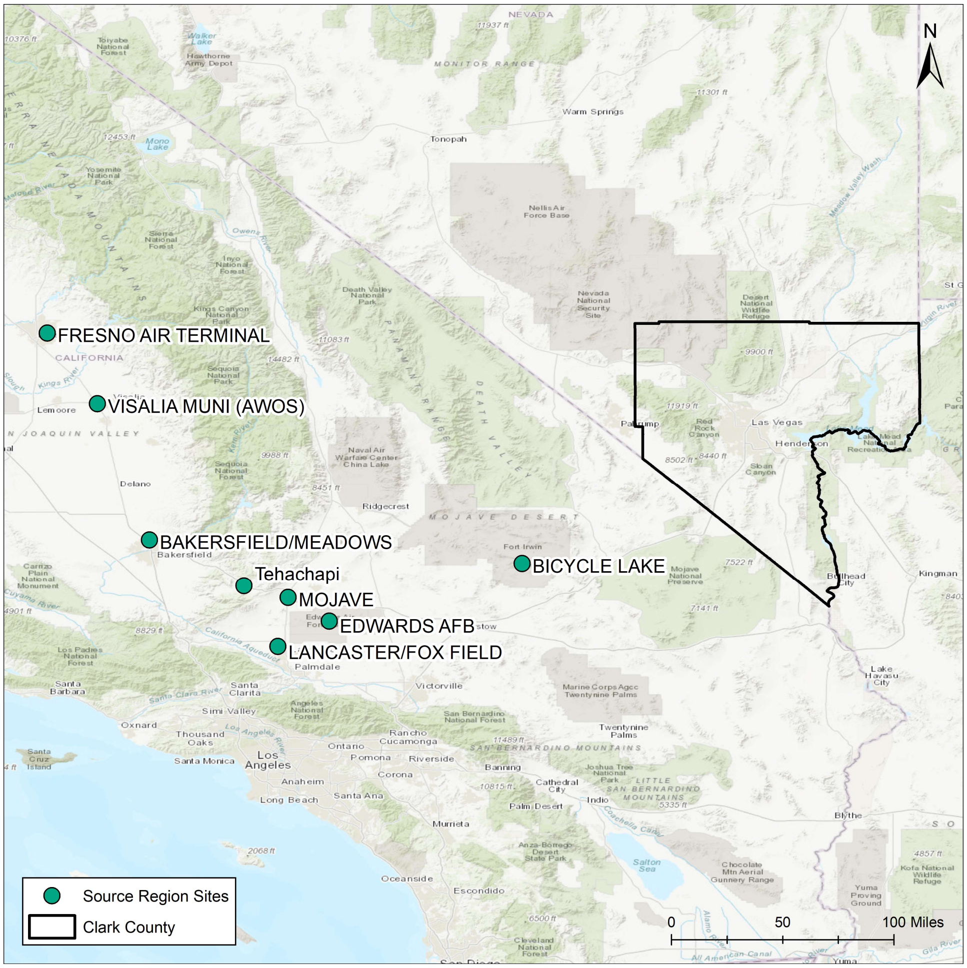


Figure 2.2-8. Location of ASOS measurement sites in the wind-blown dust source region.

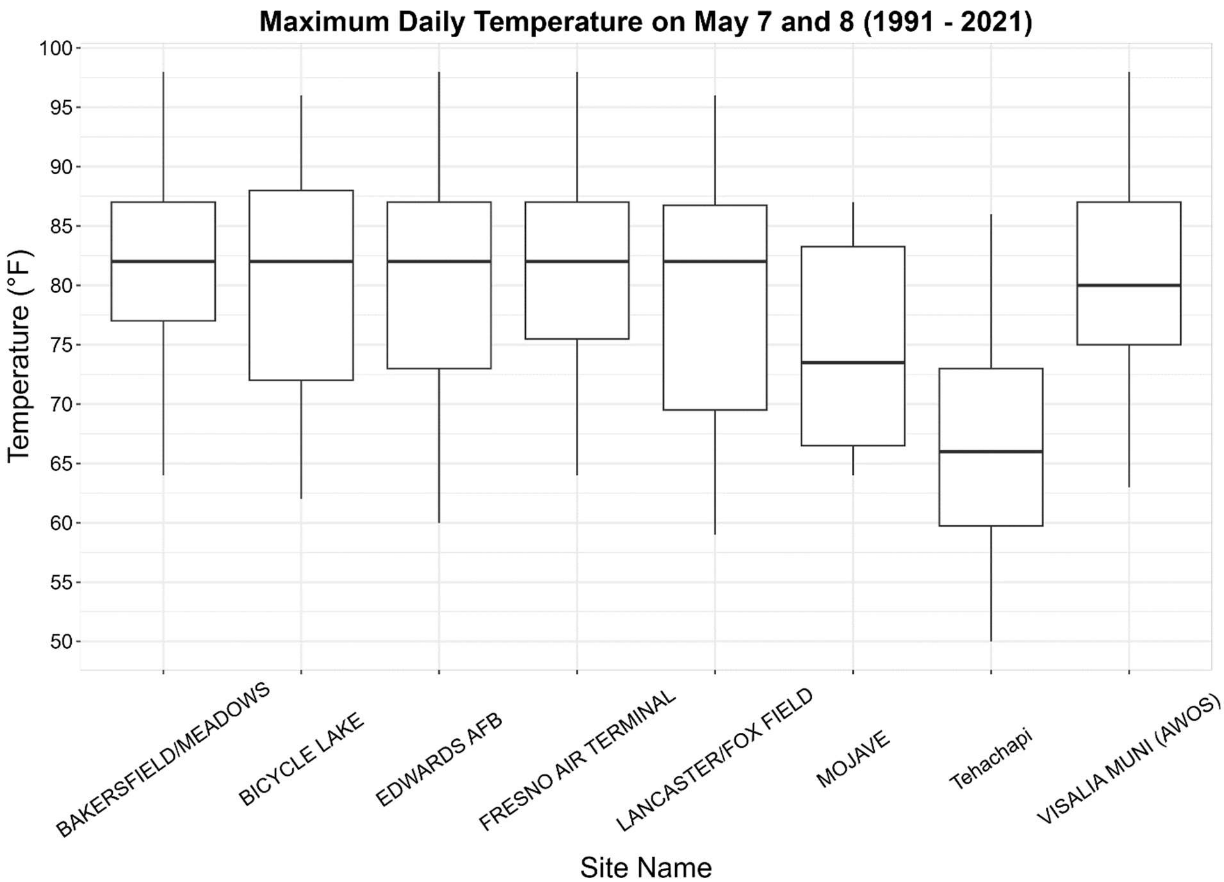


Figure 2.2-9. The average maximum daily temperature on May 7 and May 8 from 1991 through 2021.

2.2.3 Regional Emissions of PM_{10}

Open lands account for approximately 86% of the total area of Clark County (~4.3 million acres), followed by incorporated lands at 8% (~400,000 acres), tribal lands at 1.5% (~80,000 acres), and the remaining planned land use categories at a combined 4.5% (~242,000 acres) (Figure 2.2-10). Open lands and incorporated Clark County largely align with bare ground and rangeland (see Figure 2.2-2), suggesting that dust may have been picked up in Clark County during the high-wind event.

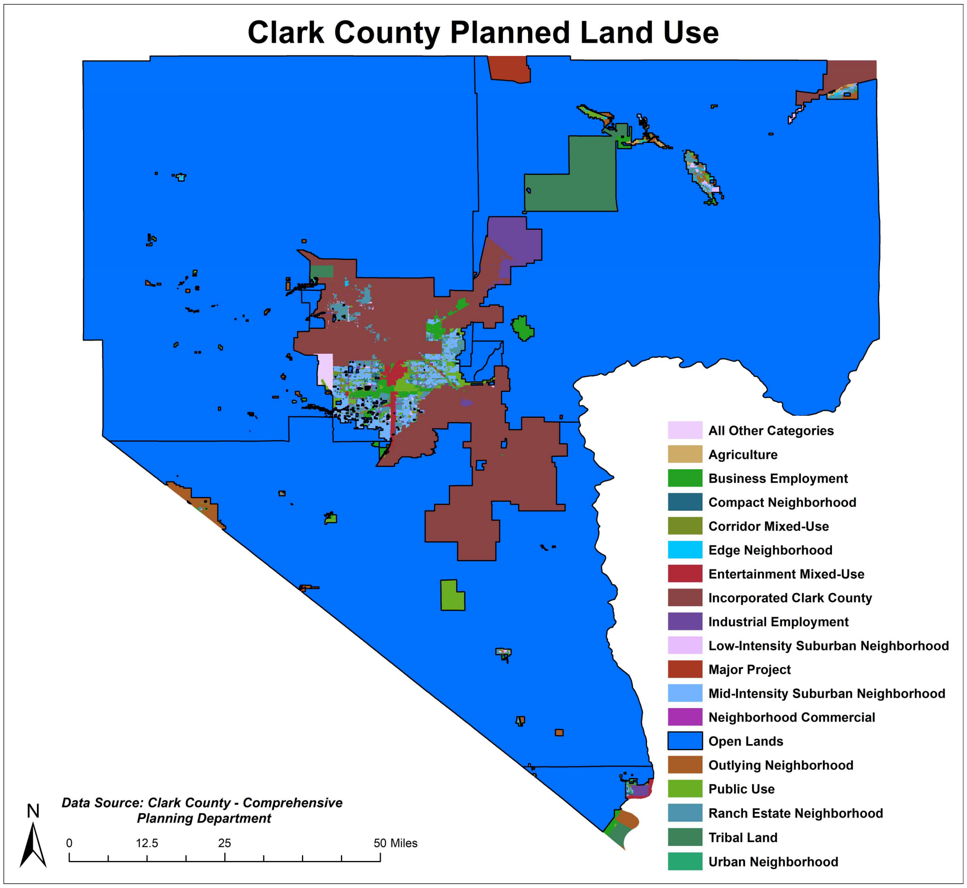


Figure 2.2-10. Planned land-use boundaries of Clark County.

Planned land use around the Green Valley site is comprised of incorporated Clark County (Figure 2.2-11). The site is situated at the north-central end of a recreational sports complex. Much of the surrounding area to the north and west of the site is occupied by buildings, including baseball fields and single-family homes, and paved surfaces consisting of parking lots and roads, with little exposed dirt or gravel. The sports complex consists of a mixture of dirt and grassy fields, paved surfaces, and patches of trees.

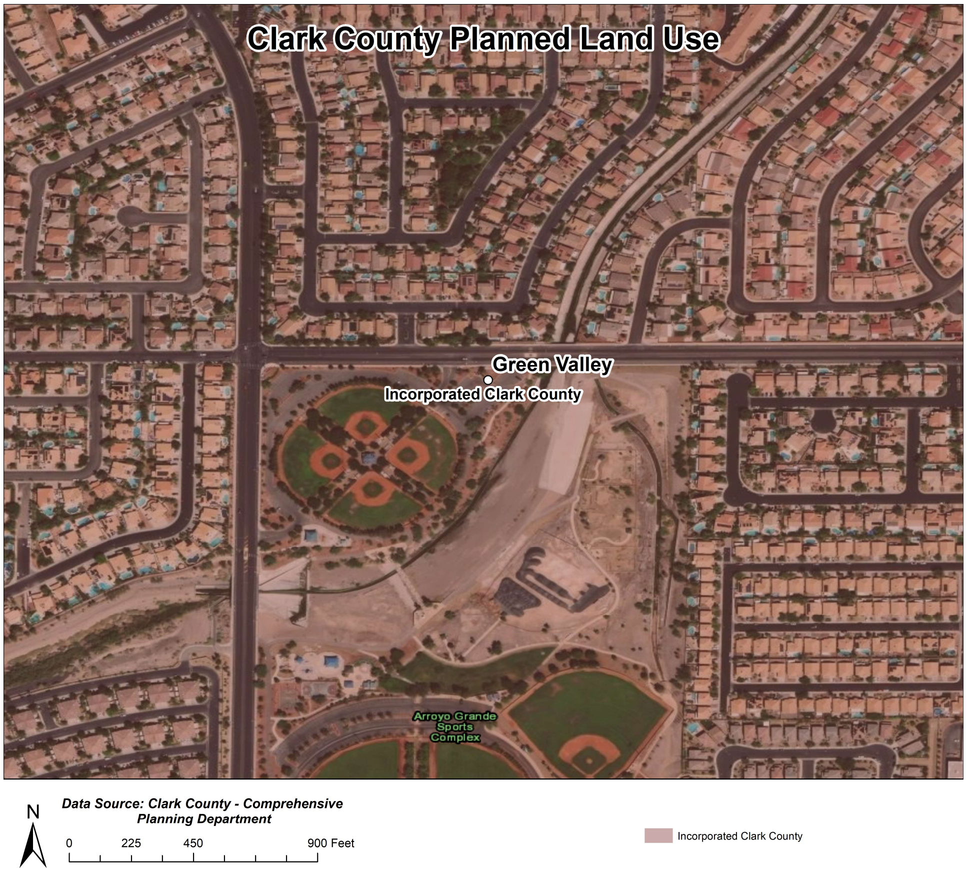


Figure 2.2-11. Planned land-use boundaries in the area around the Green Valley station.

Planned land use around the Jerome Mack site is comprised of public use to the west (Jerome Mack Middle School campus), a mid-intensity suburban neighborhood to the south, an urban neighborhood to the southeast, a compact neighborhood to the northeast, and business employment to the north and northwest. An aqueduct borders the Jerome Mack site immediately to the north (Figure 2.2-12). Much of the surrounding area includes buildings and paved surfaces consisting of parking lots and roads, with little exposed dirt or gravel.

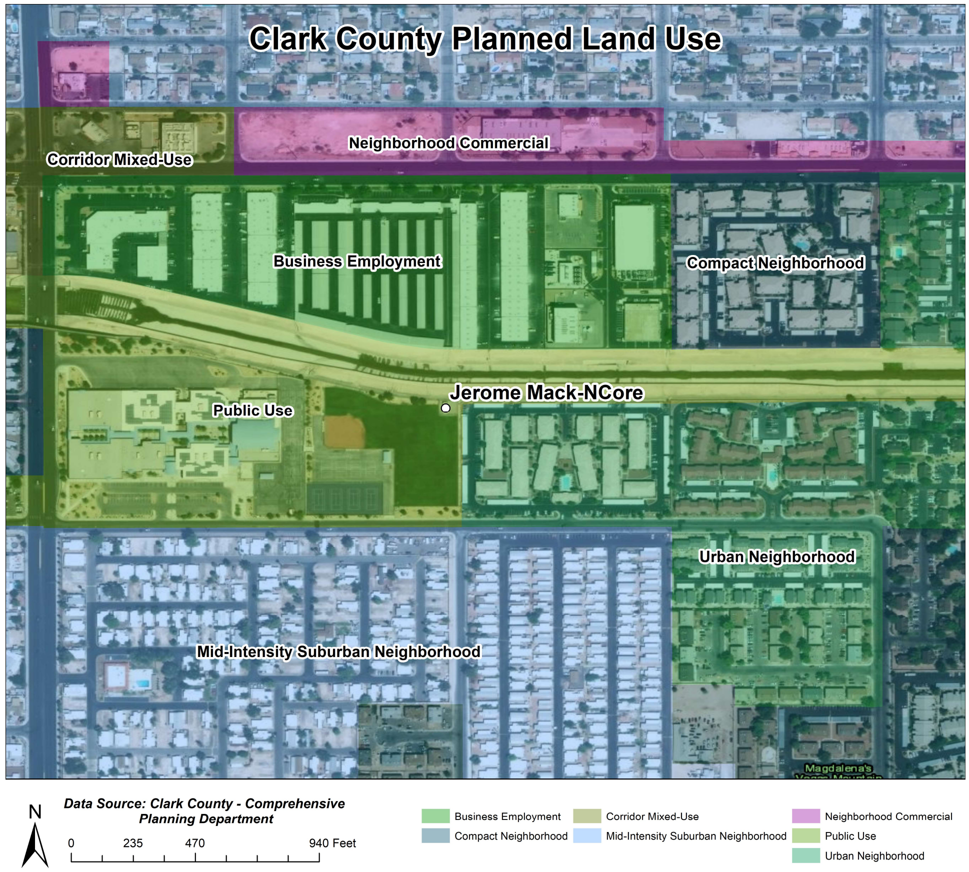


Figure 2.2-12. Planned land-use boundaries in the area around the Jerome Mack station.

Planned land use around the Joe Neal site is largely incorporated Clark County, as well as Ranch Estate Neighborhood to the west (Figure 2.2-13). Both of these uses are largely residential, with little exposed dirt or gravel; however, vacant lots are visible to the east and southeast of the monitor.

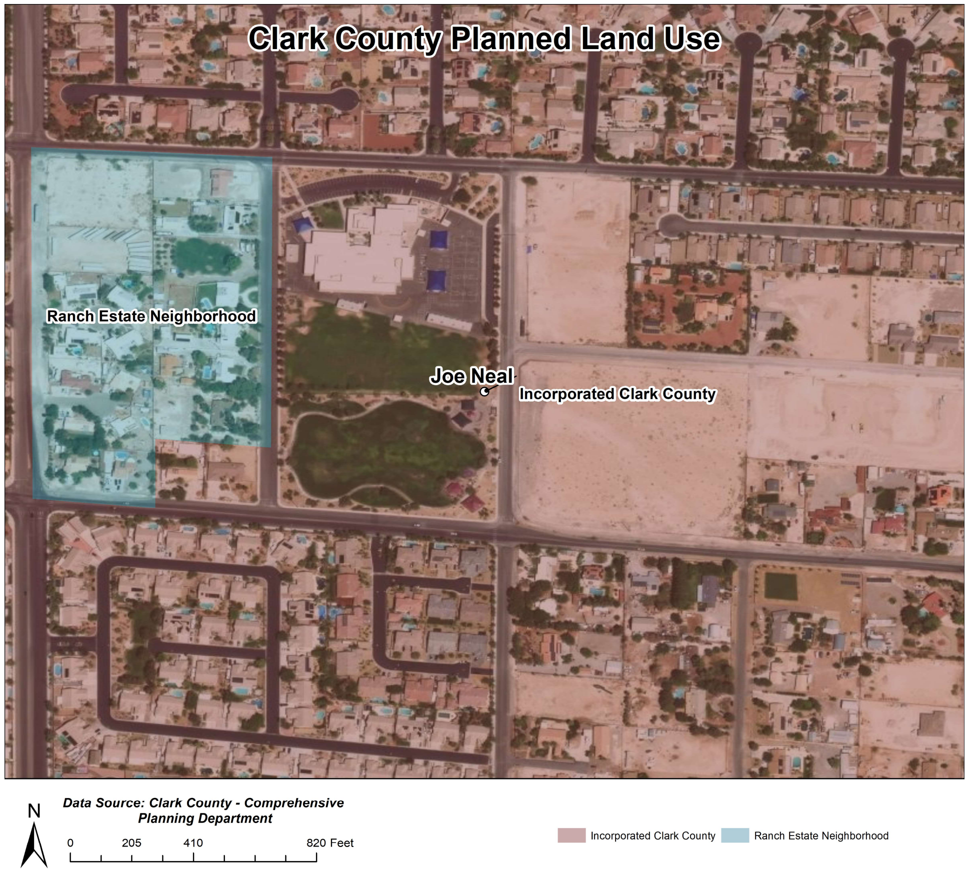


Figure 2.2-13. Planned land-use boundaries in the area around the Joe Neal station.

Planned land use around the Liberty High School site is comprised of incorporated Clark County, Ranch Estate neighborhood, neighborhood commercial, and mid-intensity suburban neighborhood to the west, and mid-intensity suburban neighborhood and corridor mixed-use to the east (Figure 2.2-14). The Liberty High School site is at the southeastern edge of the Liberty High School campus near a baseball field and bordering a road. With the exception of the baseball field and a small strip of shrubs, grass, dirt, and gravel to the east, the immediate area surrounding the Liberty High School site are mostly paved surfaces with little exposed dirt and gravel.

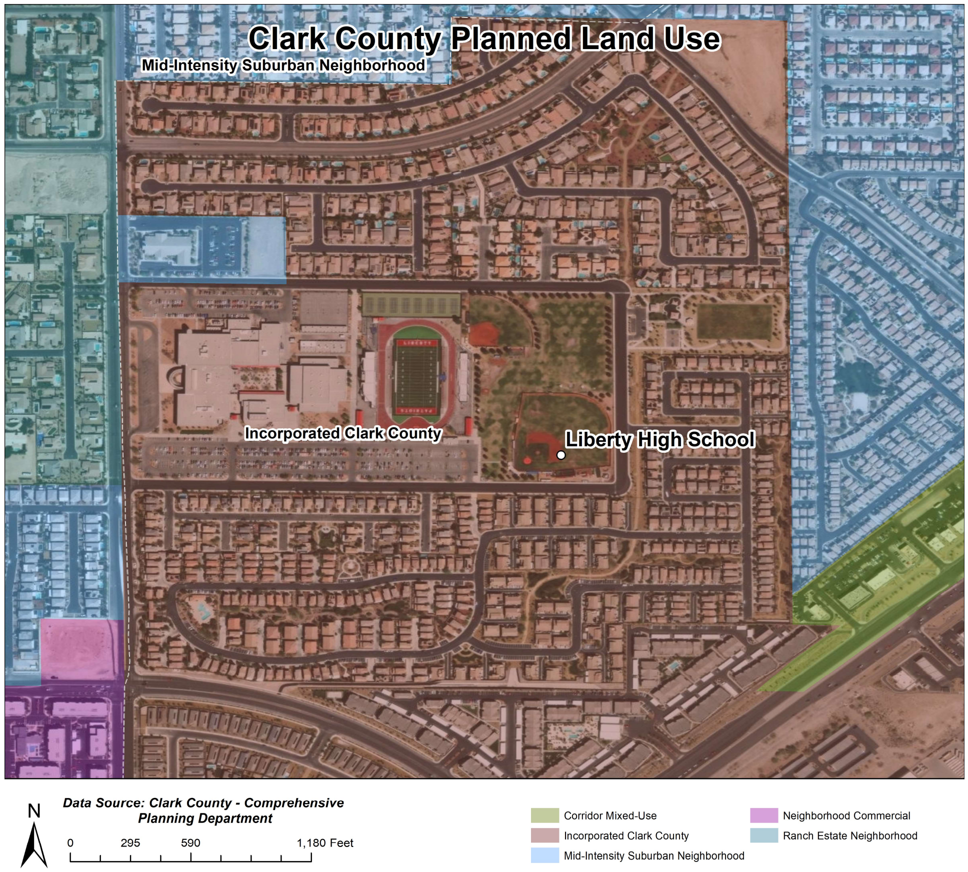


Figure 2.2-14. Planned land-use boundaries in the area around the Liberty High School station.

Planned land use around the Mountains Edge Park site is comprised of open lands to the south and mid-intensity suburban neighborhood to the north (Figure 2.2-15). Corridor mixed-use land exists to the east of the site, but it is largely residential. The Mountains Edge Park site is at the north end of Mountains Edge Regional Park, which consists of open grassy fields, baseball fields, parking lots, and short trees. Open lands outside of the park boundary are undeveloped and mostly dirt and gravel, which may contribute to local dust during high-wind events.

Figure 2.2-15. Planned land-use boundaries in the area around the Mountains Edge station.

Planned land use around the Palo Verde site is comprised entirely of incorporated land (Figure 2.2-16). Much of the surrounding area is buildings and paved surfaces consisting of parking lots and roads. The site is approximately one mile east of the 215 highway and has an aqueduct on its southern border. With the exception of baseball fields to the west, there is virtually no area with exposed dirt or gravel.

Figure 2.2-16. Planned land-use boundaries in the area around the Palo Verde station.

Planned land use around the Paul Meyer site is comprised entirely of public use and mid-intensity suburban neighborhoods (Figure 2.2-17). The site is highly residential, and, with the exception of a neighboring baseball field, there is virtually no area with exposed dirt or gravel.

Figure 2.2-17. Planned land-use boundaries in the area around the Paul Meyer station.

Planned land use around the Sunrise Acres site is comprised mostly of incorporated land (Figure 2.2-18). Residential areas, including compact neighborhoods, mid-intensity suburban neighborhoods, and commercial neighborhoods are also present to the south. Much of the surrounding area is buildings and paved surfaces consisting of parking lots and roads, with little exposed dirt or gravel. A vacant, undeveloped lot and a baseball field are present nearby, which may contribute to local dust during high-wind events.

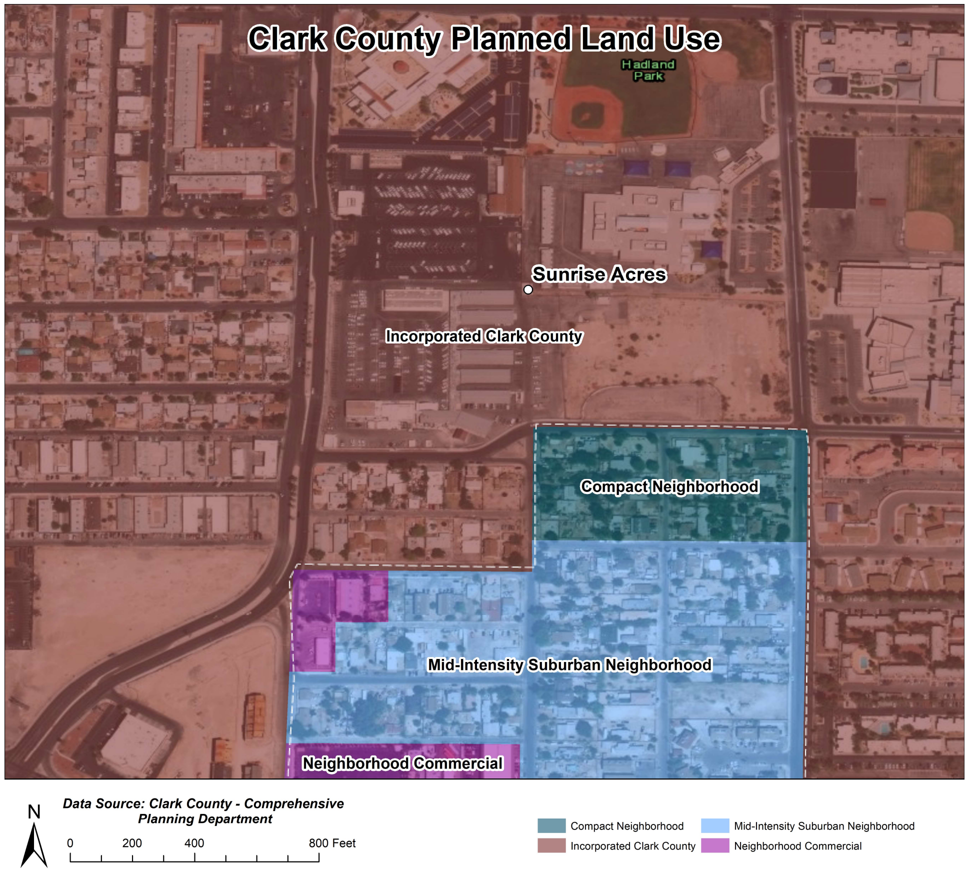


Figure 2.2-18. Planned land-use boundaries in the area around the Sunrise Acres station.

Planned land use around the Walnut Community Center site is comprised of public use (Walnut Park) and business employment to the south (Figure 2.2-19). With the exception of grass fields to the west and east, there is virtually no area with grass or exposed dirt or gravel.

Figure 2.2-19. Planned land-use boundaries in the area around the Walnut Community Center station.

Planned land use around the Walter Johnson site is comprised entirely of incorporated Clark County (Figure 2.2-20). The site is highly residential with little exposed dirt or gravel. The site is also neighboring a city park, which contains some bare ground.

Figure 2.2-20. Planned land-use boundaries in the area around the Walter Johnson station.

Figure 2.2-21 shows the 2020 National Emissions Inventory (NEI) PM_{10} point sources around the affected sites, where the size of the point source marker is proportional to the total annual of PM_{10} emissions. The map shows that most sites are not near any major point sources. For example, there are no PM_{10} point sources within approximately 2 miles of the Jerome Mack site, and the closest point sources emit less than 3 tons of PM_{10} annually. The Green Valley site is approximately 3 miles from the nearest point sources, which includes 3 sites to the east emitting up to 8-18 tons of PM_{10} annually, and 1 site to the north that emits 4-7 tons of PM_{10} annually.

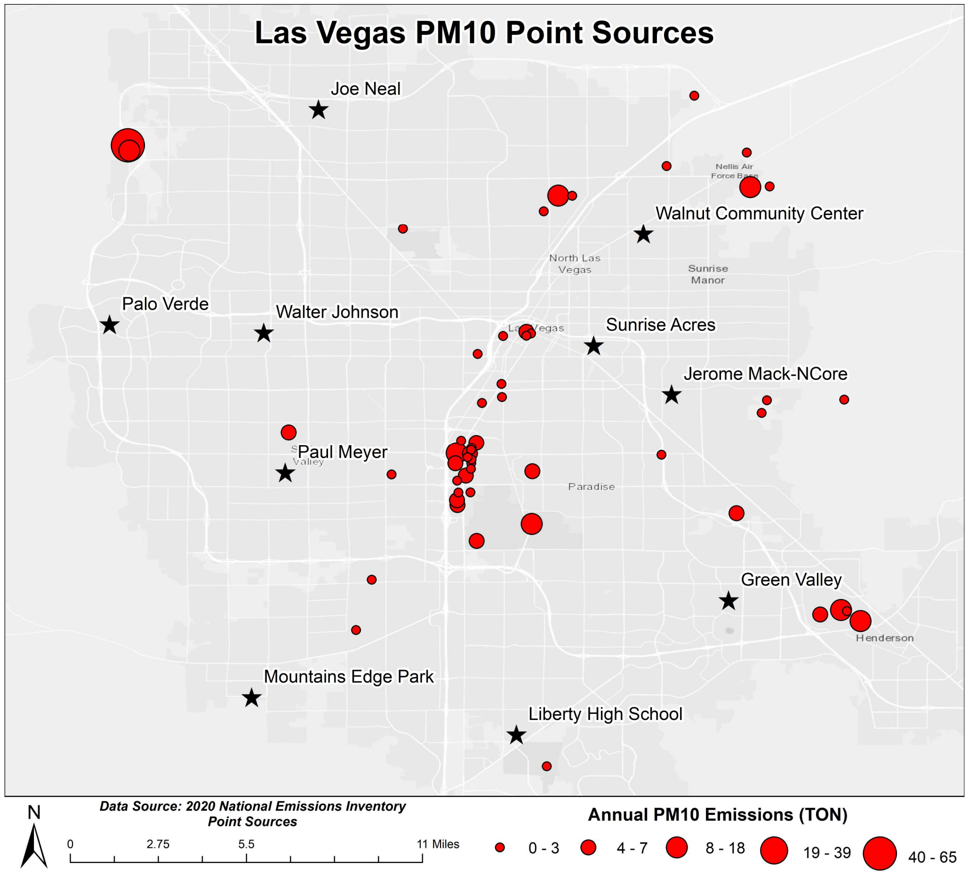


Figure 2.2-21. 2020 National Emissions Inventory (NEI) point sources of PM_{10}.

Clark County provided information on all PM_{10} emissions as part of the 2012 "Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10})" document. Point sources contributed 0.31% of PM_{10} emissions in 2008 and are projected to contribute 0.59% of PM_{10} emissions in 2023. Given the small contribution of point sources to total PM_{10} emissions and the lack of significant point sources near the sites, it is unlikely that point sources contributed to the May 8, 2022, exceedance.

Nonpoint sources in Clark County contribute greater than 98% of PM_{10} emissions. The assessment shows a reduction of 31% in total PM_{10} emissions between 2008 and 2023, with notable decreases in the contribution of wind erosion (vacant lands) to total PM_{10} emissions between 2008 and 2023 (Figure 2.2-22). Increasing contributions from construction-related emissions are due to increasing conversion of vacant lands to built areas. Therefore, there has been an increasing contribution to total emissions from wind erosion from construction, paved roads, construction, and other sources. As shown in Figure 2.2-10 through Figure 2.2-20, many sites are not near major paved roads. For example, the Jerome Mack site is approximately a quarter of a mile away from a major paved road source (S Lamb Blvd), as is the Green Valley site (N Stephanie St). Thus, paved roads and on-road emissions likely did not contribute to the May 8, 2022, exceedance. The Sunrise Acres site is approximately 530 feet from the nearest major paved road source (N Eastern Ave), so these emissions may be more likely to impact this site.

A Dust Advisory (and Dust Storm Warning) was issued for Sunday, May 8, 2022, due to blowing dust via southwesterly winds from the Mojave Desert. A Dust Advisory requires construction sites to immediately inspect their construction sites, implement BACM, and avoid blasting activities at threshold wind speeds to mitigate windblown dust. Additionally, during a Dust Advisory, compliance officers will inspect construction and stationary source sites during the dust event to ensure BACM are being implemented, with any violations receiving a Notice of Violation.

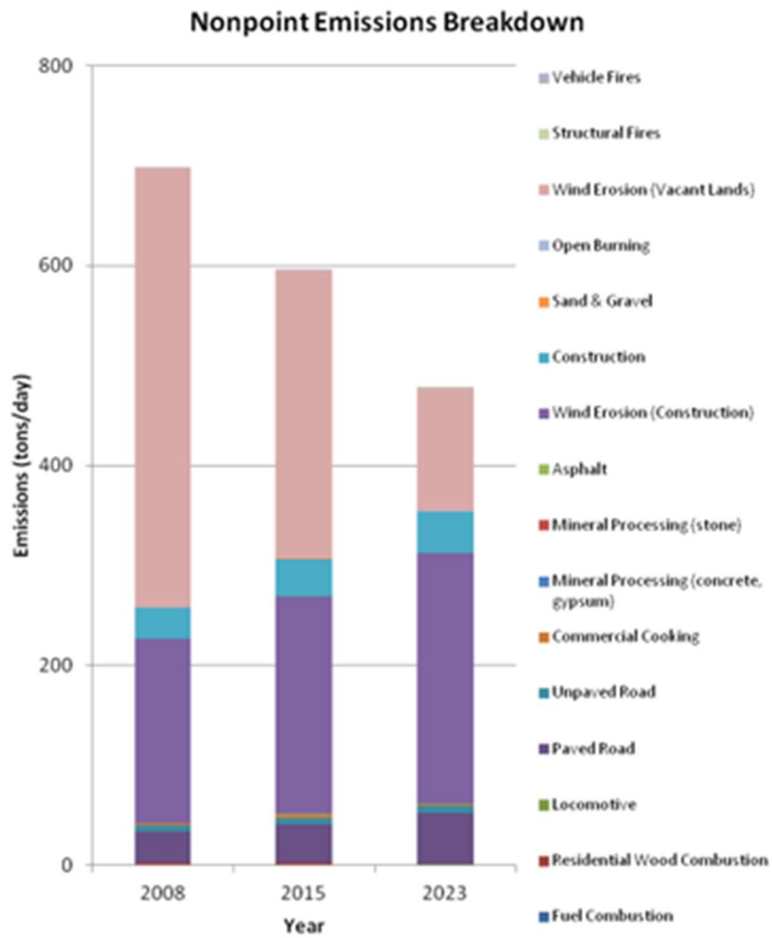


Figure 2.2-22. Nonpoint emissions inventory breakdown from the 2012 "Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10})" document.

2.2.4 Historical Analysis of PM_{10} in Clark County

Table 2.2-1 displays a statistical summary of 24-hour average PM_{10} concentrations from the five years preceding the event (2018-2022) at all sites which exceeded the 24-hour PM_{10} NAAQS in Clark County on May 8, 2022; the Casino Center, Green Valley, Jean, Jerome Mack, Joe Neal, Liberty High

School, Mountains Edge Park, Palo Verde, Paul Meyer, Sunrise Acres, Virgin Valley High School, Walnut Community Center, and Walter Johnson sites. Although not regulatorily significant, the table includes statistics for Casino Center, Jean, and Virgin Valley High School monitoring sites to examine the regional effect of the high-wind dust event. Note that data collection did not begin until 2021, at five sites; thus, summary statistics are shown for the data available through December 2022 for these sites. Mean concentrations range from 20 to 42 $\mu g/m^3$ and medians range from 16 to 37 $\mu g/m^3$.

Table 2.2-1. Five-year* statistical summary of 24-hour average PM_{10} concentration at the affected sites from 2018 – 2022.

Statistic (µg/m³)	Casino Center*	Green Valley	Jean	Jerome Mack	Joe Neal	Liberty High School*	Mountains Edge Park*	Palo Verde	Paul Meyer	Sunrise Acres	Virgin Valley High School*	Walnut Community Center*	Walter Johnson
Mean	36	25	20	35	28	31	23	20	24	36	23	42	23
Median	31	21	16	31	25	26	18	17	21	32	19	37	20
Mode	27	20	17	31	26	18	16	15	18	25	14	36	17
St. Dev	27	24	18	25	23	32	22	16	19	25	18	35	19
Minimum	7	2	1	4	2	2	1	2	3	4	3	7	3
95th percentile	70	49	47	66	52	62	47	40	47	72	49	76	44
99th percentile	129	108	89	116	85	201	104	67	88	105	104	181	78
Maximum	318	586	236	445	513	365	325	333	335	468	200	470	341
Range	311	584	235	441	511	363	324	331	332	464	197	463	338
Count	303	1,820	1,795	1,790	1,813	610	819	1,796	1,814	1,796	714	579	1,822
Exceedances (> 150 µg/m³)	3	9	7	13	7	8	5	4	6	11	3	10	7

*Sites that began data collection less than 5 years ago, and statistics were taken for the time data collection began until December 2022, as indicated by the value in the 'count' row.

Seasonal and monthly trends in the 24-hour average PM_{10} concentration data for the five years preceding the event (2018-2022) are shown in boxplots in Figure 2.2-23 and Figure 2.2-24. The lower and upper edges of the box correspond to the interquartile range (the 25th and 75th percentiles, respectively), and the middle bar is the median value. The whiskers extend to the smallest and largest value within 1.5 times the interquartile range. Points beyond this range are considered outliers and have been removed for monthly and seasonal trend clarity (see Section 3.4.2 for trends that include outliers). Interquartile ranges for 24-hour average PM_{10} values have high overlaps across seasons, ranging from 11 to 35 µg/m^3, with median values ranging from 17 µg/m^3 in winter to 26 µg/m^3 in summer. In spring, the median value is 20 µg/m^3 and the interquartile range is 14-30 µg/m^3. In May, the interquartile range is 17 – 31 µg/m^3, with a median value of 23 µg/m^3.

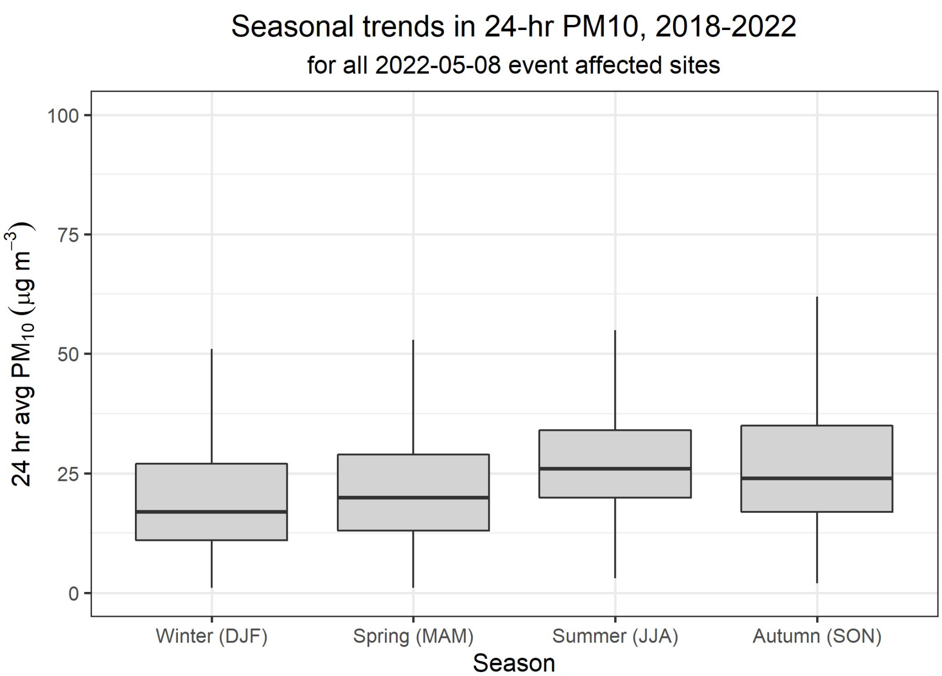


Figure 2.2-23. Seasonal trends in values of PM_{10} concentrations from 2018-2022 (outliers have been removed for trend clarity).

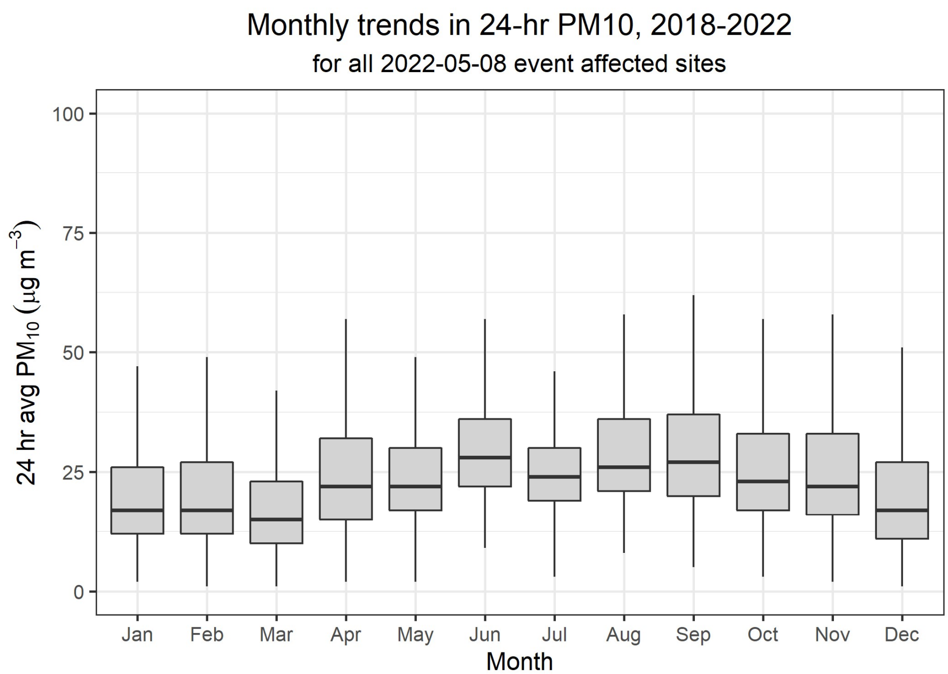


Figure 2.2-24. Monthly trends in values of PM_{10} concentrations from 2018-2022 (outliers have been removed for trend clarity).

3. Clear Causal Relationship

During early May 2022, a frontal passage through California drove a windblown dust event that increased PM_{10} concentrations in Clark County, Nevada, on May 8, 2022. Strong sustained winds in the Mojave Desert source region were greater than 40 mph. The frontal passage lofted, entrained, and transported dust from the source region to Clark County starting at 11:00 PST on May 8, 2022, and lasted through the end of the day. The severe drought conditions affecting the Mojave Desert in southeastern California, as shown in **Section 2.2**, created an ample source of dust from friable soils. Enhanced hourly average wind speeds up to 25 mph within Clark County coincided with increased PM_{10} concentrations on May 8. The Mojave Desert source region experienced sustained winds speeds above 40 mph, and evidence shows that (1) transport from the Mojave Desert to Clark County is clearly evident via HYSPLIT, meteorological analyses, and radar images, (2) visibility was greatly reduced in Clark County during the high PM_{10} concentrations, and (3) PM_{10} concentrations in Clark County were exceptionally outside of typical ranges. Within this section, we provide meteorological evidence of lofting, entrainment, and transport of dust from the dust source region (the Mojave Desert) with the frontal passage, evidence of transport from the source region to Clark County via HYSPLIT trajectory modeling and meteorological analysis, and evidence of impacts of the high-wind dust event at the surface in Clark County. We also provide additional evidence using statistical and meteorological similar event analysis to compare this dust event with other high PM_{10} days in Clark County.

3.1 High-Wind Event Origin

3.1.1 Meteorological Analysis

On May 8, 2022, dust from the Mojave Desert region of southeastern California impacted the Las Vegas region and led to 24-hour average PM_{10} concentrations above the NAAQS threshold at 13 sites through the area (ten sites experienced regulatorily significant concentrations, while three did not). Strong winds in the Mojave Desert region of southeastern California produced dense blowing dust that was transported to the Las Vegas metropolitan area on May 8, increasing PM_{10} concentrations starting at 11:00 PST, peaking at 13:00-18:00 PST, and lasting through the end of the day. All other sites within the Las Vegas Valley experienced enhanced PM_{10} concentrations concurrently with the sites that experienced the exceedance event. Several large-scale meteorological factors led to favorable conditions for blowing dust on this day. To account for these meteorological factors, observation data were analyzed leading up to and during the dust event. The following narrative will discuss the meteorological factors that led to this blowing dust event. To assess the meteorological conditions that led to poor air quality during this period, observational data were analyzed from the following sources:

- Upper-air winds and geopotential heights
- Doppler radar imagery
- Drought statistics
- Hourly surface wind speed and direction

This meteorological analysis will take a "top-down" approach, first investigating the upper-level weather conditions, then linking the upper-level observations to the corresponding mid-level and surface weather patterns. For completeness, this analysis examines the period between the mornings of May 6 and 9, 2022.

250-mb Analysis

The upper-level evolution of this dust event can trace its origins back to the morning of May 6, 2022. At this time, a 250-mb short wave trough was present off the Pacific Northwest coast, with an elongated 150-175 knot (kt) jet streak extending from the western flank of the trough to central Idaho. By the late afternoon of May 6, the upper-level trough axis remained offshore, while the jet streak west of the trough axis strengthened to 200 kts. The proximity of the jet streak in relation to the upper-level trough axis is a configuration known to aid the development and progression of upper-level troughs.

On May 7, the upper-level trough moved eastward over the Pacific Northwest coast and deepened. By the late afternoon of May 7, the 250-mb trough axis was positioned over Washington and Oregon, with a 150-175 kt jet streak west of the trough axis (see **Figure 3.1-1**). The 250-mb trough moved onshore in northern California and deepened further on the morning of May 8, with a 175-200 kt jet streak remaining west of the trough axis. Throughout the day on May 8, the jet streak remained west of the 250-mb trough but weakened slightly to 150-175 kts. Despite the weakening jet streak, the upper-level trough entered western Nevada in the late afternoon on May 8.

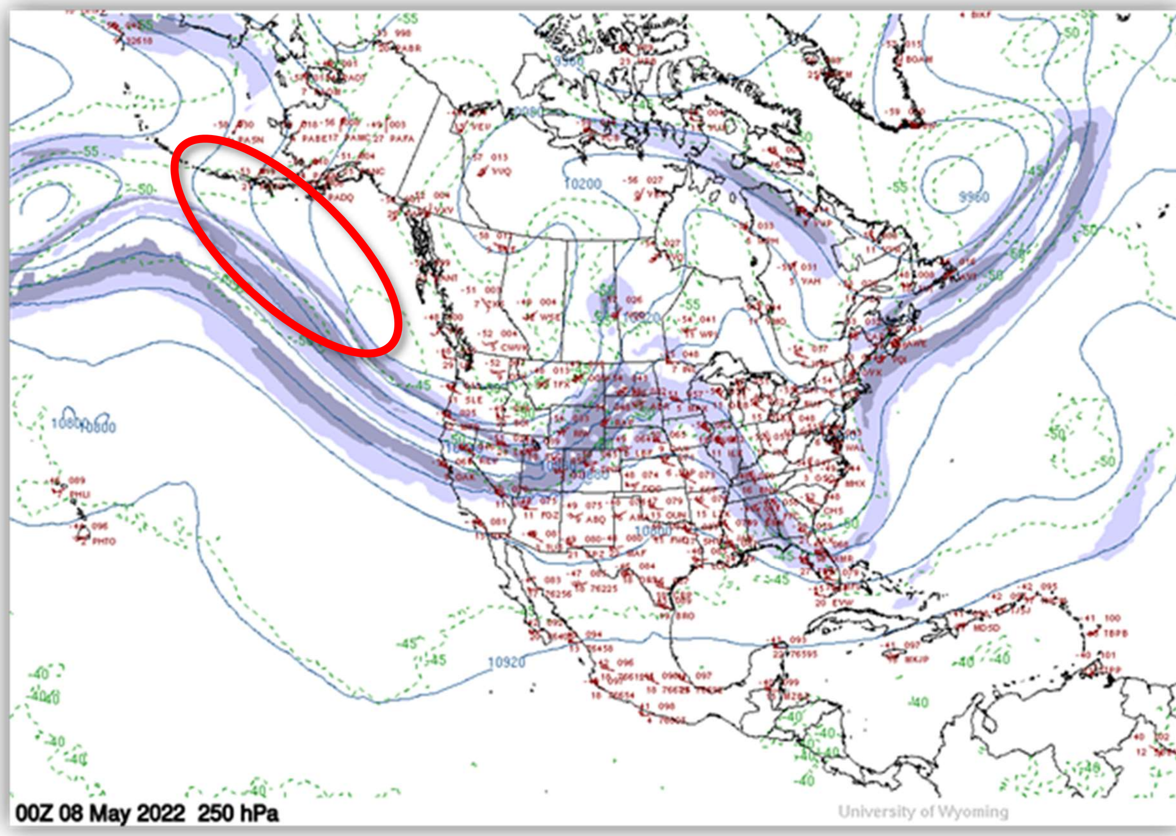


Figure 3.1-1. 250-mb map showing meteorological conditions during the late afternoon of May 7, 2022. A 175 kt jet streak (circled) is located west of the short-wave trough axis. Source: University of Wyoming.

By the morning of May 9, the 250-mb trough remained positioned over the western U.S., with the trough axis northeast of the Las Vegas region. At this time, the jet streak weakened further to 125-150 kts and became elongated on both flanks of the trough axis. Due to this configuration, the short wave 250-mb trough would weaken as it departed northeastward.

500-mb Analysis

With a strengthening 250-mb jet streak during the day on May 6, a 500-mb low pressure system quickly progressed eastward from the Aleutian Islands along the path of the 250-mb jet streak. By the late afternoon of May 6, the 500-mb low was east of the Aleutian Islands, while the 250-mb jet streak resided in a similar position. The syncing of the 250-mb jet streak over the 500-mb low pressure system provided sufficient upper-level support to develop and continue movement of the 500-mb low to the east.

The 250-mb short wave trough and 500-mb low remained moving in sync throughout May 7 as both features moved toward the Pacific Northwest coast. On the late afternoon of May 7, the 500-mb low resided within the left exit region (LER) of the 250-mb jet streak, where upper-level divergence occurs. This divergence aloft within the LER of the 250-mb jet allowed the 500-mb low to continue deepening.

Upper-level support of the 500-mb low decreased on May 8. In the early morning hours, both the 500-mb low and 250-mb trough were near the Oregon-northern California coast (see Figure 3.1-2). While the 250-mb jet streak remained west of the upper-level short wave trough, the 500-mb low was no longer within the LER of the jet streak. As a result, the 500-mb low weakened throughout the day. By the late afternoon of May 8, a 500-mb trough axis was over the northern California-Nevada border. At 250-mb, the trough axis was in a similar position as the 500-mb trough axis. At this time, the 250-mb jet streak remained well off the northern California coast and had weakened to 150-175 kts.

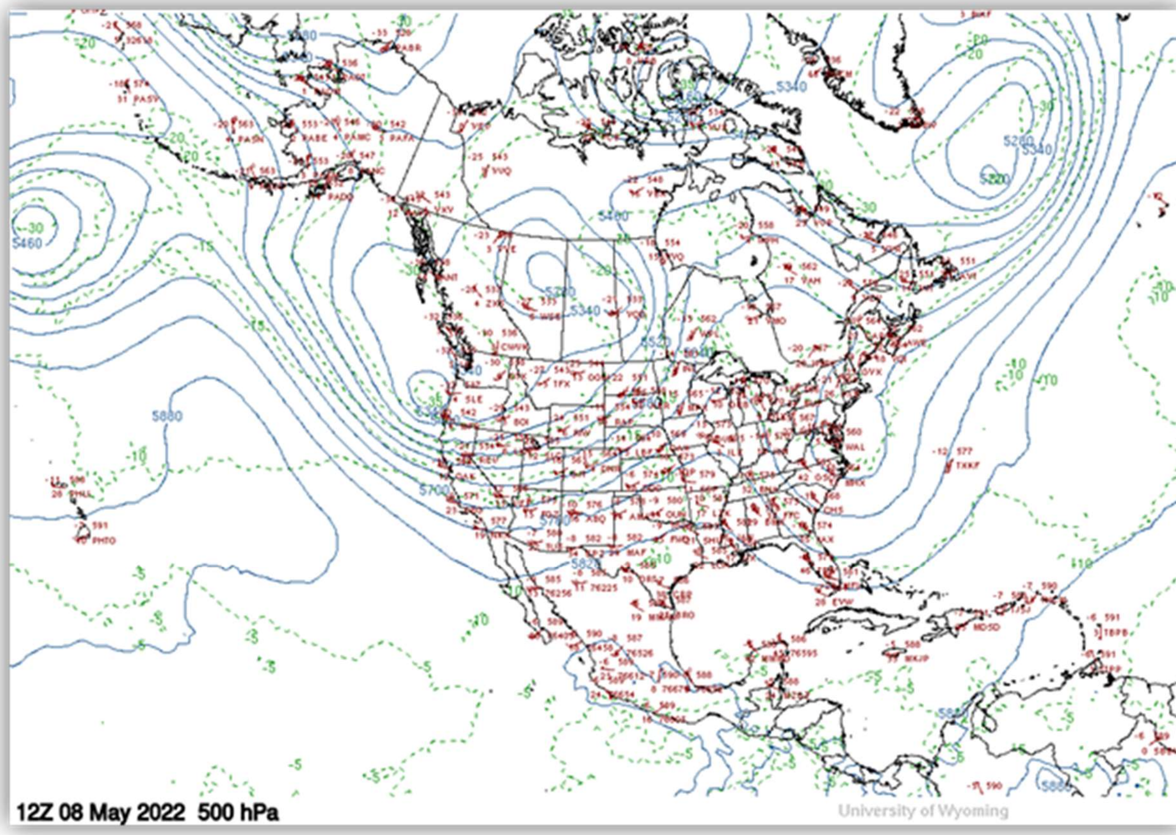


Figure 3.1-2. 500-mb weather map the morning of May 8, 2022. A 500-mb low and associated trough is located off the Oregon-northern California coast. Source: University of Wyoming

The 500-mb trough passed through Nevada during the early morning of May 9, with the trough axis positioned northeast of the Las Vegas region. At 250-mb, the upper-level trough remained directly over the mid-level trough. However, at this time the 250-mb jet streak became elongated on both flanks of the 250-mb trough axis. As a result of this configuration, both the mid- and upper-level troughs began weakening and moving away from Nevada.

Surface Analysis

Two key contributors to the May 8 dust event were an approaching surface cold front and its interaction with the terrain around the Las Vegas region. Prior to this event, the United States Drought Monitor classified southern Nevada and eastern California as in severe-to-extreme drought conditions, indicating soils across the region were abnormally dry. Due to the abundance of dry soils, the likelihood of a blowing dust event that would impact the Las Vegas region would increase.

On the late afternoon of May 7, a surface cold front was analyzed west of the Pacific Northwest coast. In the mid-levels of the atmosphere, the 500-mb low was positioned west of the surface front, which provided the surface front sufficient mid-level lift. At 250-mb, the jet streak trailed both features at the mid- and lower-levels, with both the 500-mb low and surface cold front positioned in the LER of the jet streak. Aloft divergence within the LER aided development of both the surface front and 500-mb low.

The surface cold front moved onshore to northern California during the morning of May 8. While the front was still well west of the Las Vegas region, the pressure gradient across eastern California and southern Nevada increased. As the pressure gradient steadily increased throughout the afternoon, southerly to southwesterly winds strengthened in the Las Vegas region. From the late morning until the late evening hours on May 8, numerous weather stations across Clark County recorded sustained wind speeds around 20 mph, with gusts of 30-40 mph (**Figure 3.1-3**).

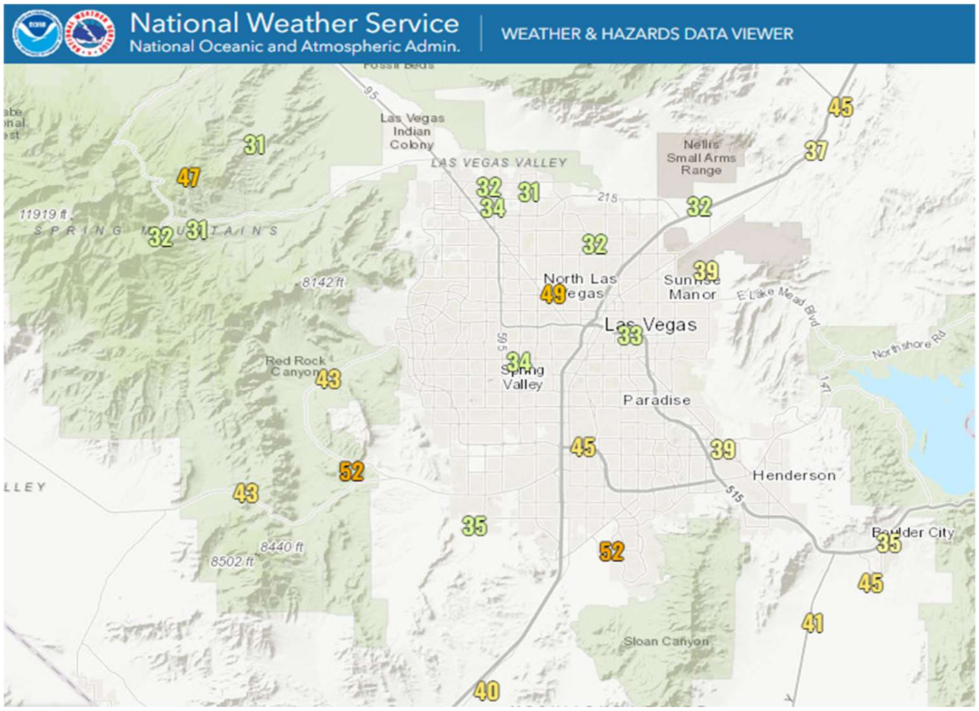


Figure 3.1-3. Maximum recorded wind gusts on May 8, 2022. Courtesy: National Weather Service

It was during this period of gusty winds on May 8 when blowing dust developed. Based on air quality monitoring sites across Clark County, PM_{10} concentrations peaked between 11:00 and 20:00 PST. During this period, hourly PM_{10} concentrations exceeded 1,000 µg/m^3 at times. Doppler radar detected dense lofted dust in the Las Vegas region as the dust moved northeastward across Clark County (Figure 3.1-4 through Figure 3.1-6). Radar imagery from dust peaked at around 16:00-18:00 PST, which is coincident with the highest concentrations of PM_{10}.

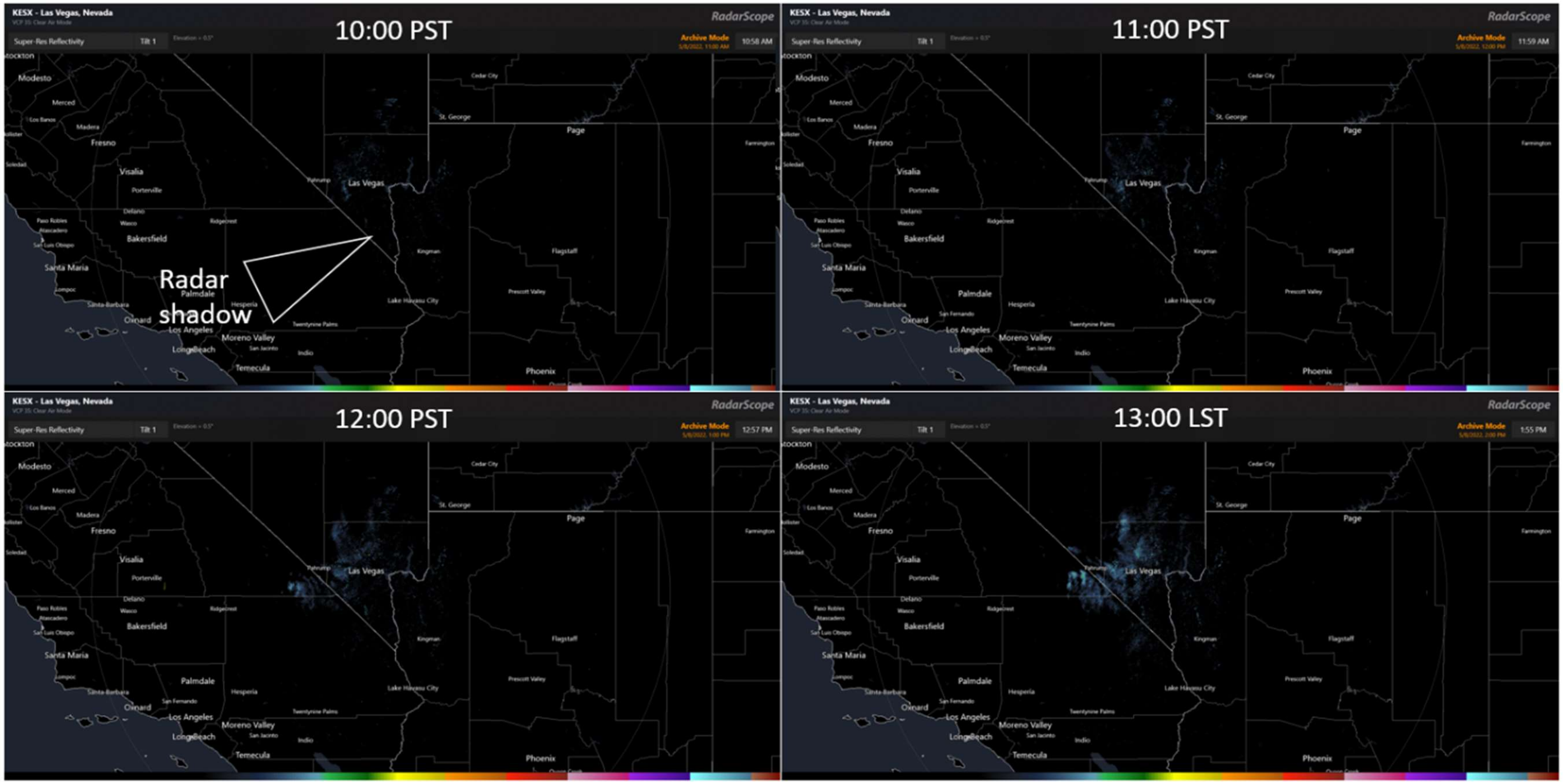


Figure 3.1-4. Doppler radar image, valid 10:00 to 13:00 PST on May 8, 2022. The radar shadow is shown as a cone in the upper left image, but is applicable to all images. Source: RadarScope.

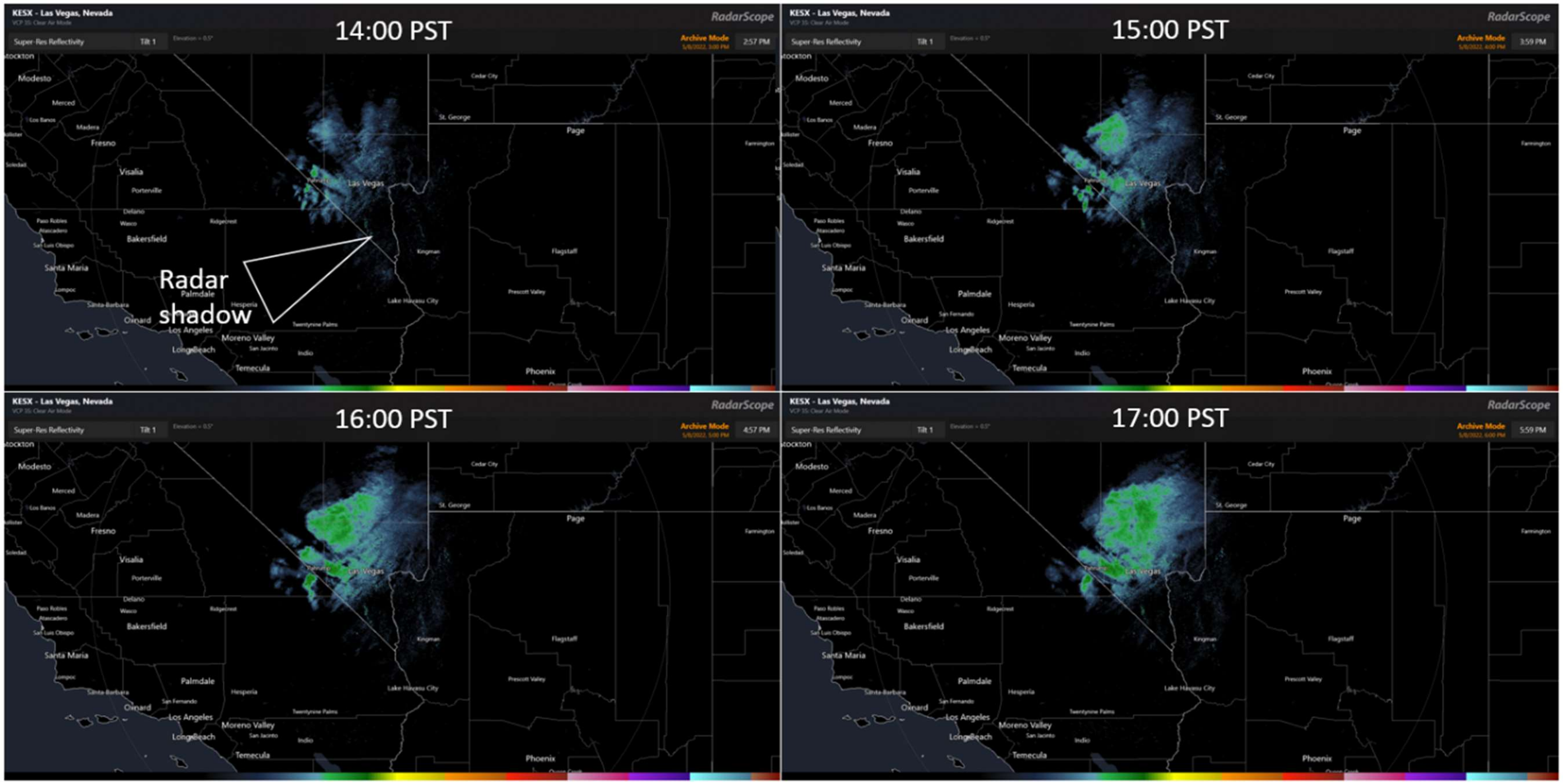


Figure 3.1-5. Doppler radar image, valid 14:00 to 17:00 PST on May 8, 2022. The radar shadow is shown as a cone in the upper left image, but is applicable to all images. Source: RadarScope.

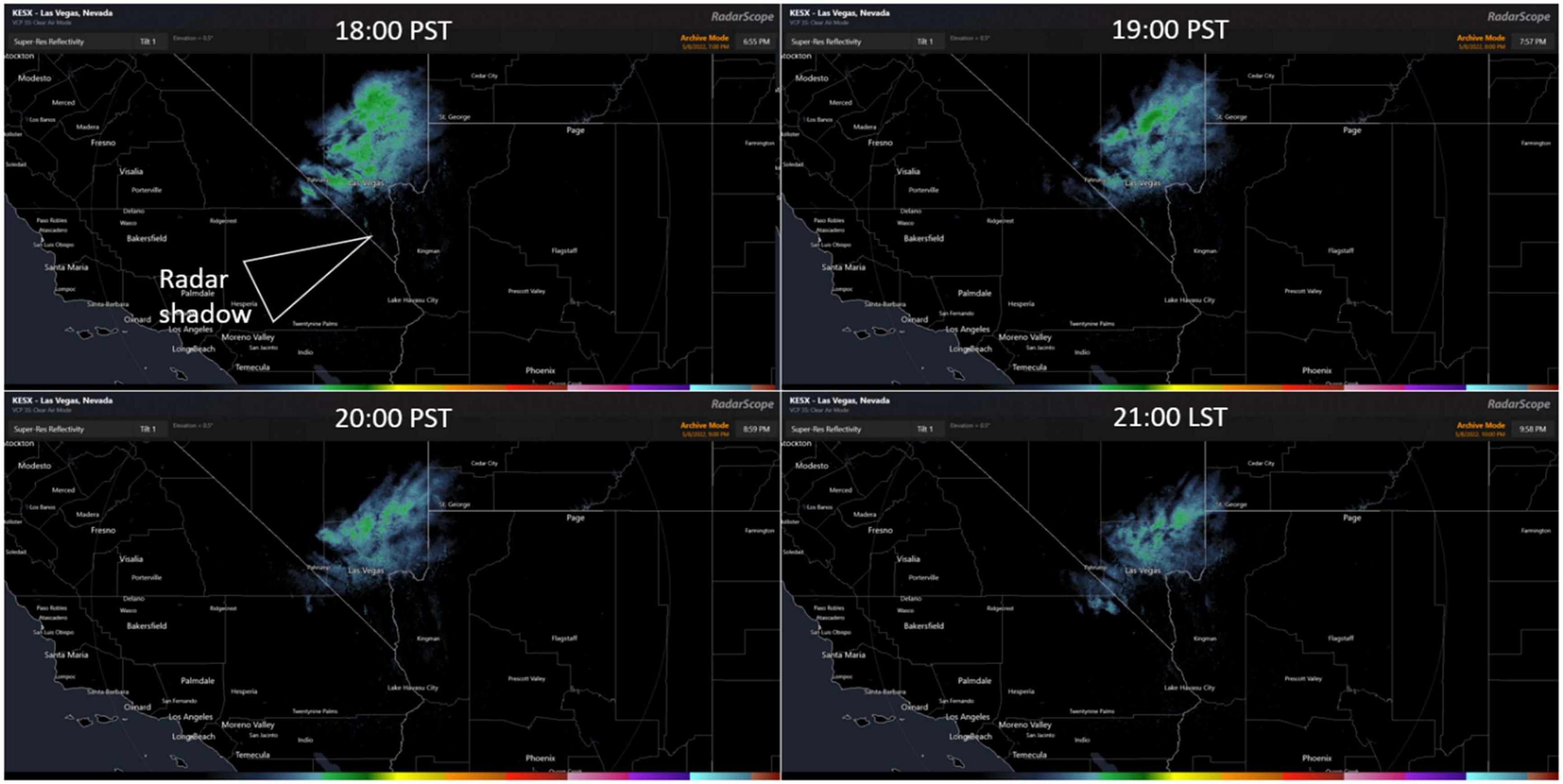


Figure 3.1-6. Doppler radar image, valid 18:00 to 21:00 PST on May 8, 2022. The radar shadow is shown as a cone in the upper left image, but is applicable to all images. Source: RadarScope.

During the evening of May 8 and continuing into the morning of May 9, the cold front gradually dissipated west of Nevada. This occurred as the 250-mb jet streak became elongated on both flanks of the upper-level short wave trough, weakening the upper-level trough. In the mid-levels, the 500-mb low pressure center transitioned to an open-wave trough, with this mid-level trough axis east of the cold front by the evening of May 8. The position of the mid-level trough relative to the surface cold front reduced mid-level lift that supported the surface cold front, preventing the front from entering Nevada. With the surface cold front dissipated, the associated pressure gradient diminished throughout the morning of May 9. This led to lighter winds and a reduction in blowing dust in Clark County.

3.1.2 Satellite Images and Analysis

Satellite imagery and reanalysis products also provide evidence of dust transport corresponding with a strong frontal passage. AOD data is retrieved from Moderate Resolution Imaging Spectroradiometer (MODIS) Terra and Aqua satellites using the Multi-Angle Implementation of Atmospheric Correction (MAIAC) algorithm. Before the frontal passage, we see a widespread area of low AOD values and near zero AOD in Clark County (**Figure 3.1-7**). Behind the frontal passage, MAIAC AOD values on May 8 show an increase in AOD across most of southeastern California, southern Nevada, and southwestern Arizona (**Figure 3.1-8**). The highest AOD values are shown in and to the southwest of Clark County.

The Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) reanalysis data show peak hourly average and hourly peak wind speeds in the source region and in the Las Vegas Valley for May 8, 2022 (**Figure 3.1-9 and Figure 3.1-10**). Strong southerly to southwesterly surface winds developed by 18:00 UTC (10:00 PST) because of the strong pressure gradient between the frontal system moving in from the west-northwest. These high winds of around 17 m/s (corresponding to approximately 38 mph) are shown in the MERRA-2 reanalysis figures (**Figure 3.1-9** and **Figure 3.1-10**) for May 8, and the strong winds continued through 06:00 UTC on May 9 (May 8 at 22:00 PST).

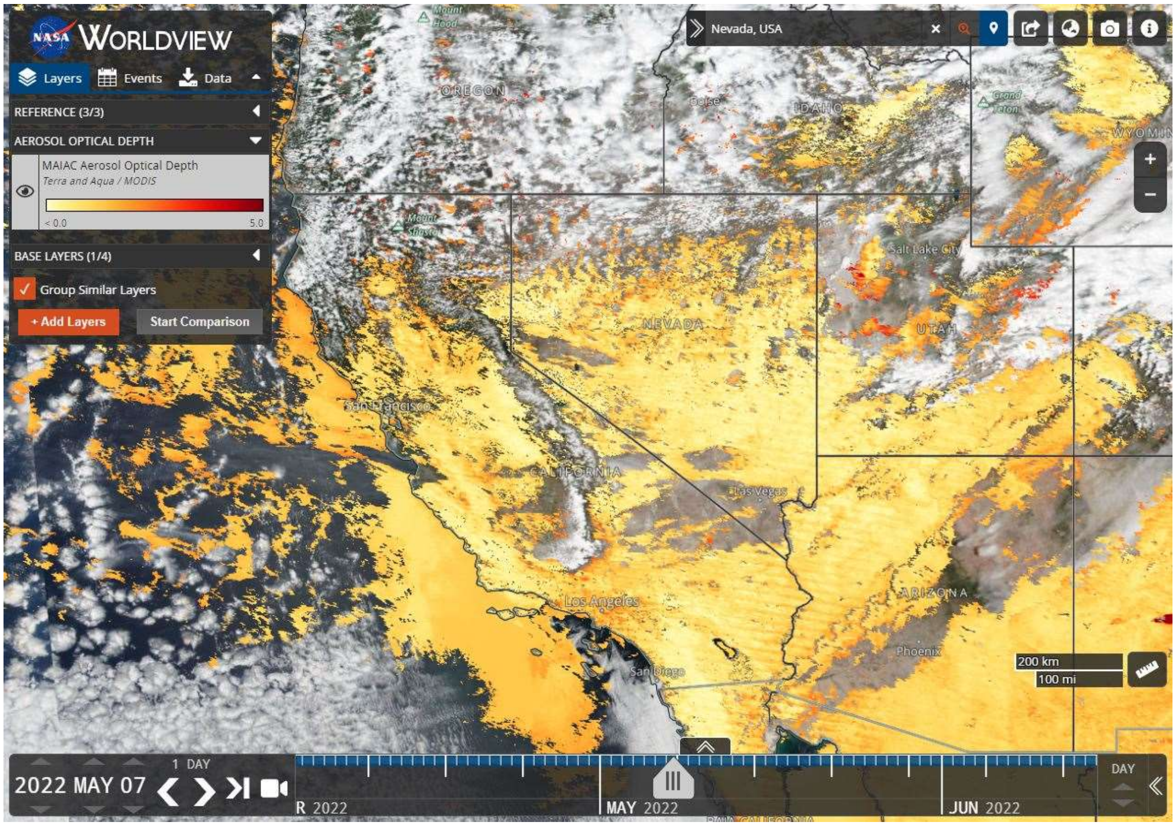


Figure 3.1-7. Satellite aerosol optical depth from MAIAC Aqua and Terra combined. Terra imagery was captured at 10:30 local time and Aqua imagery was captured at 13:30 local time on May 7, 2022 (pre-frontal passage).

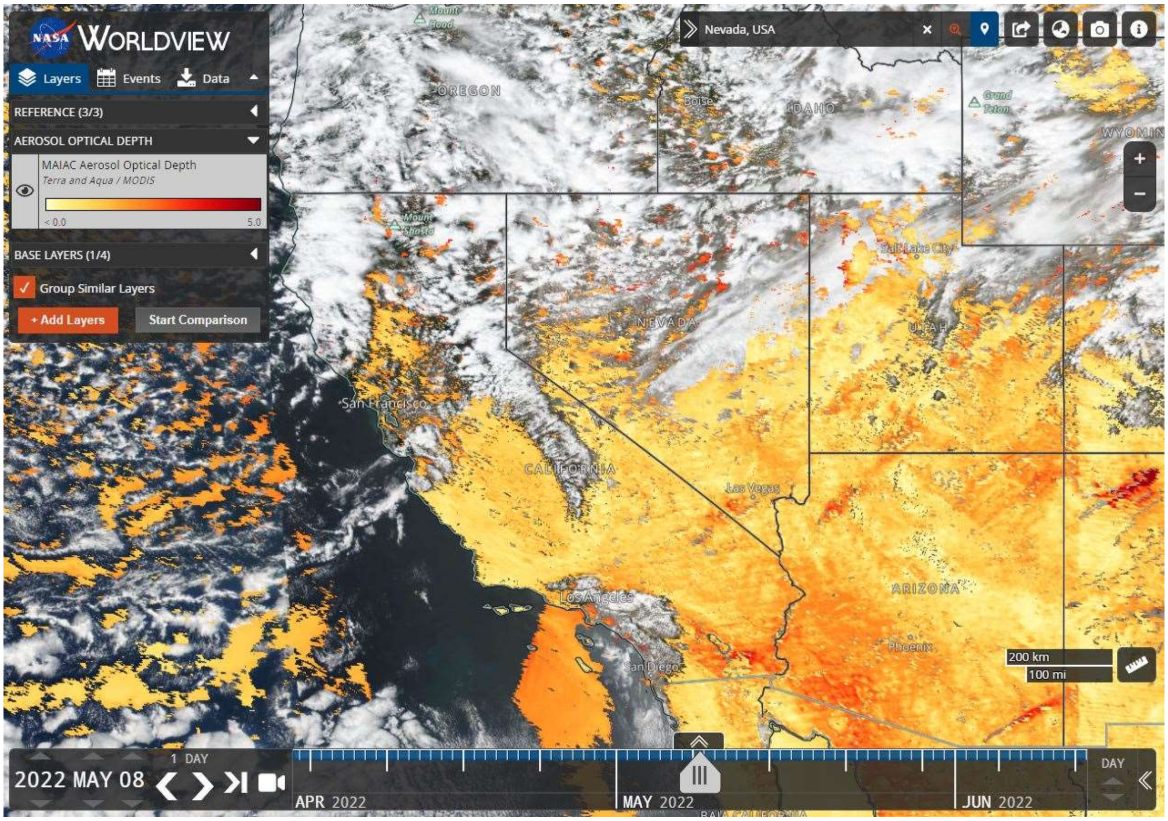


Figure 3.1-8. Satellite aerosol optical depth from MAIAC Aqua and Terra combined. Terra imagery was captured at 10:30 local time and Aqua imagery was captured at 13:30 local time on May 8, 2022.

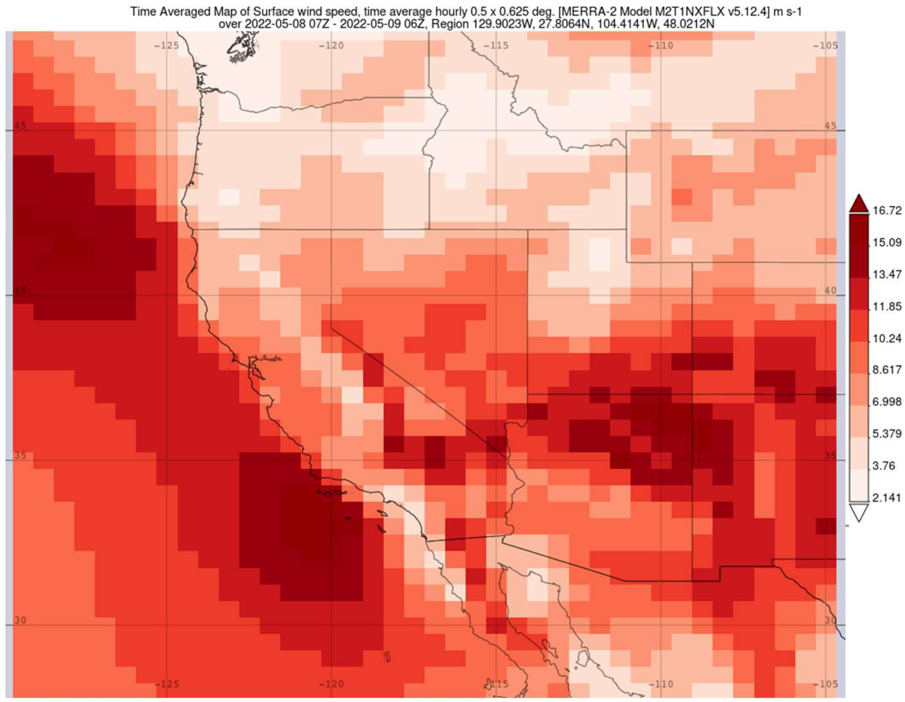


Figure 3.1-9. MERRA-2 reanalysis data showing hourly averaged surface wind speeds (m/s) over May 8, 2022, at 07:00 UTC (May 7 at 23:00 PST) through May 9 at 06:00 UTC (May 8 at 22:00 PST).

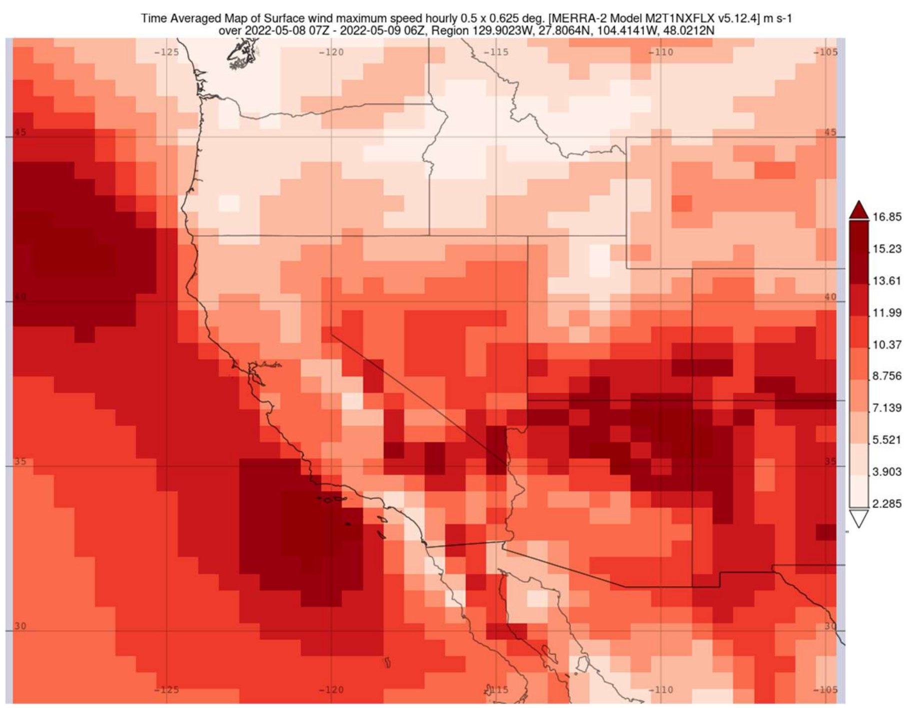


Figure 3.1-10. MERRA-2 reanalysis data showing hourly maximum surface wind speeds (m/s) from May 8, 2022, at 07:00 UTC (May 7 at 23:00 PST) through May 9 at 06:00 UTC (May 8 at 22:00 PST).

3.1.3 Supporting Ground-Based Data

We were unable to find ground-based images in the source region due to its remote location. Satellite imagery was highlighted in the previous section as a substitute.

Peak sustained winds in the Mojave Desert (southeastern California) were developed via the Iowa State University Mesonet Automated Data Plotter. This tool aggregates automated weather data records from the selected region. Figure 3.1-11 shows the peak sustained wind speeds in southeastern California and Mojave Desert of up to 48 mph on May 8, 2022. These peak sustained wind speeds were well above the 25-mph threshold in the source region and could easily loft, entrain, and transport PM_{10} downwind quickly to Clark County.

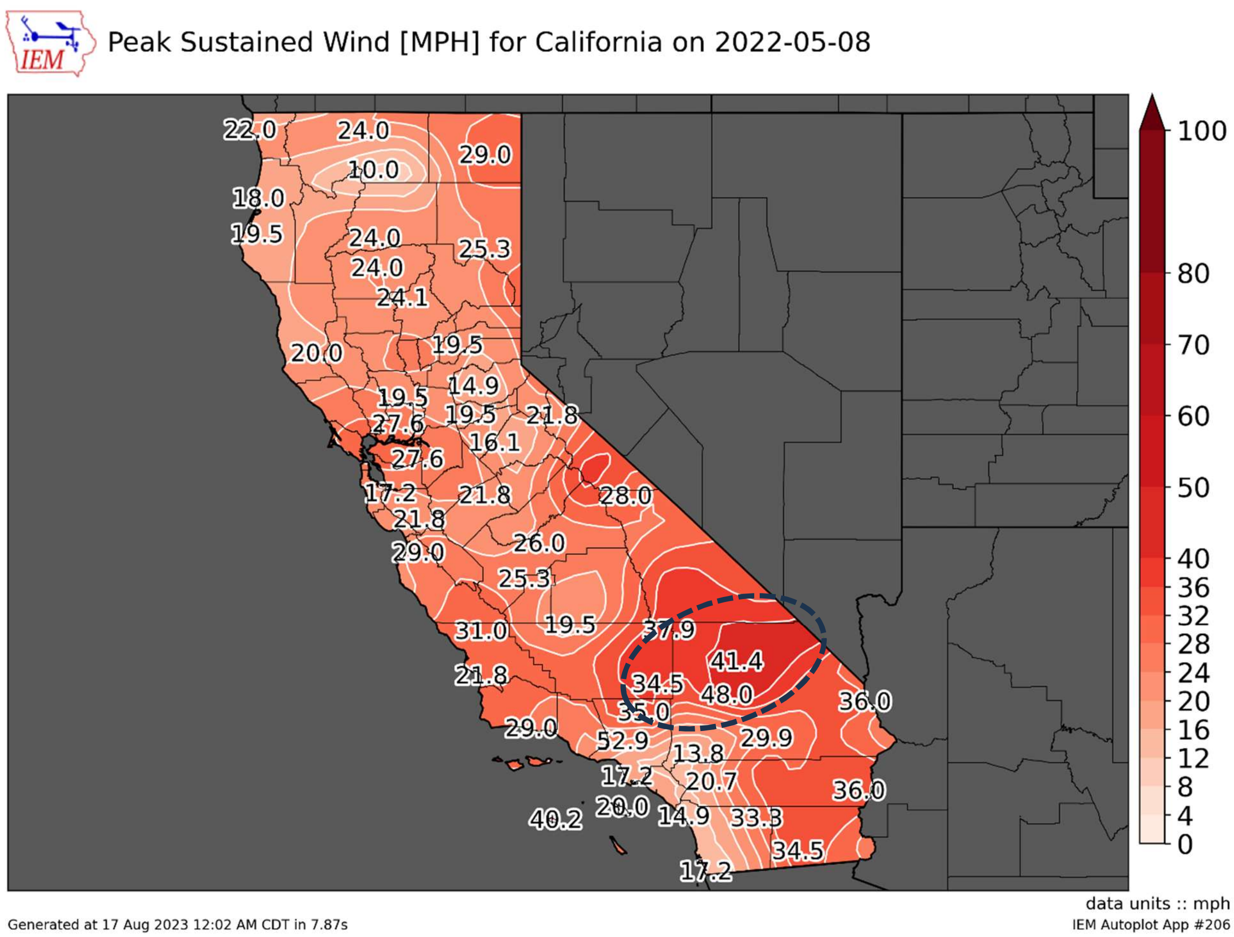


Figure 3.1-11. Peak sustained winds in California on May 8, 2022. The source region, shown approximately by the black dashed line, is located in southeastern California (the Mojave Desert region). Data source https://mesonet.agron.iastate.edu/plotting/auto/.

Figure 3.1-12 shows the distribution of maximum daily temperatures recorded at several sites in the wind-blown source region on May 7 and 8 (1991 – 2021), and the maximum daily temperatures recorded on May 7 and 8, 2022. The site locations are shown in Figure 2.2-8. Maximum daily temperatures recorded at all sites except Lancaster/Fox Field were at or above the median in the dust region and along the transport path compared to the maximum daily temperatures from 1991 – 2021. Maximum daily temperatures recorded at all sites on May 8, 2022, the day of the PM_{10} exceedance, were below the median due to blowing dust reducing incoming solar radiation. The maximum daily temperatures recorded on May 7 provide evidence that the wind-blown dust source regions in the Mojave Desert were unusually hot on the day before the PM_{10} exceedance.

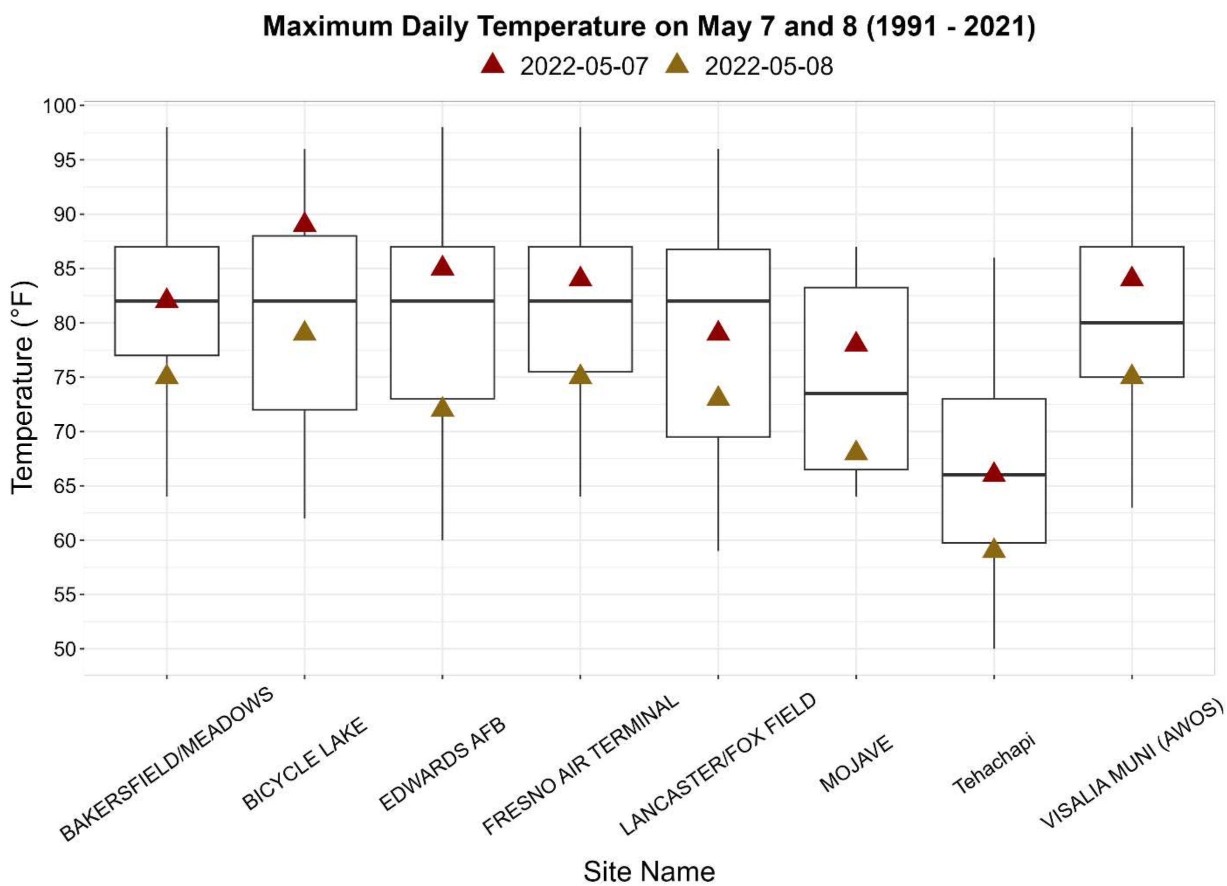


Figure 3.1-12. Maximum daily temperature on May 7 and 8, 2022, compared to the 1991 – 2021 distribution at each site.

Overall, we find overwhelming evidence that PM_{10} was very likely lofted, entrained, and transported from the Mojave Desert region in southeastern California in the late morning through the afternoon of May 8, 2022, via a frontal passage. The evidence corroborating this assertion includes (1) the meteorological analysis that shows conditions were consistent with a high-wind event in the Mojave Desert, (2) radar images from Las Vegas showing the progression of dust moving from the Mojave

Desert into the Clark County area, (3) satellite retrievals showing high AOD and winds in the Mojave Desert and Clark County, (4) ground-based measurements of high temperatures in the Mojave Desert region before the event on May 8, and (5) aggregated measurements of high winds in the Mojave Desert source region on May 8.

3.2 Transport to Clark County

3.2.1 HYSPLIT Analysis

Backwards trajectories were modeled from the Jerome Mack, Jean, Green Valley Station, Joe Neal, Mountains Edge, and Virgin Valley monitoring sites starting at May 8, 2022, at 12:00 PST, the start of the high PM_{10} concentrations (hourly concentration greater than 150 µg/m^3). These trajectories were modeled at 50, 500, and 1,000-m heights (**Figure 3.2-1**). Archived North American Mesoscale Forecast System (NAM) data with resolution of 12 km was used as meteorologic input. Temporal resolution of the NAM-12 km is three hours and is run by the NCEP.

At all heights, trajectories approach the Las Vegas region from the west-southwest, over the Mojave Desert, revealing it as the source region. The Mojave Desert is just east-southeast of the Sierra Nevada range and located within its rain shadow, yielding a majorly barren and scrub/shrub landcover (**Figure 3.2-2** and **Figure 3.2-3**, left). Throughout the region, each trajectory aligns with the large, continuous area in severe drought conditions (**Figure 3.2-2** and **Figure 3.2-3**, right).

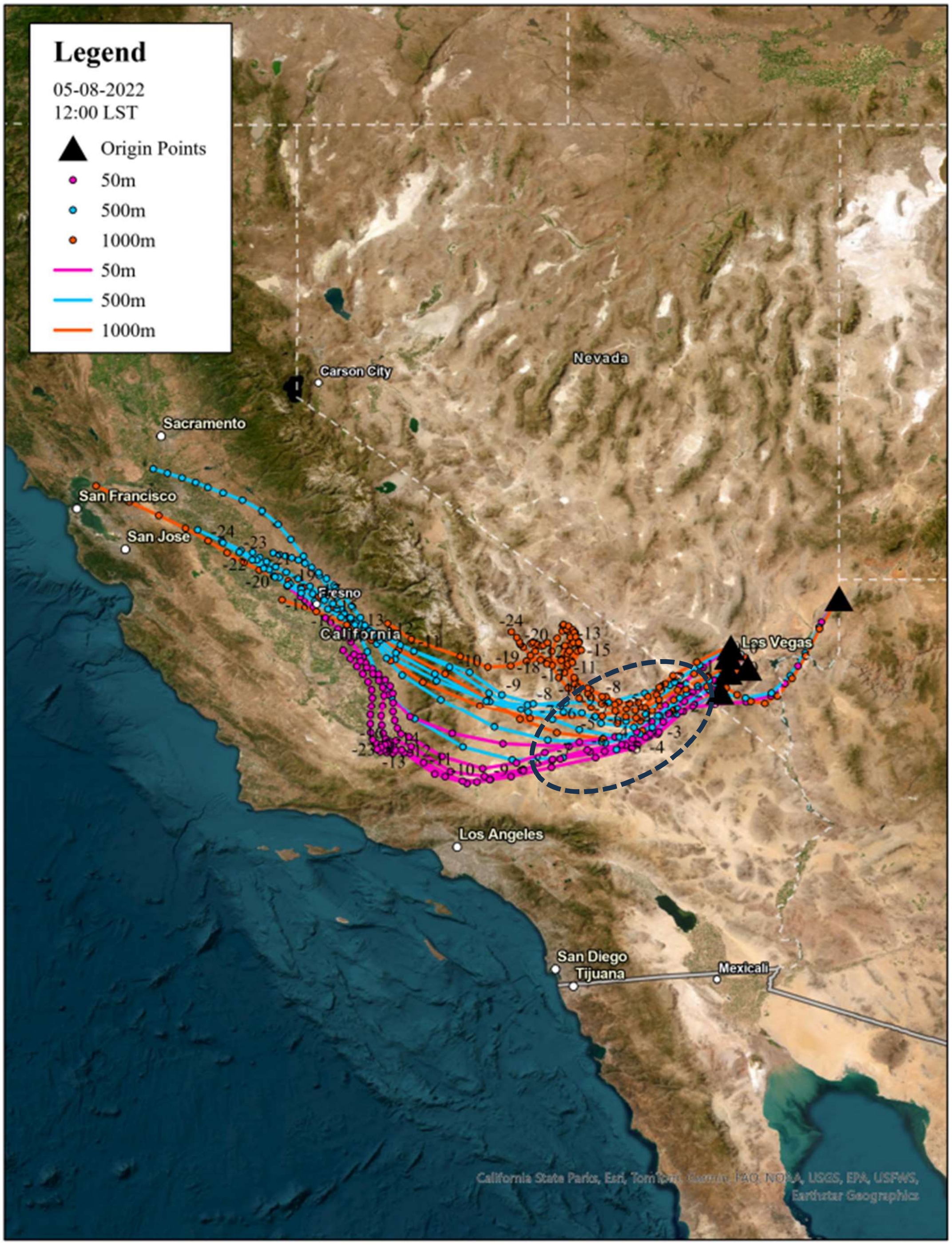


Figure 3.2-1. HYSPLIT 24-hour back trajectories showing hourly points from the Jerome Mack, Jean, Green Valley Station, Joe Neal, Mountains Edge, and Virgin Valley monitoring sites on May 8, 2022, at 12:00 PST, originating at (maroon) 50-m, (green) 500-m, and (blue) 1,000-m. The approximate location of the Mojave Desert source region is shown by a black, dashed circle.

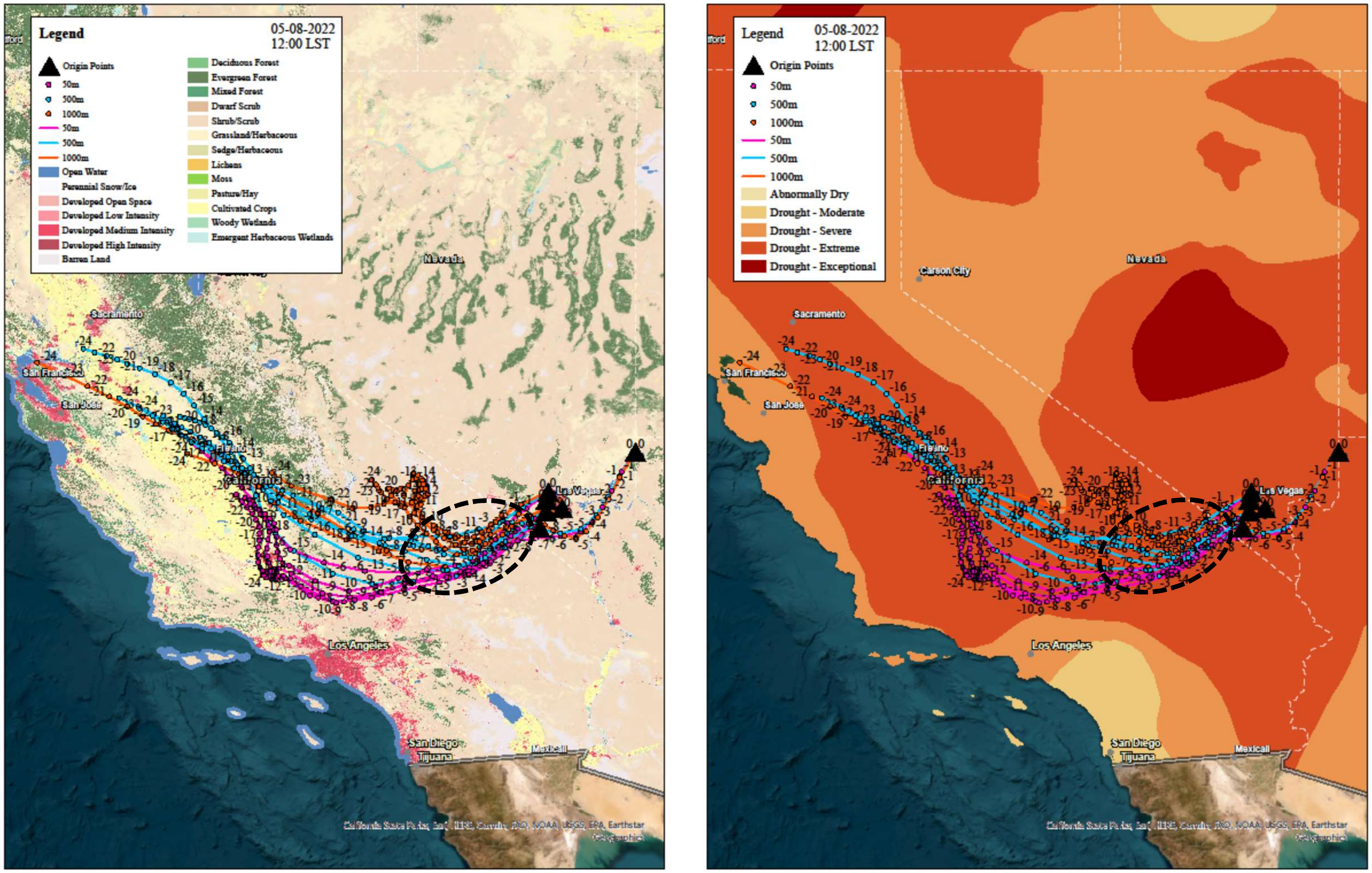


Figure 3.2-2. HYSPLIT 24-hour back trajectories from the Jerome Mack, Jean, Green Valley Station, Joe Neal, Mountains Edge, and Virgin Valley monitoring stations on May 8, 2022, at 12:00 PST, overlayed on (left) national land type database and (right) drought monitor class data. The approximate location of the Mojave Desert source region is shown by a black, dashed circle.

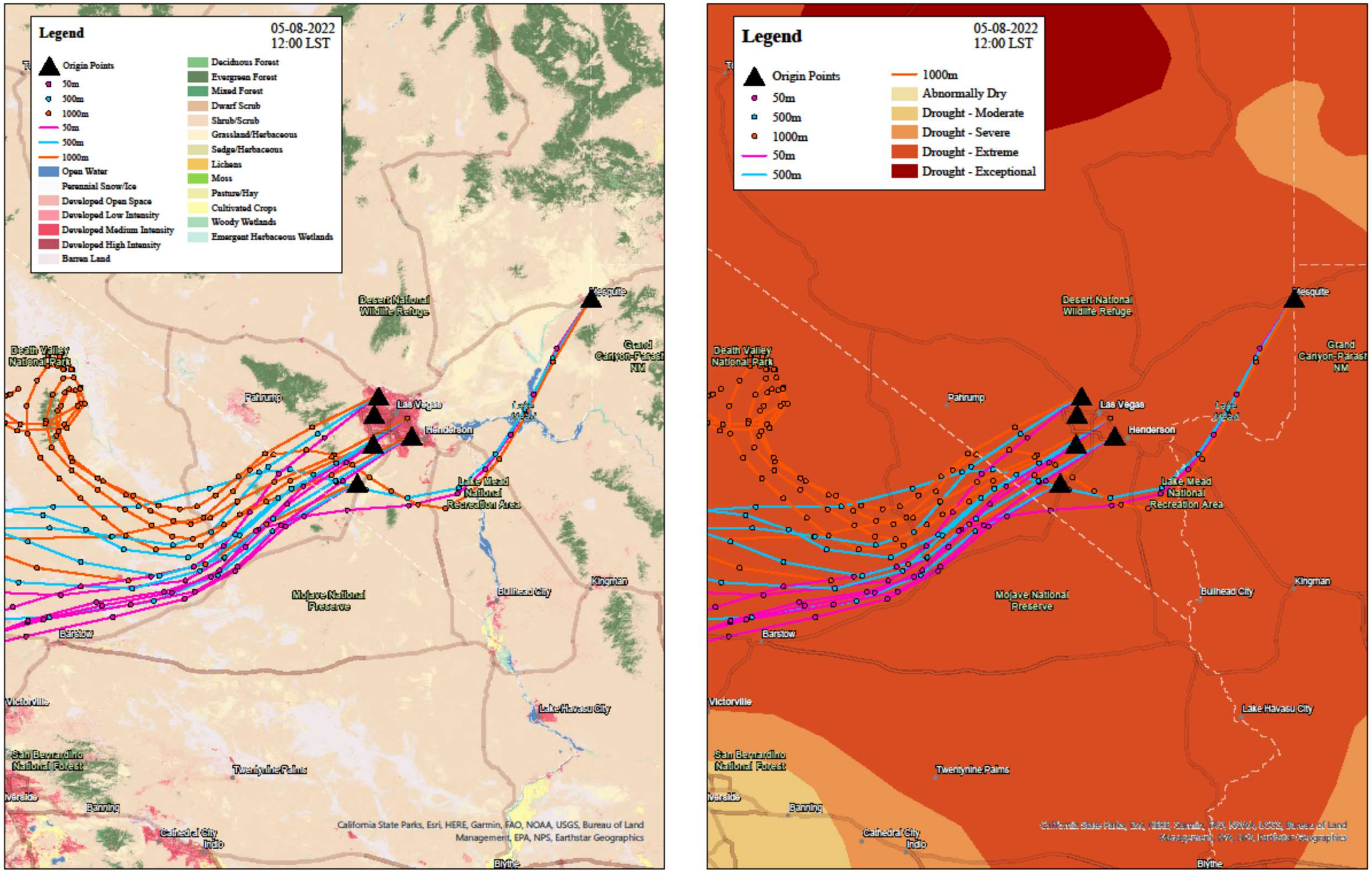


Figure 3.2-3. Zoomed In HYSPLIT 24-hour back trajectories from the Jerome Mack, Jean, Green Valley Station, Joe Neal, Mountains Edge, and Virgin Valley monitoring sites on May 8, 2022, at 12:00 PST, overlayed on (left) national land type database and (right) drought monitor class data.

3.2.2 High-Wind Event Timeline

The wind-blown dust event that occurred on May 8, 2022, caused 24-hour PM_{10} NAAQS exceedances with regulatory significance at ten measurement sites (with three additional sites experiencing NAAQS exceedances that were not regulatorily significant) in Clark County and caused a maximum 24-hour PM_{10} concentration of 258 µg/m^3 at the Mountain's Edge site. Concentrations of PM_{10} began to rise at 11:00 PST, reaching a peak concentration between 13:00 to 18:00 PST, and remaining enhanced through midnight at measurement sites throughout Clark County.

In addition to the meteorological evidence of the approach of the frontal system, timeseries graphs and a map showing PM_{10} concentrations and hourly average wind speeds in the source region are also provided in **Figure 3.2-4 and Figure 3.2-5Figure 3.2-4.** . As stated in the meteorological analysis in **Section 3.1.1**, the movement of the frontal passage onshore on the morning of May 8 strengthened the pressure gradient across eastern California and southern Nevada by the late morning. This is reflected by the enhanced PM_{10} concentrations and wind speeds throughout the region between 10:00-21:00 PST. The eastern regions of California, specifically Kern, Inyo, and San Bernardino counties in California (shown in the map in Figure 3.2-4 as the circled regions one through three) were first affected by the dust storm, and measurements showed an increase in PM_{10} concentrations between 10:00-13:00 PST. During this period, hourly average wind speeds rose above the 25-mph threshold at multiple sites within the Mojave Desert region (Ridgecrest-Ward, Dirty Socks, Mill Site, Barstow and Trona) fulfilling a key factor for a Tier 2 high-wind dust event as defined by EPA guidance (i.e., sustained winds above 25 mph in a natural undisturbed desert source region). The increase in PM_{10} concentrations in Kern, Inyo and San Bernadino counties precedes a rise in PM_{10} concentrations in Pahrump and Las Vegas, Nevada (shown in the map in Figure 3.2-4 as the circled regions four and five), between 13:00-16:00 PST as the frontal system moves eastward along with suspended PM_{10} through the afternoon of May 8. Figure 3.2-5 shows concurrent increases in wind speed compared with the PM_{10} concentrations in the source region. Hourly average wind speeds in Clark County sites did not reach the intensity of peak sustained winds in the source region. This provides significant evidence of windblown dust caused by high winds related to the approach of a frontal system transported eastward from the Mojave Desert region of California over southern Nevada.

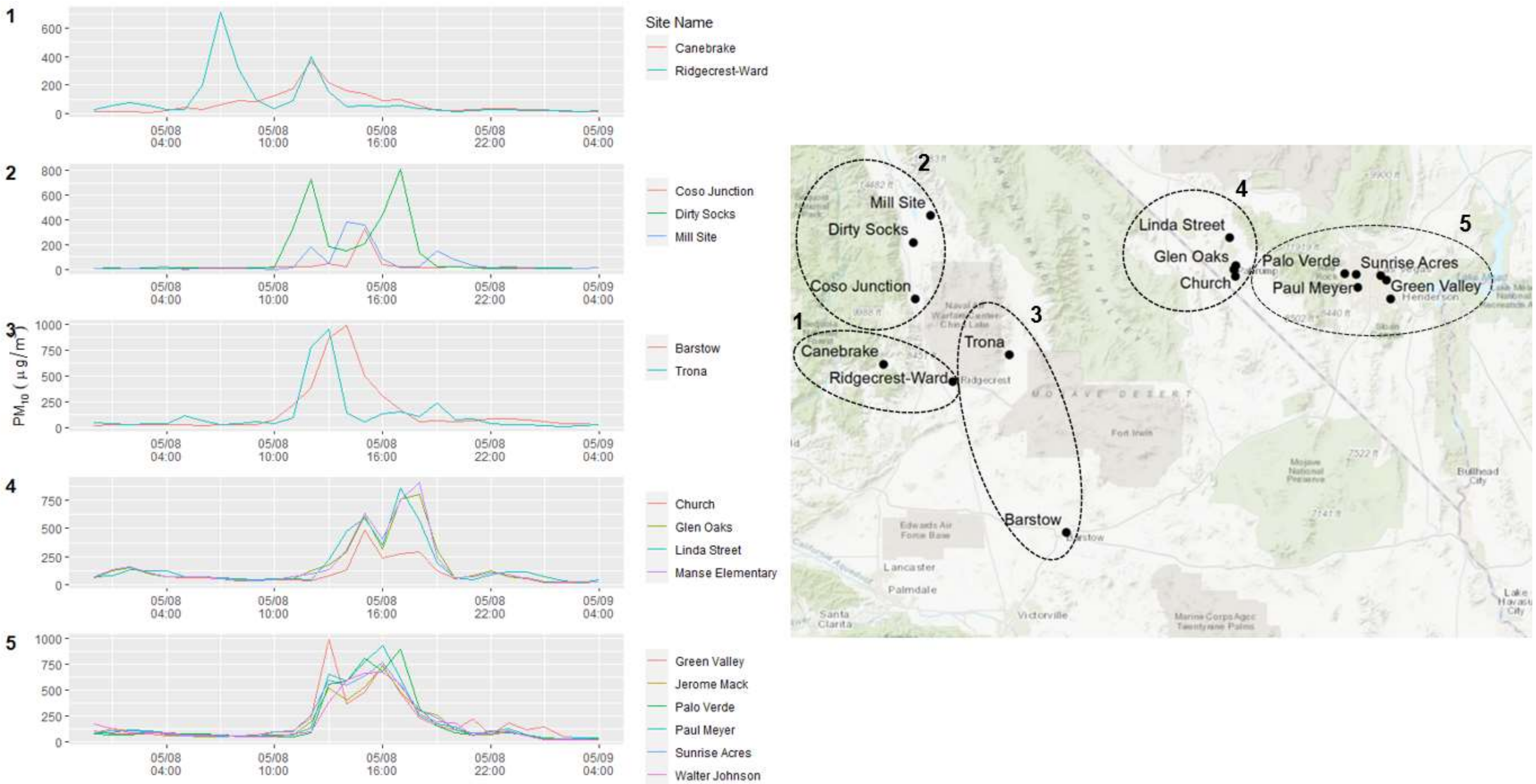


Figure 3.2-4. Timeseries of PM_{10} (left) along the strong pressure gradient associated with an approaching cold front. Panel 1 includes data from Kern County, California; panel 2 includes data from Inyo County, California; panel 3 includes data from San Bernadino County, California; panel 4 includes data from the Pahrump, Nevada, area; and Panel 5 includes data from the Las Vegas, Nevada, area. The map (right) and site locations are mapped and circled by each region. Numbering in the map corresponds to the numbering in the time series figures.

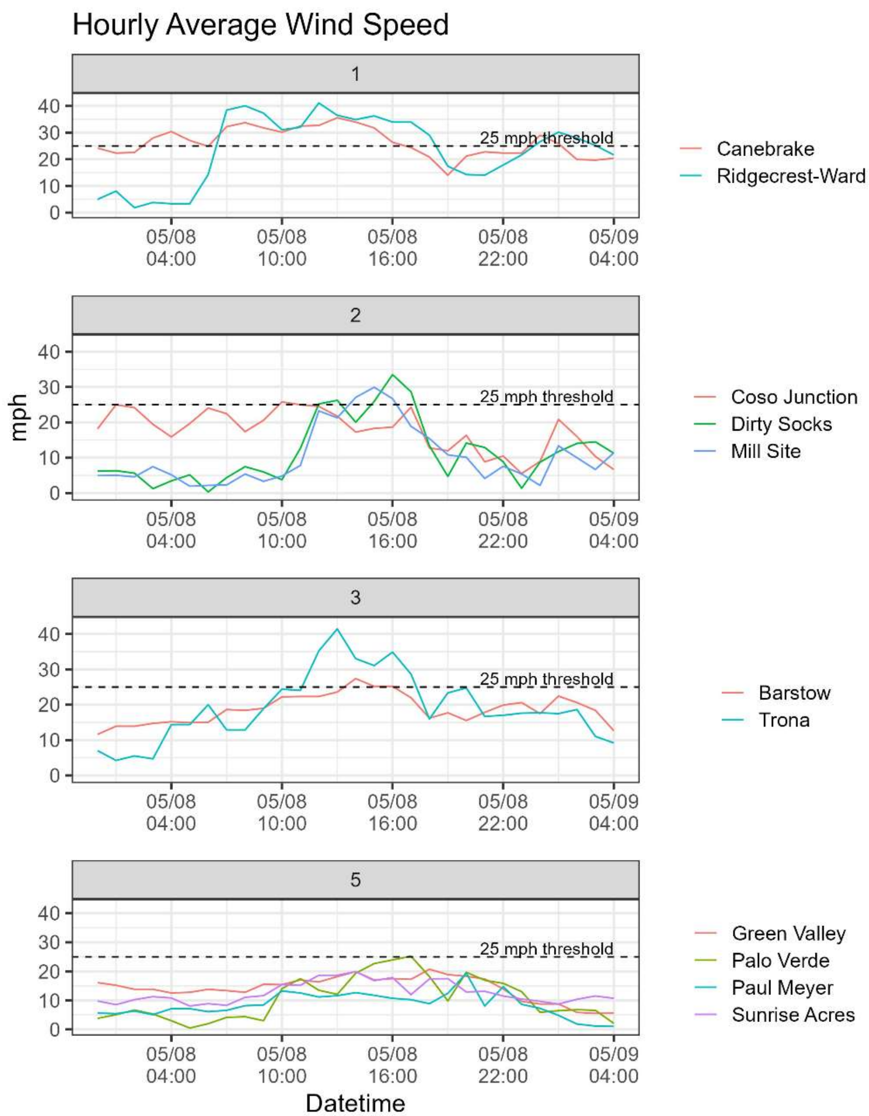


Figure 3.2-5. Hourly average wind speed at sites shown in Figure 3.2-4 sourced from the AQS database. Sites that do not report meteorological data are omitted. The number above each plot panel matches the numbered panels and circled regions in Figure 3.2-4.

The rise in PM_{10} concentrations on May 8, 2022, coincides with increasing wind speeds in Clark County as dust is transported into the region with the movement of the pressure system. **Figure 3.2-6** shows the distribution of wind speed and direction across wind observations taken at five-minute increments at Harry Reid Int'l airport (LAS) on May 8. The highest five-minute wind speeds, peaking at 30 mph, came from the south-southwest direction which corroborates an approaching cold front.

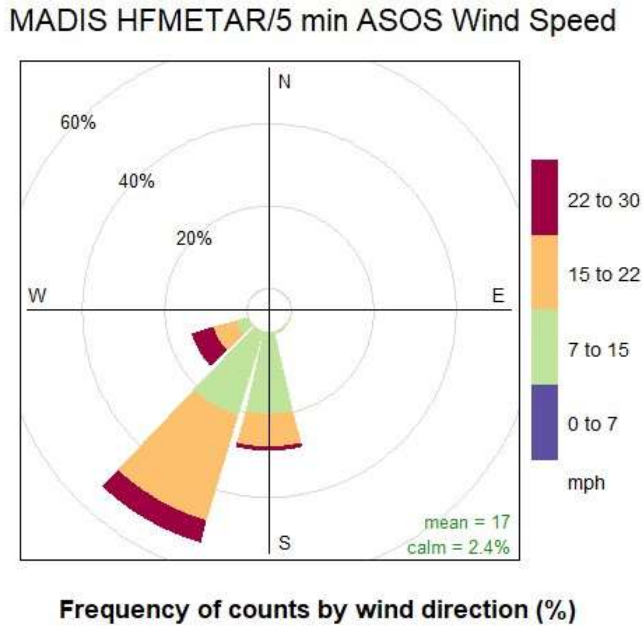


Figure 3.2-6. Wind rose including both wind speed and direction for May 8, 2022, at Harry Reid Int'l Airport (LAS). Wind data was sourced from the Iowa Environmental Mesonet (**https://mesonet.agron.iastate.edu/**).

Wind speed, direction, and PM_{10} concentrations across Clark County, Nevada, were also consistent with a frontal passage (Figure 3.2-7 to Figure 3.2-11).). By 12:00 PST, winds shifted southwesterly throughout the Las Vegas Valley due to the influx of winds through the mountain pass between the Spring Mountains and the McCullough Range, a major wind and transport corridor into the Valley. With the shift in winds, sites in the southern Valley (closest to the mountain pass) and lower elevations (directly downwind of the mountain pass) showed higher PM_{10} concentrations compared to the rest of the Valley. As PM_{10} from the dust event filled the Valley over the next few hours (13:00 to 15:00 PST), all sites within the Las Vegas Valley experienced concentrations of > 500 µg/m^3. By 16:00-17:00, all sites in the valley recorded "hazardous" levels of PM_{10} concentrations with winds from the southwest, indicating a regional influence of PM_{10} concentrations from the southwest that were impacting the whole Las Vegas Valley. Winds started to decrease in the Valley by 17:00 PST and although PM_{10} concentrations remained high through the end of the day, the drop in wind speeds is mirrored by a decrease in PM_{10} concentrations.

Enhanced PM_{10} concentrations at the Enhanced PM_{10} concentrations at the affected sites were likely caused by a high wind event in the source region rather than local emissions in part because planned land use around these sites, which can be generally described as developed with little exposed dirt or gravel, is not conducive to elevated concentrations. Further, the fact that enhanced PM_{10} concentrations were recorded at all sites in the Las Vegas Valley indicates a regional high-wind dust event. While it is possible that some portions of planned land use, such as the undeveloped lot to the east of the Joe Neal site, may have contributed to local dust during the high wind event, evidence of high winds over a natural, undisturbed Mojave Desert region upwind of Clark County is clearly the main driver of this dust event. As shown by the timeline of events, high winds from a front lofted PM_{10} in the Mojave Desert source region and caused a regional dust event across southern California extending into Clark County. Even if there were some contributions from local dust sources due to high winds, the regional dust event is the main source of the extreme PM_{10} concentrations experienced on May 8, 2022.

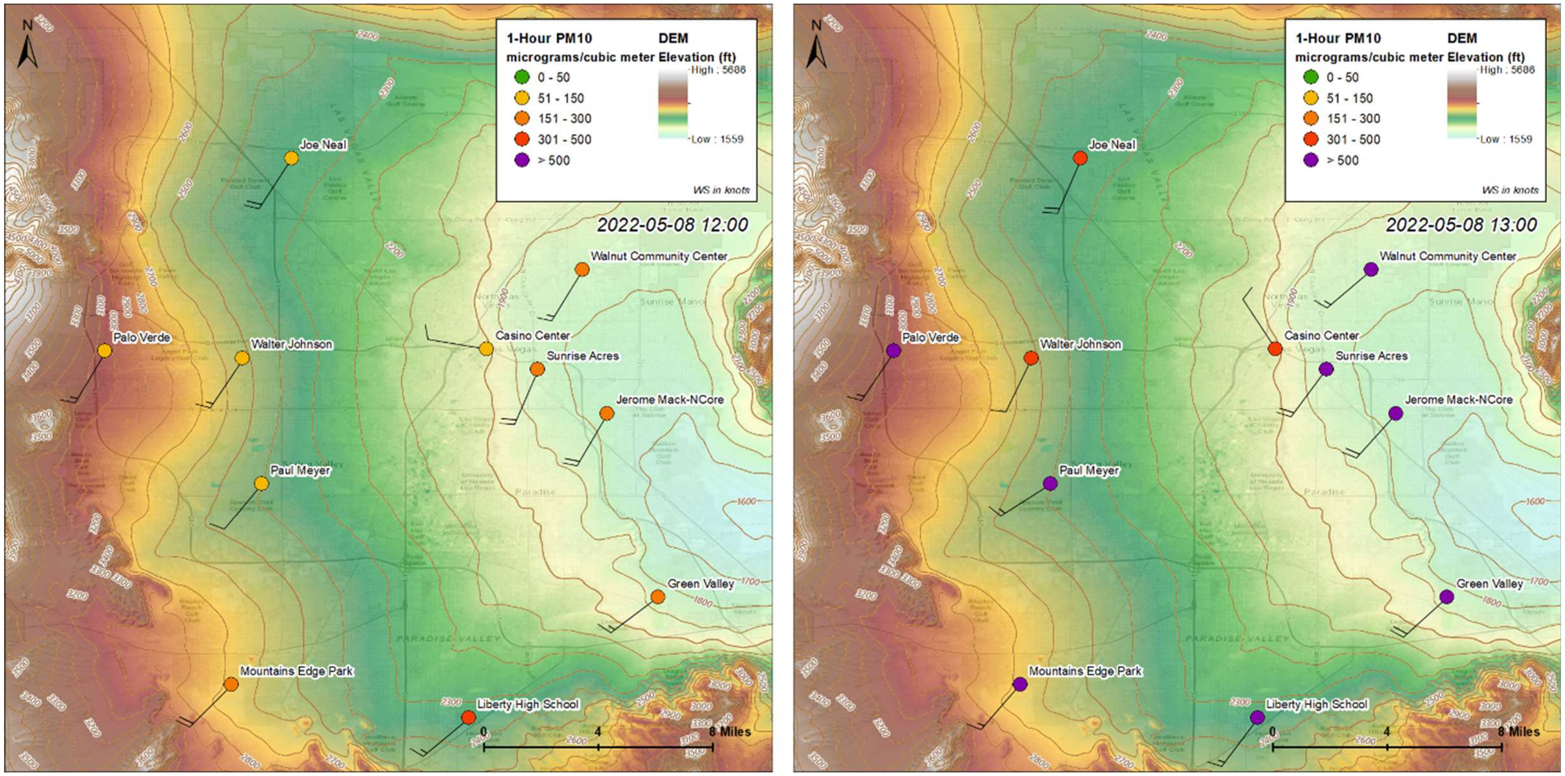


Figure 3.2-7. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for May 8, 2022, from 12:00 PST to 13:00 PST.

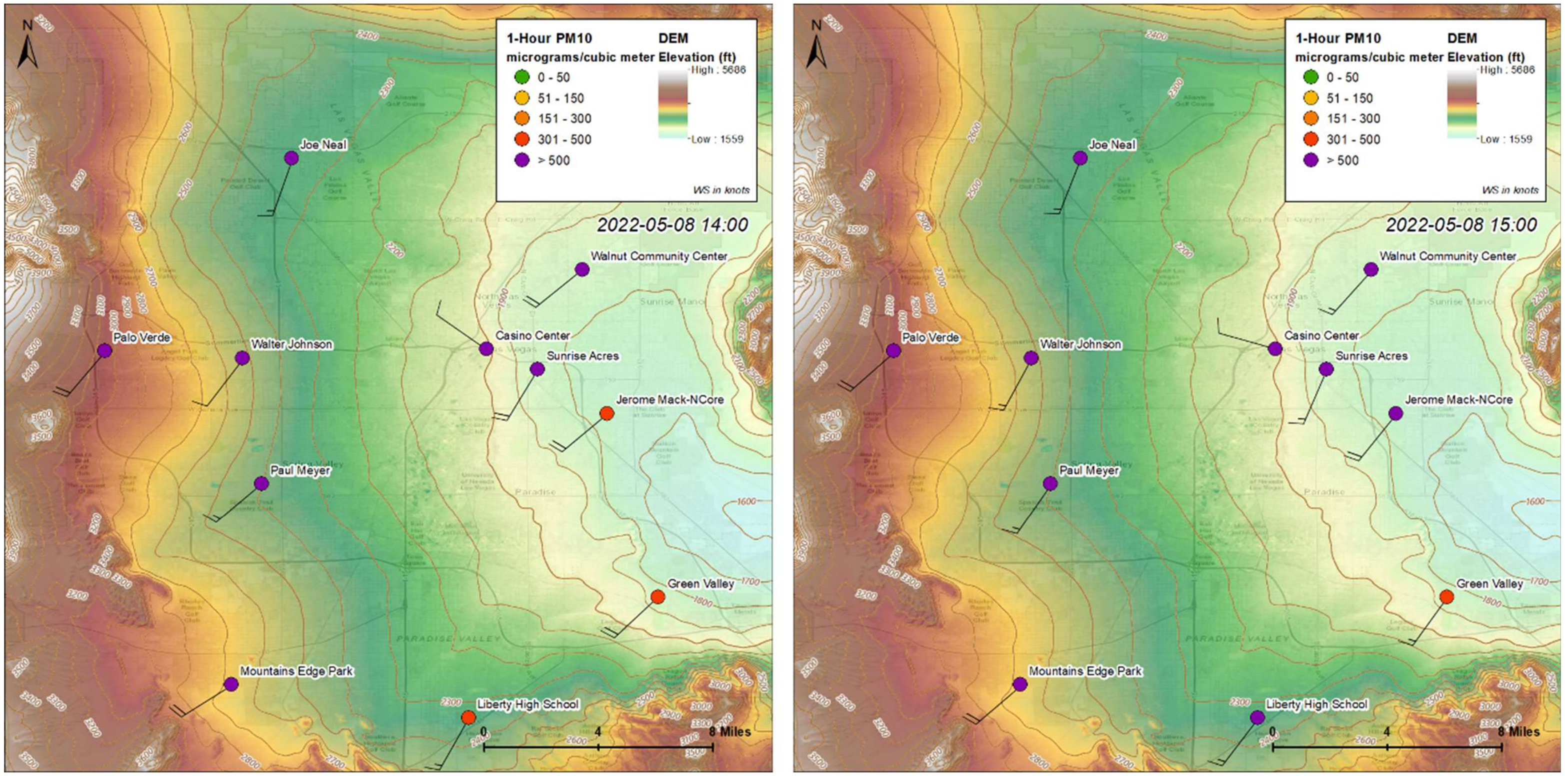


Figure 3.2-8. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for May 8, 2022, from 14:00 PST to 15:00 PST.

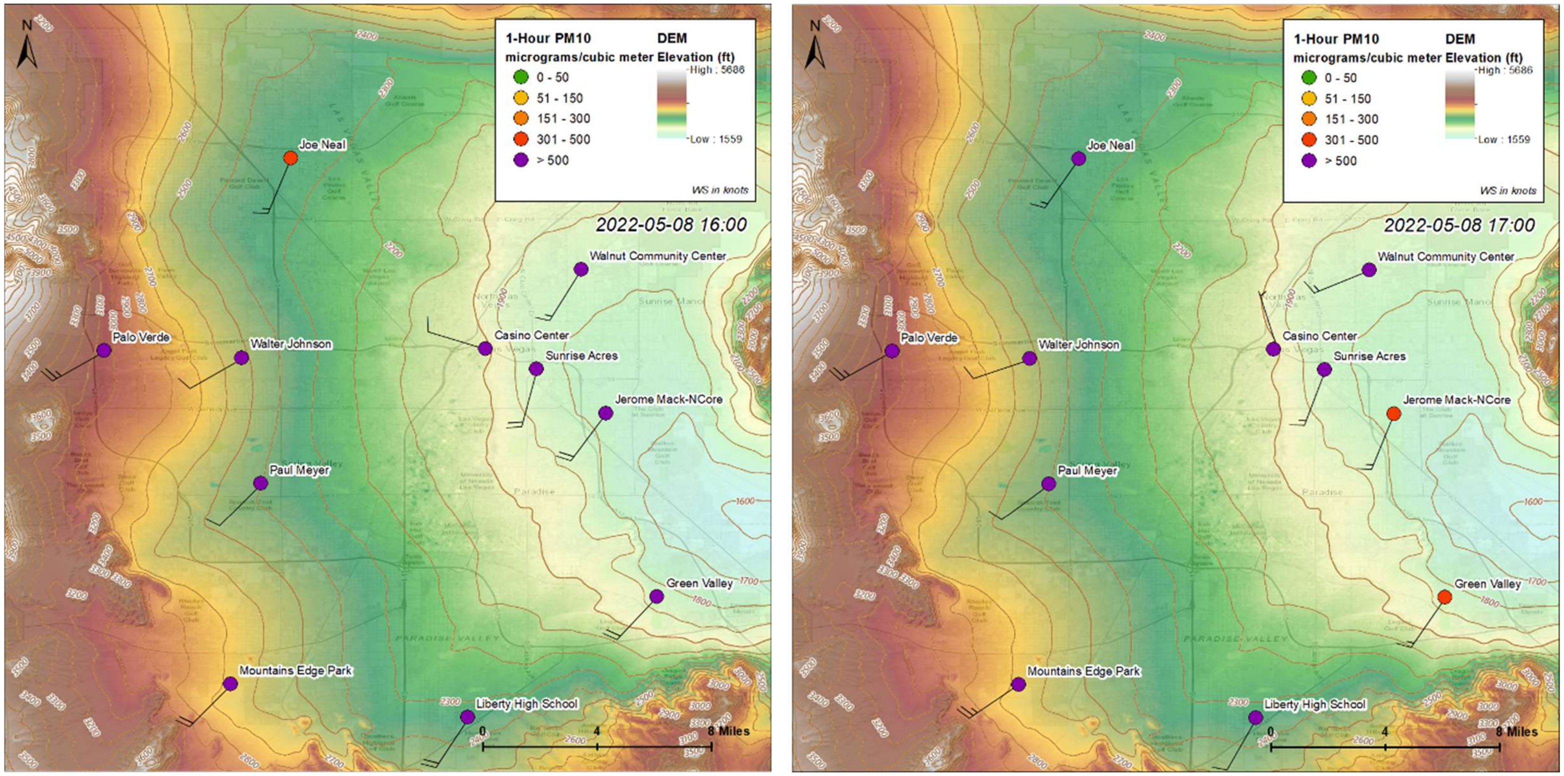


Figure 3.2-9. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for May 8, 2022, from 16:00 PST to 17:00 PST.

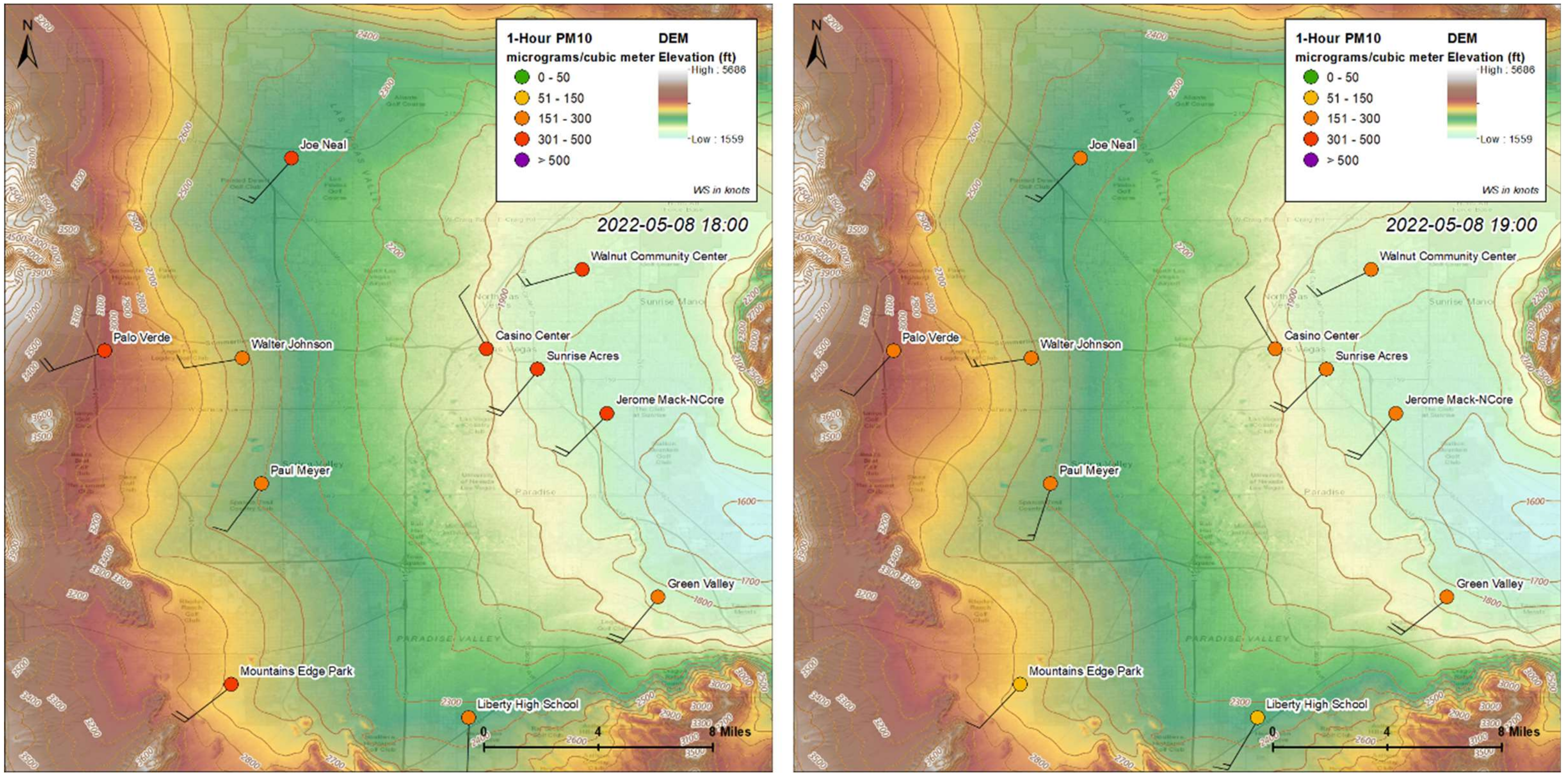


Figure 3.2-10. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for May 8, 2022, from 18:00 PST to 19:00 PST.

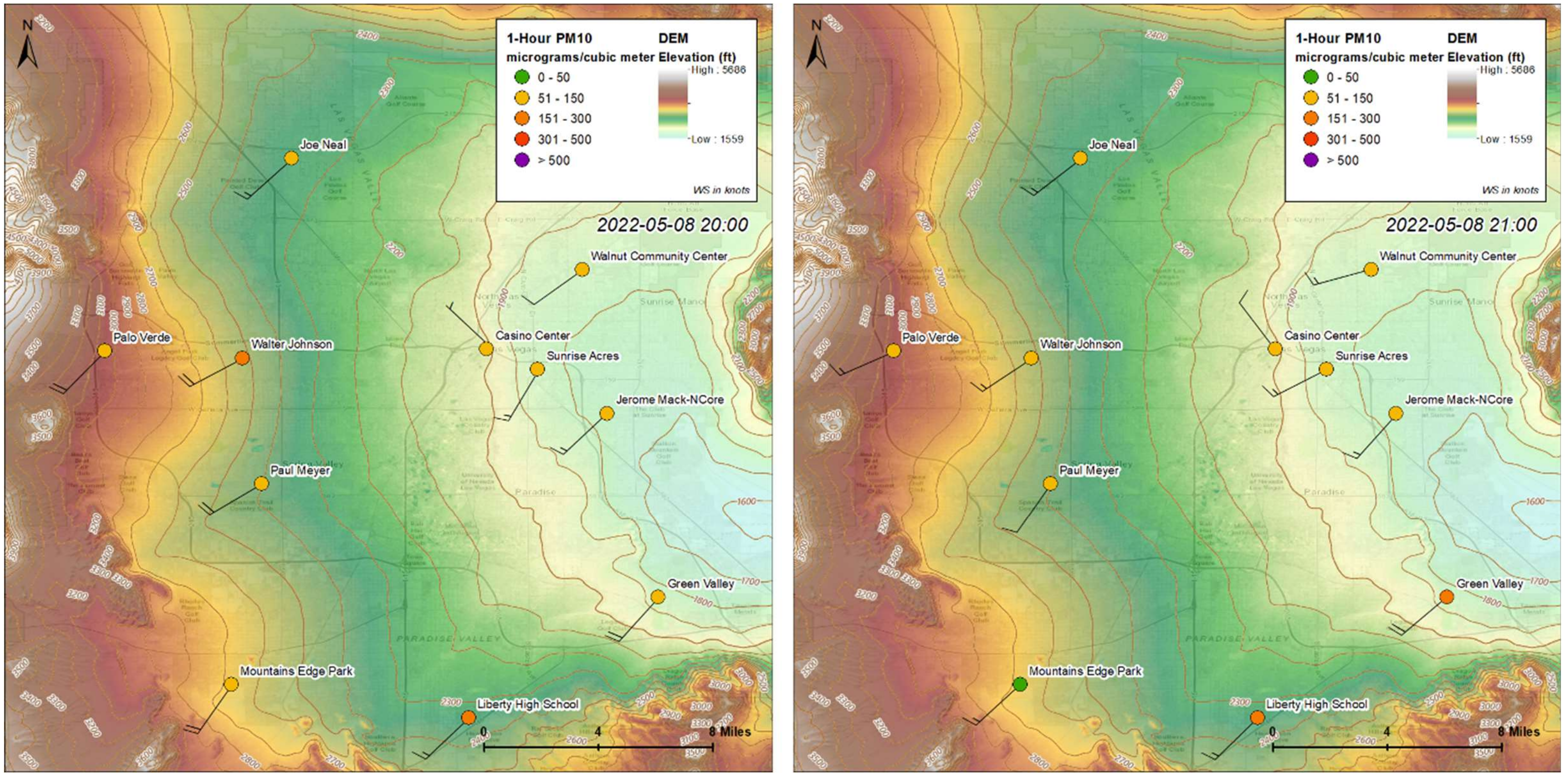


Figure 3.2-11. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for May 8, 2022, from 20:00 PST to 21:00 PST.

Peak sustained winds for Clark County, Nevada, and the surrounding regions were also confirmed using the Iowa State University Mesonet Automated Data aggregation tool, and the results are shown in Figure 3.2-12. This plot shows sustained winds greater than the 25-mph high-wind threshold on May 8, 2022, providing further proof that this was a high-wind event affecting the source region and Clark County.

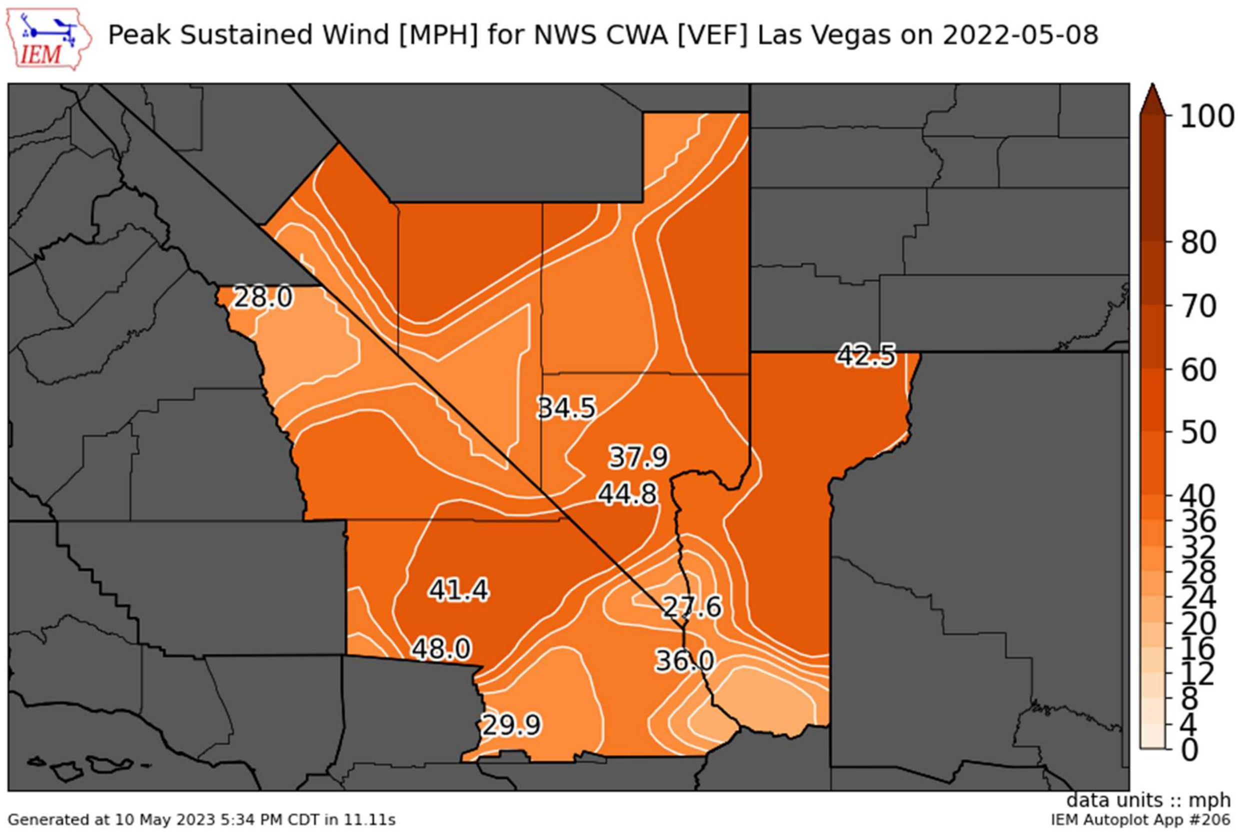


Figure 3.2-12. Peak sustained winds in Clark County, Nevada, and surrounding counties on May 8, 2022. Data source: https://mesonet.agron.iastate.edu/plotting/auto/.

Overall, we find overwhelming evidence that PM_{10} was transported by a strong frontal passage from the Mojave Desert in the late morning through evening on May 8, 2022. Hourly average wind speeds in the source region and along the transport path show sustained speeds greater than 25 mph, the high-wind threshold. PM_{10} concentrations from monitors along the frontal passage also show the lofted dust from the Mojave Desert in southeastern California. The evidence corroborating this assertion includes (1) HYSPLIT analyses showing transport from the Mojave Desert in southeastern California to Clark County in two to six hours, (2) changes in wind speed along the transport path, (3) enhanced PM_{10} concentrations from monitoring sites along the transport path, and (4) ground-based observation of PM_{10} and wind speed/direction in Clark County that corroborate the PM_{10} event time of arrival.

3.3 Impacts of Wind-Blown PM_{10} Dust at the Surface

3.3.1 Clark County Alerts

On Friday, May 6, 2022, Clark County issued a Dust Advisory to all dust control permit holders, contractors, and stationary sources to immediately inspect their sites and employ BACM to control and stabilize soil in advance of the dust event forecasted for May 8, 2022. **Figure 3.3-1** provides the email sent by Clark County. During a Dust Advisory, compliance officers inspect construction and stationary source sites during the dust event to ensure BACM are being implemented, with any violations receiving a Notice of Violation.

Clark County Nevada created a news release on May 6, 2022, indicating an air quality dust advisory that was issued for May 8, 2022 (**Figure 3.3-2**). They advised residents and local construction sites of the possible high levels of blowing dust due to high winds. During windy conditions, people with respiratory diseases, older adults, and children may feel better when staying indoors since they are at a greater risk. Airborne dust is described as a form of particulate matter pollution that aggravates respiratory diseases. The article includes recommendations such as limiting outdoor exertion when dust is in the air and keeping doors and windows closed to reduce exposure to the dust.

DES
DEPARTMENT OF ENVIRONMENT AND SUSTAINABILITY

Clark County Department of Environment and Sustainability

Division of Air Quality

DUST ADVISORY

for Sunday, May 8, 2022

Attention Dust Control Permit Holders, Contractors, and Stationary Sources

National Weather Service reports and the weather models used by the Division of Air Quality (DAQ) predict **sustained winds at 20-25 mph**, with **gusts of 35-45 mph**, beginning in the morning and lasting throughout the afternoon.

DAQ directs all permittees to immediately inspect their site(s) and employ Best Available Control Measures to stabilize all disturbed soils and reduce blowing dust. Permittees with multiple sites should contact each site superintendent to ensure compliance with the Clark County Air Quality Regulations.

BLASTING: This forecast is for wind gusts 35-45 mph or more. Project operators should not load blasting materials or perform any blasting operations. You are required to monitor National Weather Service reports for wind speeds; if wind gusts above 25 mph are forecast, discontinue charging additional blast holes. Limit the blast to holes charged at the time the wind report is made.

Compliance officers will inspect construction and stationary source sites during this episode to ensure Best Available Control Measures are being implemented. Any observed violation may receive a Notice of Violation.

Figure 3.3-1. News release by Clark County, Nevada, on Friday, May 6, 2022, for Sunday, May 8, 2022, indicating dust present and air quality advisory.

News Release

County Commission:
James B. Gibson, Chairman
Justin Jones, Vice Chairman
Marilyn Kirkpatrick
William McCurdy II
Ross Miller
Michael Naft
Tick Segerblom

Yolanda King, County Manager

Office of Public Communications • (702) 455-3546 • FAX (702) 455-3558 • www.ClarkCountyNV.gov

Contact: Kevin J. MacDonald
Public Information Officer

Mobile: (702) 232-0931
E-mail: KevMac@ClarkCountyNV.gov

For Immediate Release **Friday, May 6, 2022**

Air Quality Dust Advisory Issued for Sunday

The Clark County Department of Environment and Sustainability has issued a dust advisory for **Sunday, May 8,** to advise residents and local construction sites of the possibility of elevated levels of blowing dust due to the forecast of high winds in our area.

Airborne dust is a form of inhalable air pollution called particulate matter or PM, which aggravates respiratory diseases. Under windy conditions people with heart or lung disease, older adults, and children may feel better staying indoors as much as possible because they could be at greater risk from particulates, especially when they are physically active, according to the U.S. Environmental Protection Agency. Consult your physician if you have a medical condition that makes you sensitive to air pollution.

Figure 3.3-2. News release by Clark County Nevada on May 6, 2022, issuing the air quality dust advisory for May 8, 2022.

3.3.2 Media Coverage

Many news sources, including KTNV Las Vegas, the Las Vegas Review-Journal, Fox 5 Las Vegas, Satellite Liaison Blog, News 3, and Fox Weather reported on the windy conditions and dust present on May 8, 2022. The National Weather Service Las Vegas and IEM Bot VEF posted on X (formerly known as Twitter) about the dusty conditions, low visibility, and Dust Storm Warning on May 8, 2022 (Figure 3.3-3 through Figure 3.3-5). Screenshots of the news articles referenced in this section are provided in Appendix A.

KTNV Las Vegas reported that conditions on May 8, 2022, produced strong winds with dust storm warnings throughout the Great Southern Basin. Clark County, Nevada, and the southern tip of Nye County experienced high-winds warnings in effect until early in the day on May 9, 2022. There were concerns over blowing dust and low visibility on roadways. A red flag warning was also in effect for Southern Nevada and Mohave County due to the very dry air. (https://www.ktnv.com/weather/13-first-alert-weather-forecast-sunday-evening-may-8-2022)

KTNV Las Vegas reported on the high-wind warning, red flag warning, and wind advisory that were put in effect in the evening on May 8, 2022. There were concerns about blowing dust and debris due to the sustained southwest winds from 25-35 mph, and gusts that could reach above 50-60 mph in southern Nevada. The report noted high fire danger with the gusty winds and low relative humidity conditions with concerns over downed power lines, dust, and power outages. (https://www.ktnv.com/weather/13-first-alert-weather-forecast-sunday-morning-may-8-2022).

The Las Vegas Review-Journal reported that winds were bringing in a dust storm with a view of the Luxor building in Las Vegas. (https://www.reviewjournal.com/local/weather/red-rock-gust-hits-75-mph-winds-expected-to-diminish-overnight-2573318/attachment/the-luxor-is-seen-as-winds-bring-in-a-dust-storm-on-sunday-may-8-2022-in-las-vegas-chase-s/).

Fox 5 Las Vegas reported that there was a dust storm warning that lasted two hours with the strong winds that blew into Las Vegas on May 8, 2022. The Red Rock Canyon area in southern Nevada reported the highest wind gust reached 75 mph. The instability that was created by the low-pressure system weakened overnight, so winds on May 9 were a lot calmer until the afternoon. (https://www.fox5vegas.com/2022/05/09/forecast-outlook-5822/).

The Satellite Liaison Blog posted about the blowing dust, gusty winds, and low relative humidity across a broad area of the southwest United States on May 8, 2022. Critical fire conditions were present with many areas of blowing dust throughout the day, with wind gusts over 50 mph at the surface. (https://satelliteliaisonblog.com/2022/05/09/8-may-2022-blowing-dust/).

News 3 reported on the dust storm warning that the National Weather Service issued for areas in Southern Nevada on May 8, 2022, until 16:00 PDT. They warned about sudden drops in visibility and recommended drivers pull off the road. The winds were expected to peak from 16:00 PDT to 19:00 PDT at 30-40 mph, with gusts up to 60 mph. The high-wind warning was extended until 02:00 PDT on May 9, 2022. (https://news3lv.com/news/local/dust-storm-warning-issued-for-las-vegas-area).

Fox Weather reported on the dust storm across the Southwest U.S. that impacted visibility conditions. The Harry Reid International Airport in Las Vegas had low visibility conditions, which forced the Federal Aviation Administration (FAA) to issue a ground stop. On May 8, 2022, the National Weather Service issued Dust Storm Warnings about a "dust channel" across San Bernardino County in California. The California Department of Transportation reported many accidents in southeastern California, when there was visibility of less than a quarter of a mile on several interstates due to the dust. (https://www.foxweather.com/weather-news/dust-storm-swallows-cities-across-the-southwest)

The Las Vegas Review-Journal reported that during the weekend of May 7-8, 2022, and into the following week, people in southern Nevada, northwest Arizona, and southeast California needed to be aware of fire, wind, and dust dangers. The forecast for May 8, 2022, included sustained winds of 25-35 mph and gusts up to 60 mph for northeast and western Clark County, southern Nye County, the Spring Mountains, the Red Rock Canyon, and Las Vegas Valley, Nevada. Reports noted that power outages, damaging winds, and difficult travel were possible. (https://www.reviewjournal.com/local/weather/high-wind-warning-coming-for-mothers-day-in-las-vegas-2572862/).

The Las Vegas Review-Journal reported that the peak gust recorded in the region on May 8, 2022, was in the Red Rock Canyon, which reached a peak of 75 mph. (https://www.reviewjournal.com/local/weather/red-rock-gust-hits-75-mph-winds-expected-to-diminish-overnight-2573318/)

Figure 3.3-3. X post from the National Weather Service Las Vegas on May 8, 2022, indicating a dust storm warning and displaying dust in the area via the Black Mountain webcam.

Figure 3.3-4. X post from National Weather Service Las Vegas on May 8, 2022, displaying dust in the Las Vegas area via the Black Mountain webcam.

Figure 3.3-5. X post from a bot that automatically posted a dust storm warning for Clark County from May 8, 2022, from 13:02 to 15:00 PST.

Table 3.3-1 includes all urgent weather messages (include wind advisories) and dust storm warnings issued for Clark County, the Mojave source region, and the surrounding counties also affected by the dust event. Text associated with each of these warnings and messages is included in Appendix A.

Table 3.3-1. Warnings issued by the National Weather Service Las Vegas, Nevada, on May 8, 2022.

Warning	Time (PDT)	Location
Urgent Weather Message	00:11	Western Mojave Desert-Eastern Mojave Desert, Eastern Sierra Slopes-Owens Valley, Western Clark and Southern Nye County-Spring Mountains- Red Rock Canyon-Las Vegas Valley-Southern Clark County, White Mountains of Inyo County-Death Valley National Park- Esmeralda and Central Nye County-Lincoln County-Sheep Range, Northwest Plateau-Lake Mead National Recreation Area-Northeast Clark County, Lake Havasu and Fort Mohave-Northwest Deserts-Morongo Basin- Cadiz Basin-San Bernardino County-Upper Colorado River Valley

Warning	Time (PDT)	Location
Urgent Weather Message	08:54	Western Mojave Desert-Eastern Mojave Desert, Eastern Sierra Slopes-Owens Valley, Western Clark and Southern Nye County-Spring Mountains- Red Rock Canyon-Las Vegas Valley-Southern Clark County, White Mountains of Inyo County-Death Valley National Park- Esmeralda and Central Nye County-Lincoln County-Sheep Range, Northwest Plateau-Lake Mead National Recreation Area-Northeast Clark County, Lake Havasu and Fort Mohave-Northwest Deserts-Morongo Basin- Cadiz Basin-San Bernardino County-Upper Colorado River Valley,
Dust Storm Warning	14:02	Central Clark County in southern Nevada
Dust Storm Warning	14:21	Central Clark County
Dust Storm Warning	14:34	East-central Esmeralda County in south-central Nevada
Dust Storm Warning	14:45	West-central San Bernardino County in southern California
Dust Storm Warning	15:00	North-central San Bernardino County in southern California, southeastern Inyo County in south central California
Dust Storm Warning	15:20	East-central Esmeralda County
Dust Storm Warning	15:40	Central Mohave County in northwestern Arizona
Dust Storm Warning	15:51	Central Clark County
Dust Storm Warning	15:56	East-central Esmeralda County in south-central Nevada
Dust Storm Warning	15:59	East-central Esmeralda County
Dust Storm Warning	16:19	North-central San Bernardino and southeastern Inyo Counties
Dust Storm Warning	16:37	West-central San Bernardino County
Dust Storm Warning	16:52	North-central San Bernardino and southeastern Inyo Counties
Dust Storm Warning	17:18	South-central San Bernardino County in southern California
Dust Storm Warning	17:39	Central Mohave County
Dust Storm Warning	17:53	East-central Esmeralda County
Dust Storm Warning	18:01	South-central San Bernardino County
Dust Storm Warning	18:40	South-central San Bernardino County

Warning	Time (PDT)	Location
Urgent Weather Message	22:47	Eastern Sierra Slopes-Owens Valley, Western Clark and Southern Nye County-Spring Mountains- Red Rock Canyon-Las Vegas Valley-Southern Clark County, White Mountains of Inyo County-Death Valley National Park-Esmeralda and Central Nye County-Lincoln County-Sheep Range, Northwest Plateau-Lake Mead National Recreation Area- Northeast Clark County, Lake Havasu and Fort Mohave-Northwest Deserts-Morongo Basin- Cadiz Basin-San Bernardino County-Upper Colorado River Valley, Western Mojave Desert-Eastern Mojave Desert

3.3.3 Pollutant and Diurnal Analysis

As discussed in **Section 3.2**, the period of high PM_{10} concentrations in the Las Vegas Valley on May 8, 2022, coincided with high-wind speeds related to an approaching frontal system. **Figure 3.3-6** shows the hourly PM_{10} concentrations at monitoring sites throughout Clark County. At 11:00 PST, all sites showed a rapid increase in PM_{10} concentrations, with most sites reaching a peak concentration between 12:00 and 18:00 PST. A majority of stations measured PM_{10} concentrations that exceeded 600 µg/m^3 on the event date. The maximum hourly concentration measured on May 8, 2022, was 1,204 µg/m^3 at the Mountains Edge site. Enhanced PM_{10} concentrations persisted through 18:00 before falling steadily through midnight.

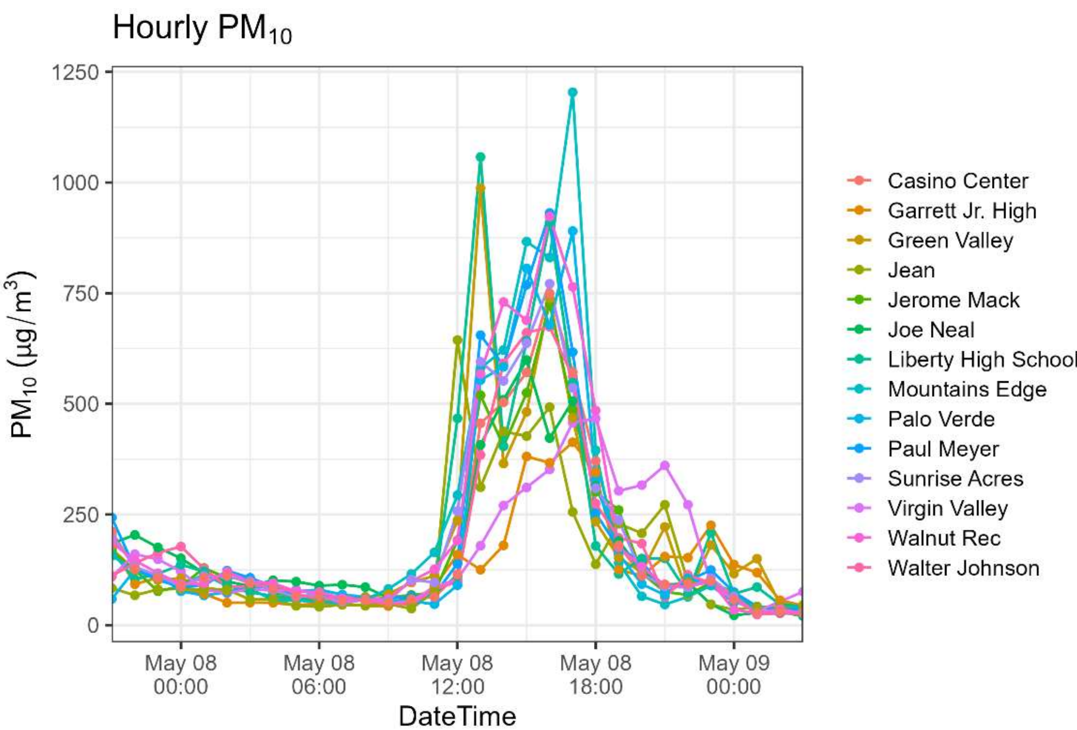


Figure 3.3-6. Hourly PM_{10} concentration observations in µg/m^3 from all Clark County measurement sites on the event date, including the regulatorily significant sites: Paul Meyer, Walter Johnson, Palo Verde, Joe Neal, Green Valley, Jerome Mack, and Sunrise Acres.

The 24-hour average PM_{10} values at all sites in Clark County remained below the 99th percentile of the five-year (2018-2022) historical values before the exceedance event on May 8, 2022 (**Figure 3.3-7**). On May 8, the day of the exceedance, the 24-hour average PM_{10} values at all sites exceeded the 99th percentile value. PM_{10} concentrations at all but one site in the area exceeded the NAAQS value of 150 µg/m^3, with the Mountain's Edge site recording the highest concentration of 258 µg/m^3 and the Jean site recording the lowest of 177 µg/m^3. The simultaneous increase in PM_{10} concentrations at all sites, with all exceeding the 99th percentile threshold, suggests a regional source of PM_{10} pollution such as a windblown dust event.

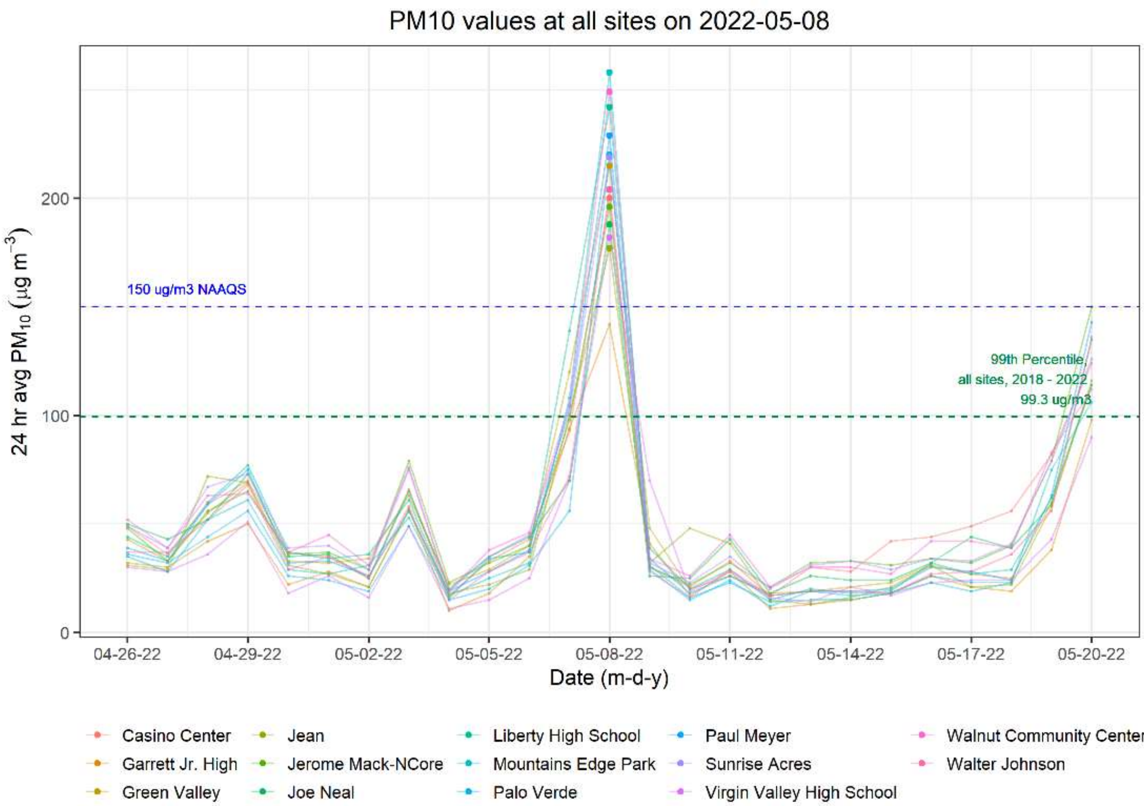


Figure 3.3-7. PM_{10} values at all Clark County, Nevada, measurement sites from April 26-May 20, 2022, with the NAAQS (blue dash) indicated. The green dashed line indicates 99.3 µg/m^3, the 99th percentile of the combined five-year historical values at these sites.

Figure 3.3-8 shows the measured hourly PM_{10} concentrations on May 8, 2022, together with the diurnal profile of the historical hourly data from 2018-2022. Measurements above the five-year 95th percentile are shown in red. A peak in hourly PM_{10} measurements was first identified on May 7, 2022. Most sites returned to below the 95th percentile overnight. On May 8, starting near 09:00 PST, the hourly PM_{10} concentrations again surpassed the five-year 95th percentile. Peak values near 1,000 µg/m^3 were observed between 12:00-18:00 PST for these sites and returned to normal values near midnight.

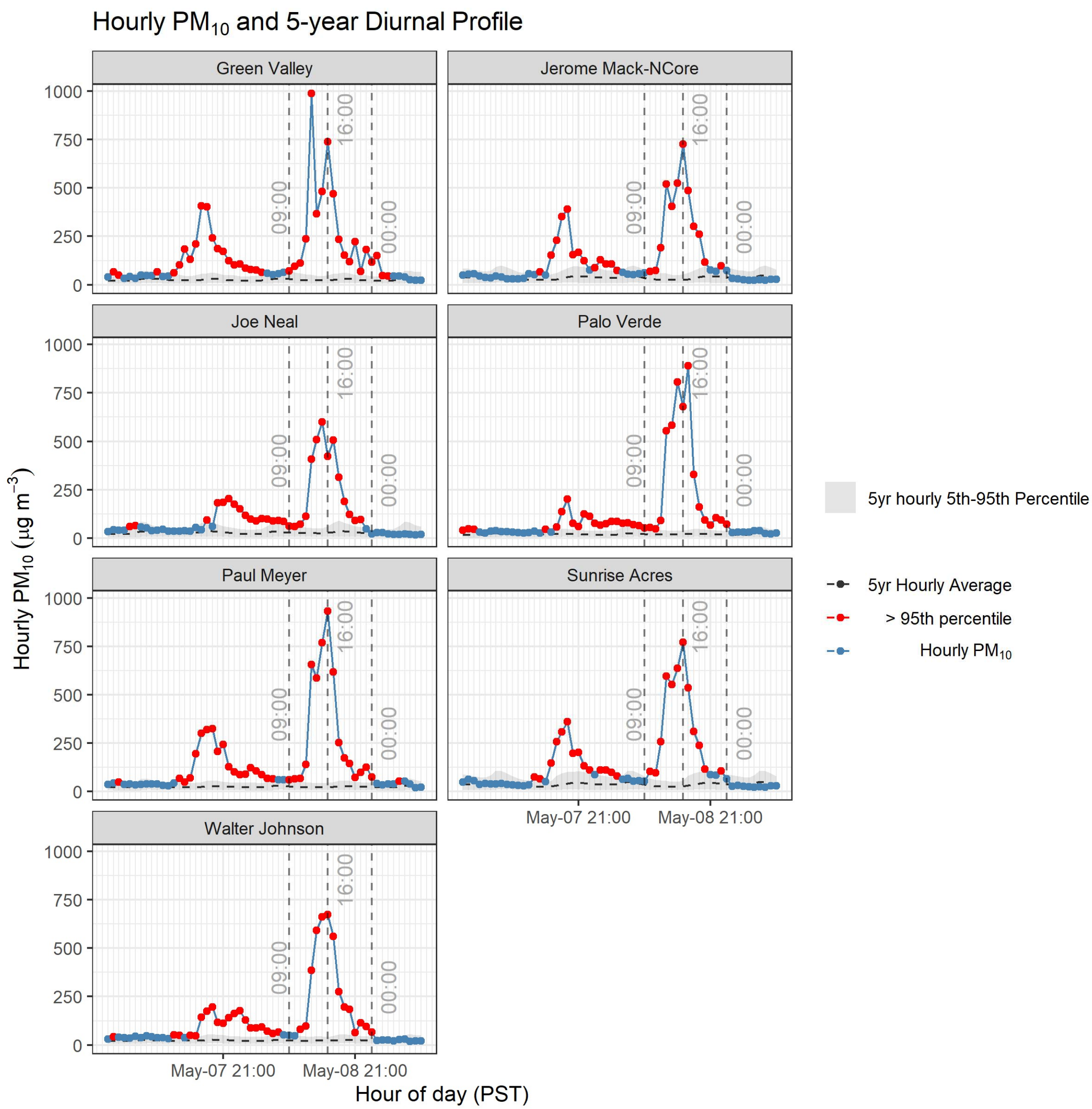


Figure 3.3-8. Measured hourly PM_{10} values compared to five-year diurnal pattern. The dotted solid line represents the hourly PM_{10} values measured on the event day at each site. The dashed line represents the mean hourly PM_{10} concentration for each hour of the day from 2018-2022 at each site, and the shaded area indicates the 5th to 95th percentile. Measurements above the five-year 95th percentile are shown in red.

3.3.4 Particulate Matter Analysis

Before the high-wind dust event on May 8, 2022, the hourly $PM_{2.5}/PM_{10}$ ratios was below average at all sites based on the 2018-2022 ratio data (Figure 3.3-9). Around noon on May 8, the hourly $PM_{2.5}/PM_{10}$ ratio at all sites dropped to or below the 5th percentile and stayed below the 5th percentile for the rest of the day. The low $PM_{2.5}/PM_{10}$ ratio value of less than 0.1 is consistent with values from dust events reported in studies (Jiang et al., 2018). The decrease in the $PM_{2.5}/PM_{10}$ ratios observed during midday is also consistent with the increase in hourly PM_{10} concentrations, as described in **Section 3.2.2**. $PM_{2.5}/PM_{10}$ ratios rose early in the morning on May 9, then continued to rise to less than normal levels throughout the day following the high-wind dust event.

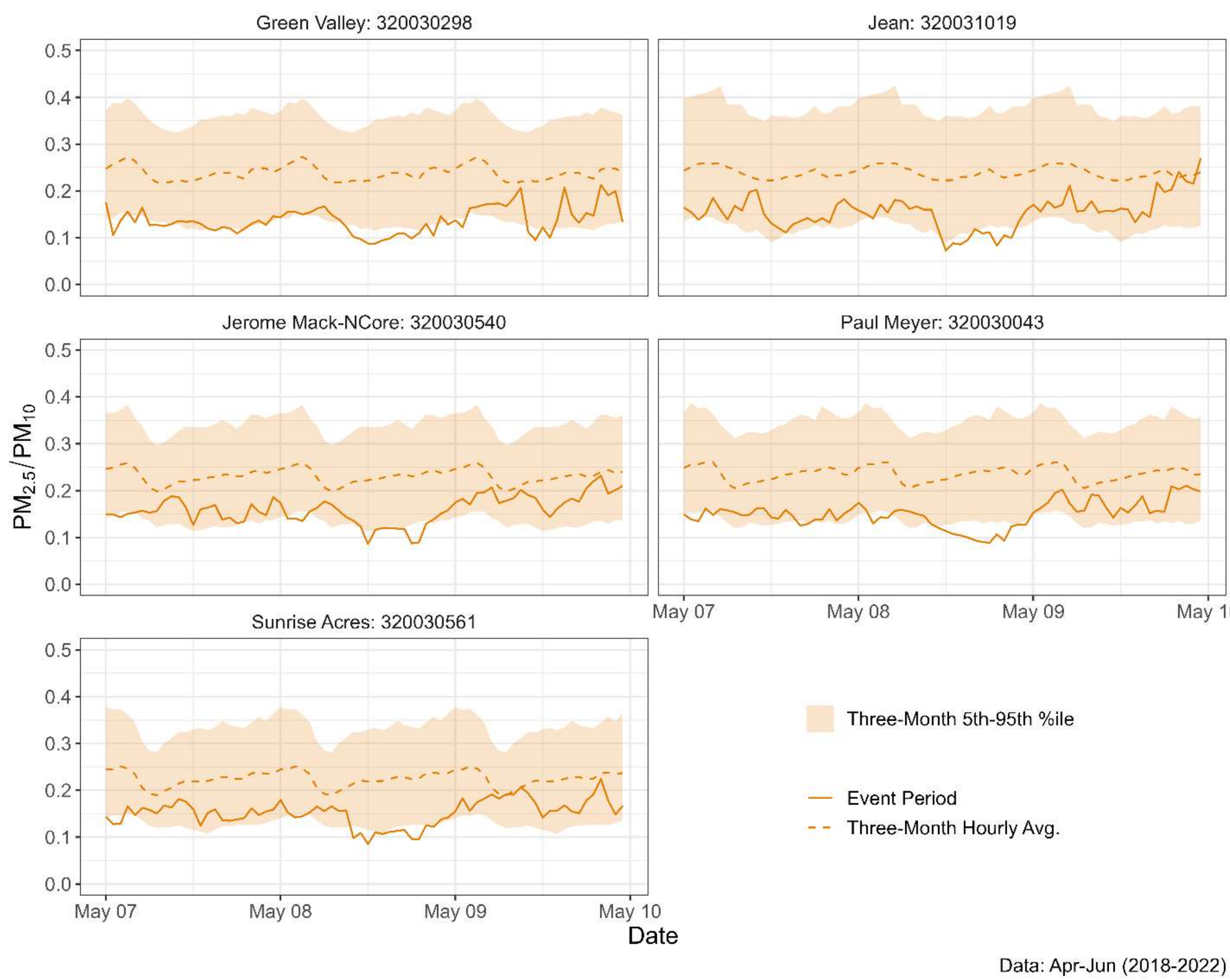


Figure 3.3-9. Ratio of $PM_{2.5}/PM_{10}$ concentrations at the Green Valley, Jean, Jerome Mack, Paul Meyer, and Sunrise Acres sites before, during, and after the May 8, 2022, PM_{10} exceedance. The five-year average $PM_{2.5}/PM_{10}$ diurnal ratio is displayed as a dotted line, and the 5th to 95th percentile range is shown as a shaded ribbon. The average and 5th to 95th percentile ratio is calculated across April-June of 2018-2022.

Speciated $PM_{2.5}$ measurements were recorded at the Jerome Mack site on May 8, 2022. $PM_{2.5}$ measurements are collected on a three-day cadence in Clark County. **Figure 3.3-10** shows the measurements of crustal elements calcium, iron, and potassium, as well as soil during the wind-blown dust event, in comparison to the 90th percentile measurement calculated across seven years of data. On May 8, the concentration of each examined parameter was well above the 90th percentile concentration. This evidence strongly supports the abundance of airborne, soil-based dust during the event period.

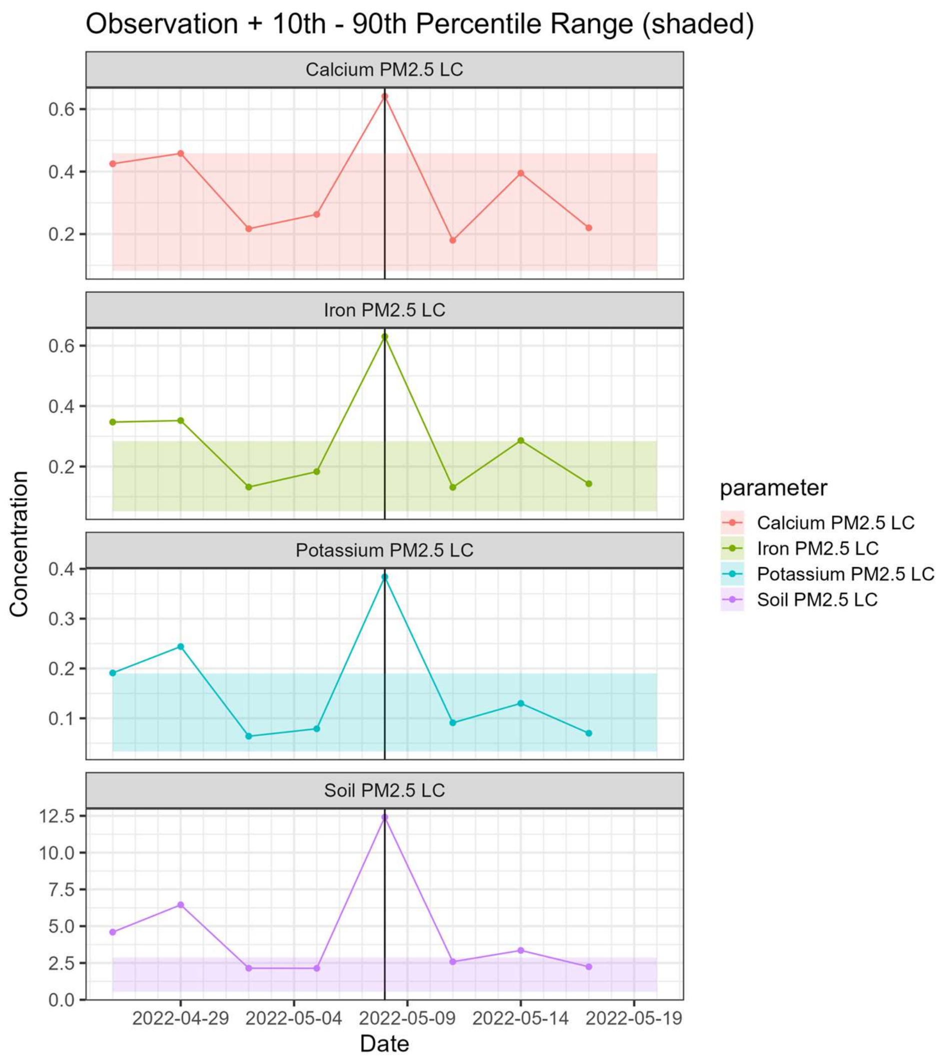


Figure 3.3-10. Speciated $PM_{2.5}$ measurements recorded at the Jerome Mack monitoring site. The shaded region shows the 10th-90th percentile of measurements calculated over 7 years (2016-2022).

3.3.5 Visibility/Ground-Based Images

Visibility data is available from airport monitoring sites at LAS through the NWS Weather and Hazards Data Viewer. Figure 3.3-11 shows visibility observations on May 8, 2022, at LAS in Las Vegas. Concurrent with the increasing wind speeds and the estimated time of the frontal passage, visibility decreased between 12:00-14:00 PST, and remained below the 10-mile maximum measurement through 19:00 PST. This is confirmed by camera images taken in the Las Vegas Valley (**Figure 3.3-12** through **Figure 3.3-16**), which show the increased intensity of the dusty conditions and low visibility between 12:00 and 14:00 PST.

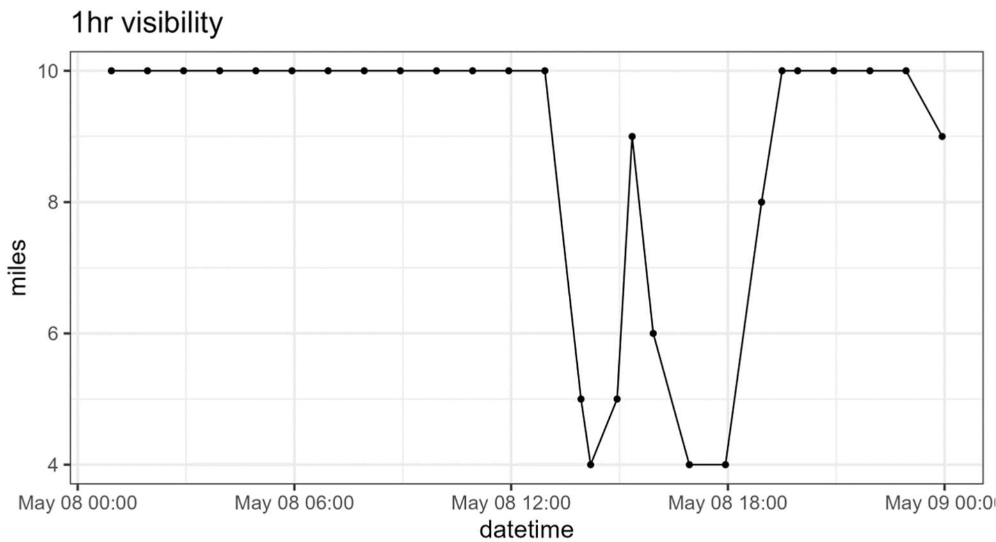


Figure 3.3-11. Visibility in miles on May 8, 2022, recorded at LAS. Visibility data is sourced from the Iowa Environmental Mesonet (*https://mesonet.agron.iastate.edu/*).

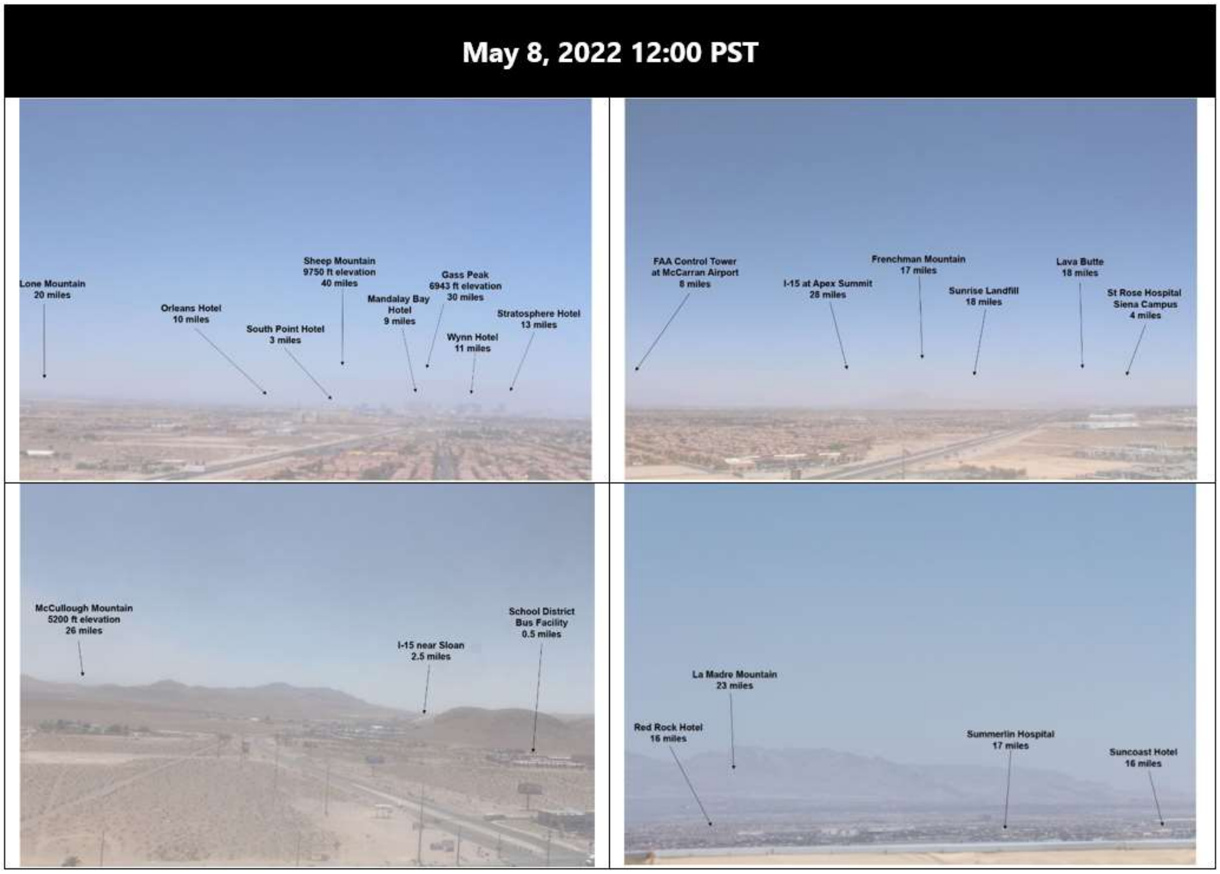


Figure 3.3-12. Camera images the north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions taken from the M Resort Hotel in Clark County, Nevada, on May 8, 2022, at 12:00 PST.

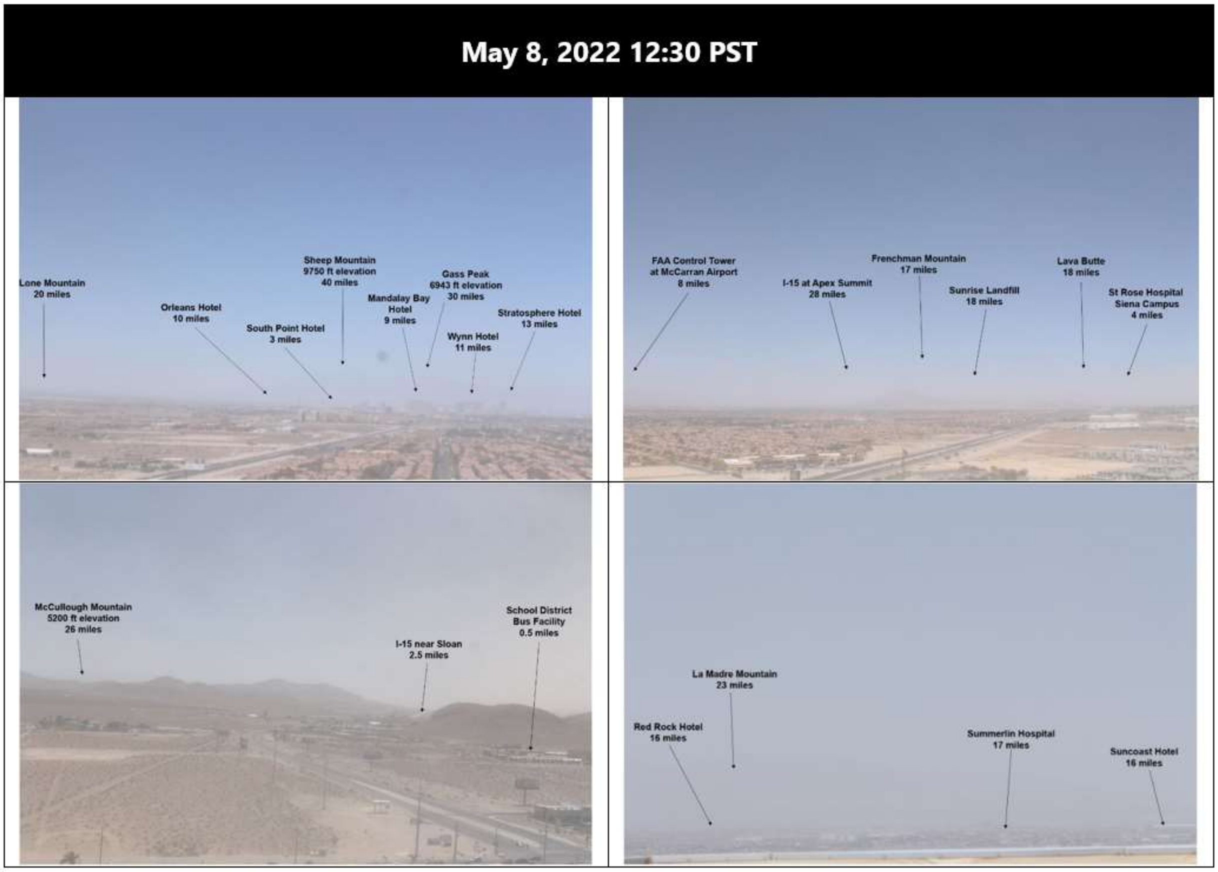


Figure 3.3-13. Camera images the north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions taken from the M Resort Hotel in Clark County, Nevada, on May 8, 2022, at 12:30 PST.

Figure 3.3-14. Camera images the north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions taken from the M Resort Hotel in Clark County, Nevada, on May 8, 2022, at 13:00 PST.

Figure 3.3-15. Camera images for the north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions taken from the M Resort Hotel in Clark County, Nevada, on May 8, 2022, at 13:30 PST.

Figure 3.3-16. Camera images the north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions taken from the M Resort Hotel in Clark County, Nevada, on May 8, 2022, at 14:00 PST.

Overall, we find overwhelming evidence that PM_{10} was transported from the Mojave Desert in southeastern California to Clark County by approximately 11:00-18:00 PST on May 8, 2022. PM_{10} concentrations increased along with the frontal passage that entered the Clark County area at approximately 11:00 PST on May 8, and peaked at around 13:00-18:00 PST. This suggests that Clark County was impacted by a regional high-wind dust event originating in the Mojave Desert. The evidence corroborating this assertion includes (1) forecasted alerts and media coverage in Clark County and surrounding areas; (2) an abrupt, concurrent increase in PM_{10} concentrations at all monitoring sites in Clark County; (3) a drop in $PM_{2.5}/PM_{10}$ ratio values, indicating windblown dust sources; (4) decreased visibility at the LAS airport corresponding with the PM_{10} event time of arrival; and, (5) extremely dusty ground-based images from the M Resort Hotel in Las Vegas on May 8. All pieces of evidence suggest a significant impact of windblown dust at the surface in Clark County on the event date.

3.4 Comparison of Exceptional Event with Historical Data

3.4.1 Percentile Ranking

The 24-hour average PM_{10} concentration observed on May 8, 2022, ranked above the 99.3 percentile of all the concentrations observed in the five-year period from 2018-2022 at all monitoring sites, as shown in Table 3.4-1.

Table 3.4-1. Five-year (2018-2022) rank and percentile of PM_{10} values on May 8, 2022 at affected sites.

Date	Site	Rank	Percentile	24-hour PM_{10} (µg/m^3)
5/8/2022	Casino Center*	2	99.67	200
5/8/2022	Green Valley	5	99.78	215
5/8/2022	Jean	6	99.72	177
5/8/2022	Jerome Mack	8	99.61	196
5/8/2022	Joe Neal	5	99.78	188
5/8/2022	Liberty High School*	4	99.51	242
5/8/2022	Mountains Edge Park*	3	99.76	258
5/8/2022	Palo Verde	3	99.89	220
5/8/2022	Paul Meyer	4	99.83	229
5/8/2022	Sunrise Acres	6	99.72	219
5/8/2022	Virgin Valley High School*	2	99.86	182
5/8/2022	Walnut Community Center*	5	99.31	249
5/8/2022	Walter Johnson	5	99.78	204

*Sites that began data collection less than 5 years ago.

Annual time series graphs of 24-hour average PM_{10} concentrations for each affected site (regulatorily and not regulatorily significant) are provided in Figure 3.4-1 through Figure 3.4-13. May 8, 2022, is marked by a red point for comparison to the 150 µg /m^3 NAAQS threshold (blue line) and the five-year (2018-2022) 99th percentile (green line), as described in Table 2.2-1. At all sites, observations of PM_{10} concentrations on May 8 were above the five-year 99th percentile.

Five-year time series graphs of 24-hour average PM_{10} concentrations for each affected site (regulatorily and not regulatorily significant) are provided in **Figure 3.4-14 through Figure 3.4-26** to further compare the event day to the range of normal values. Other exceedances of the 150 µg/m^3 NAAQS threshold (blue dashed line) were further investigated for potential dust event evidence based on meteorological data and visibility camera images to compare to conditions on May 8, 2022. Days that showed preliminary evidence of being a high-wind dust event or for which other exceptional event narratives have been prepared are also marked in the annual and five-year time series figures at all sites.

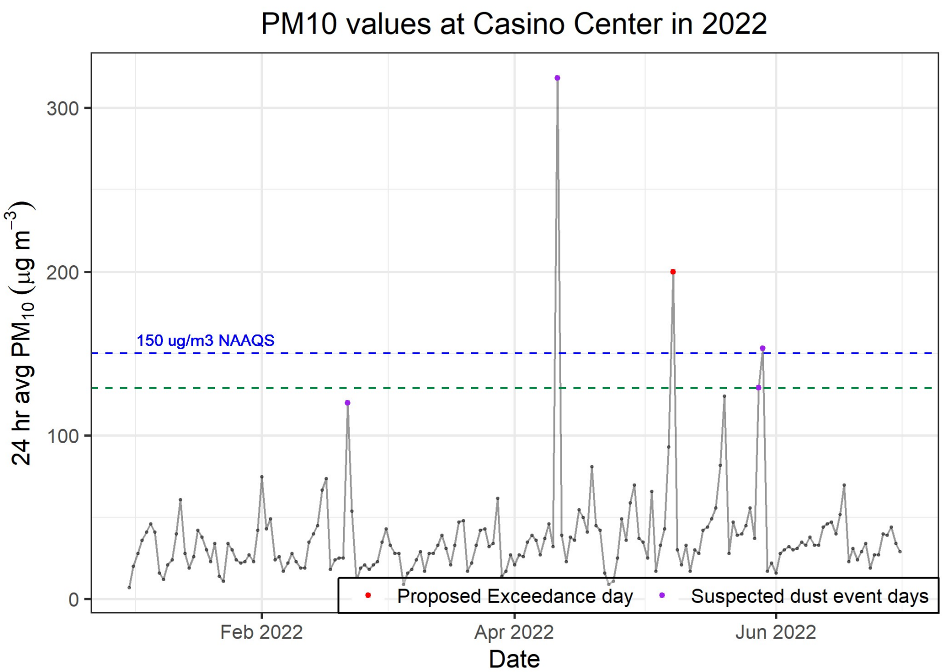


Figure 3.4-1. Casino Center monitoring site 24-hour PM_{10} measurements in µg/m^3 for 2022, showing the (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day.

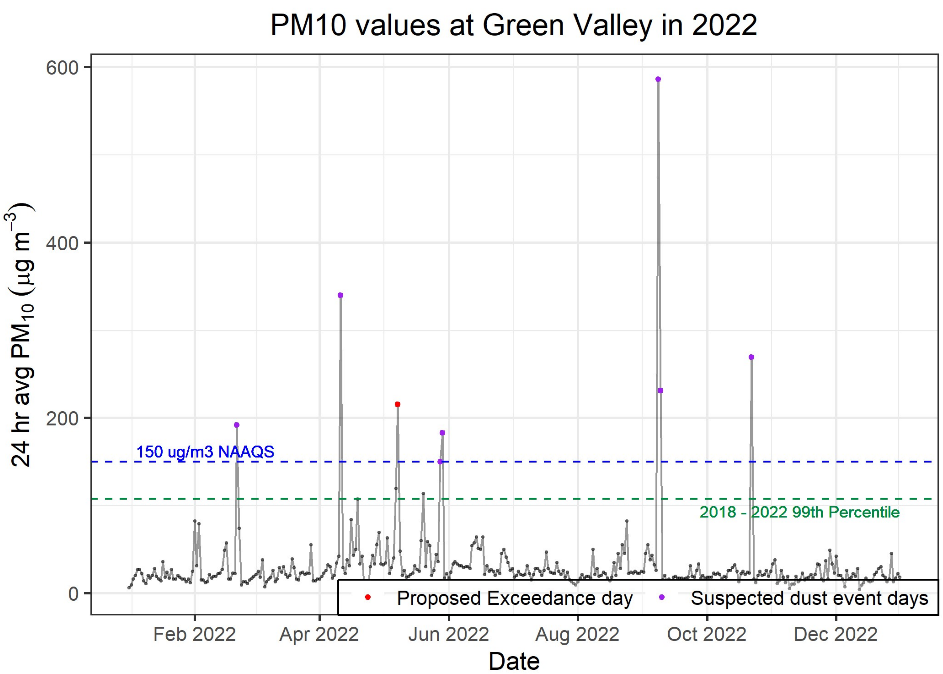


Figure 3.4-2. Green Valley monitoring site 24-hour PM_{10} measurements in µg/m^3 for 2022, showing the (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day.

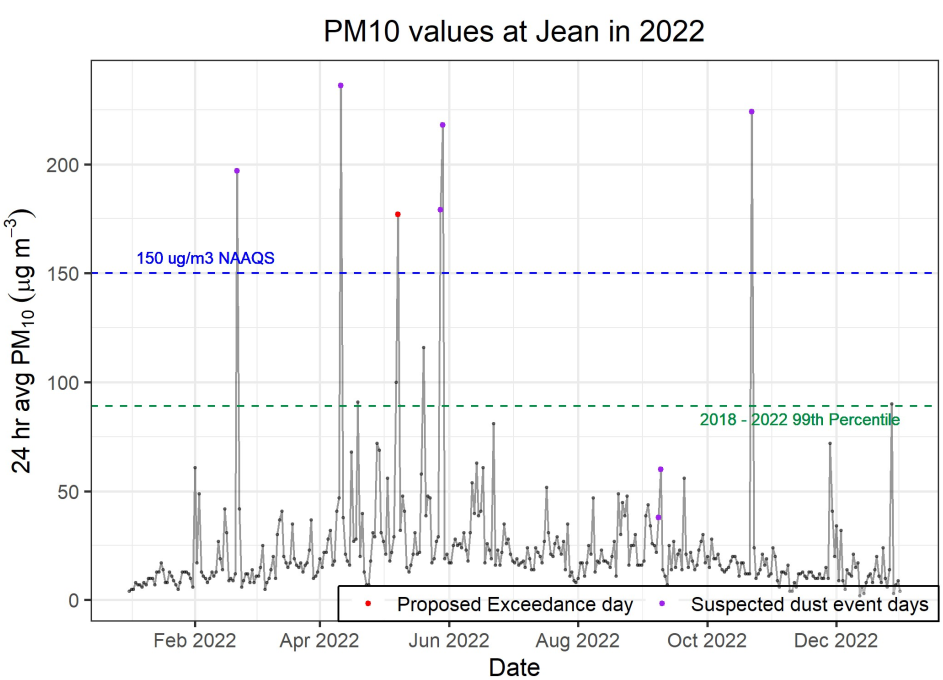


Figure 3.4-3. Jean monitoring site 24-hour PM_{10} measurements in µg/m^3 for 2022, showing the (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day.

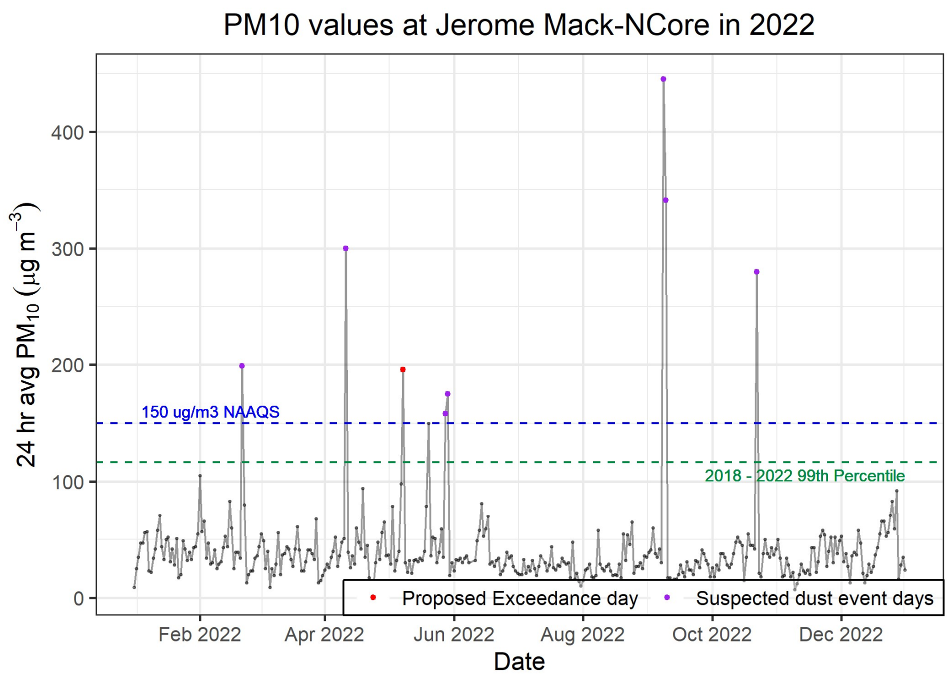


Figure 3.4-4. Jerome Mack monitoring site 24-hour PM_{10} measurements in µg/m^3 for 2022, showing the (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day.

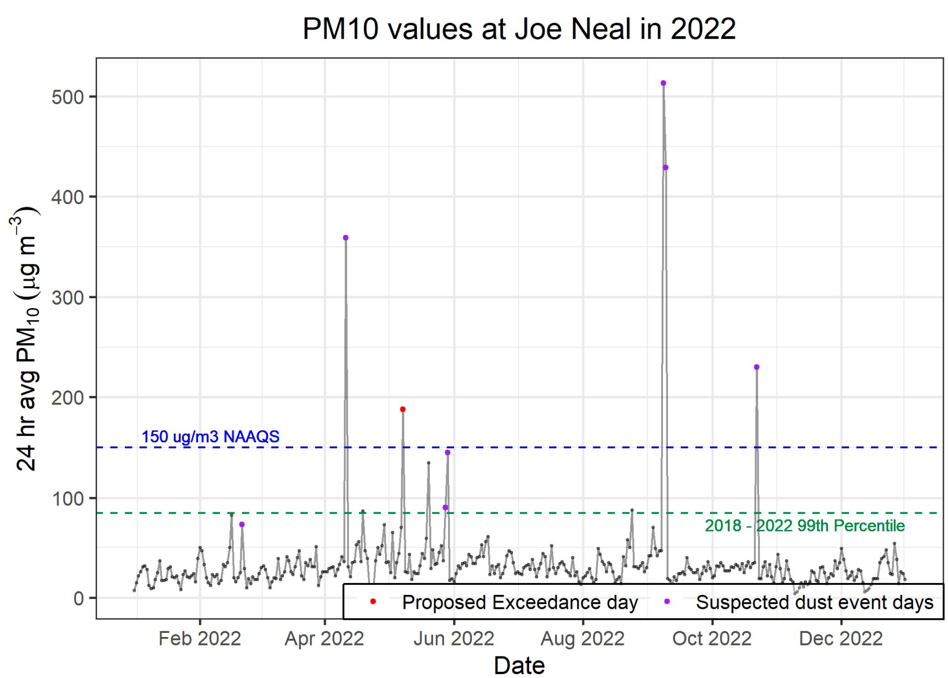


Figure 3.4-5. Joe Neal monitoring site 24-hour PM_{10} measurements in µg/m^3 for 2022, showing the (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day.

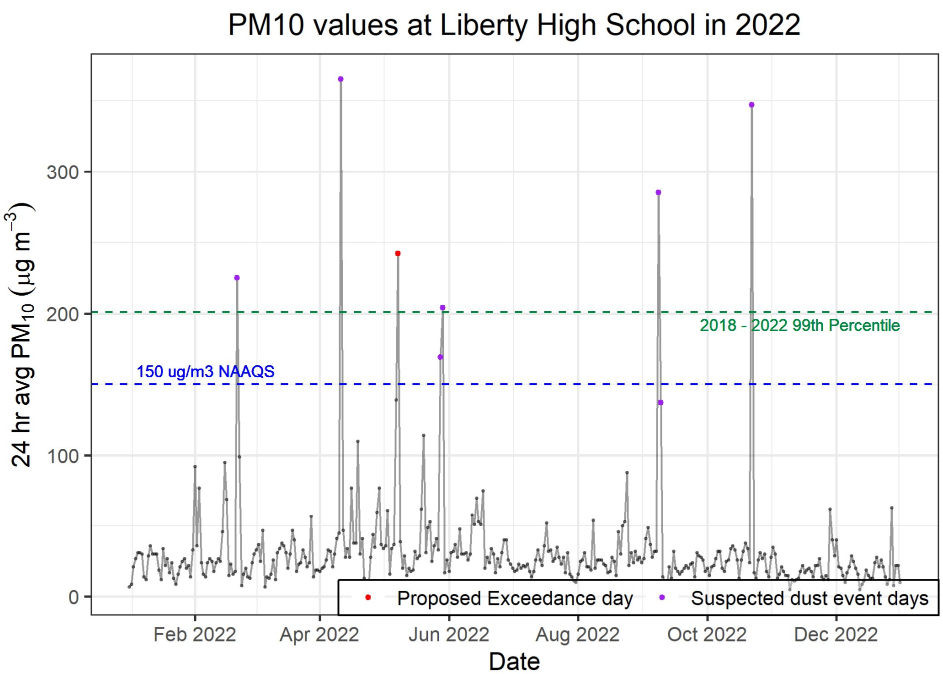


Figure 3.4-6. Liberty High School monitoring site 24-hour PM_{10} measurements in μg/m^3 for 2022, showing the (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day.

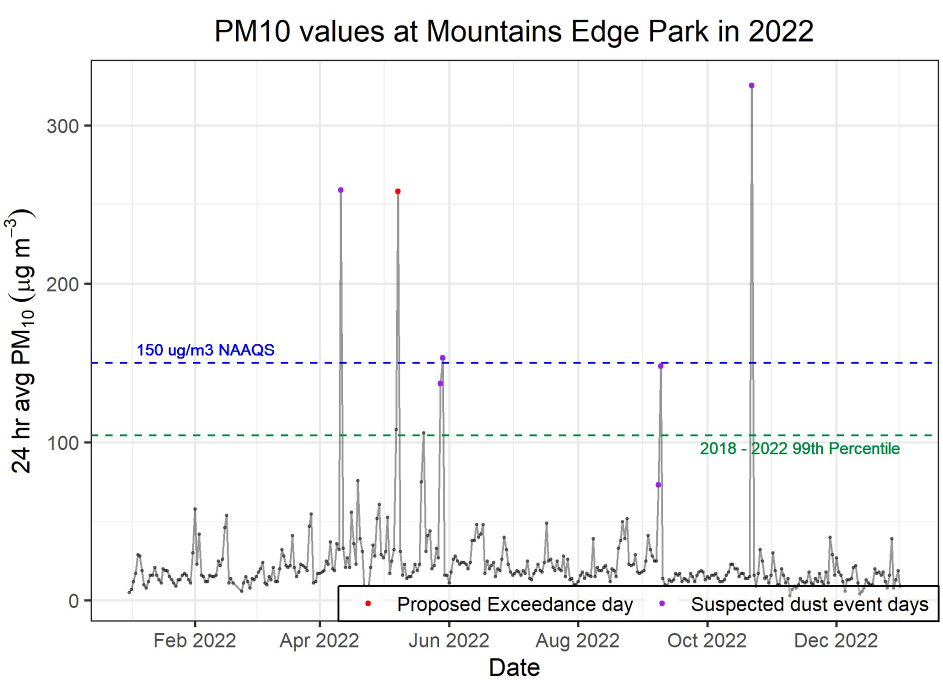


Figure 3.4-7. Mountains Edge Park monitoring site 24-hour PM_{10} measurements in μg/m^3 for 2022, showing the (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day.

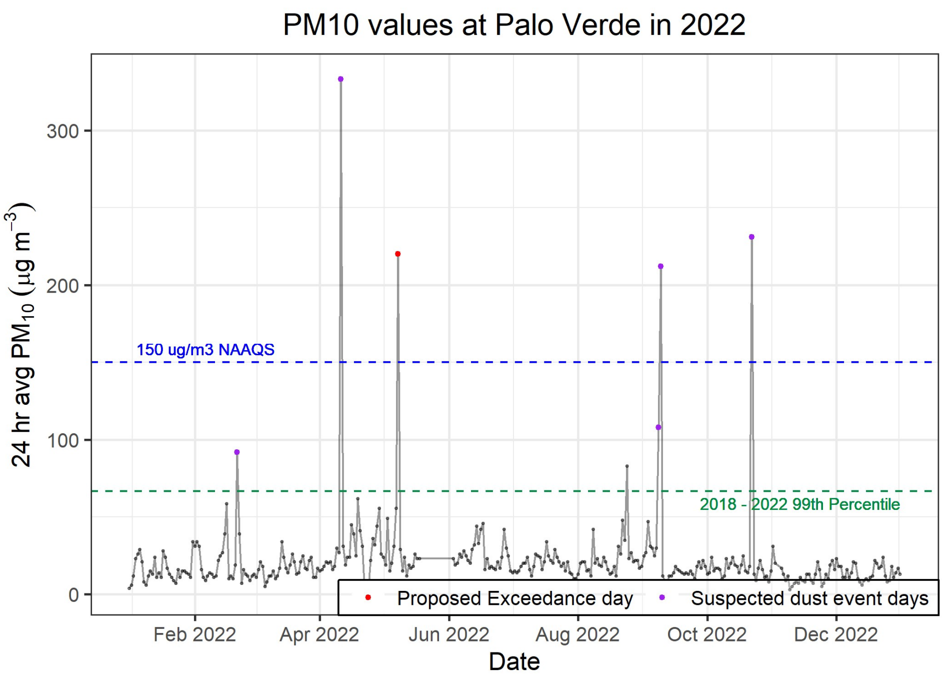


Figure 3.4-8. Palo Verde monitoring site 24-hour PM_{10} measurements in µg/m^3 for 2022, showing the (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day.

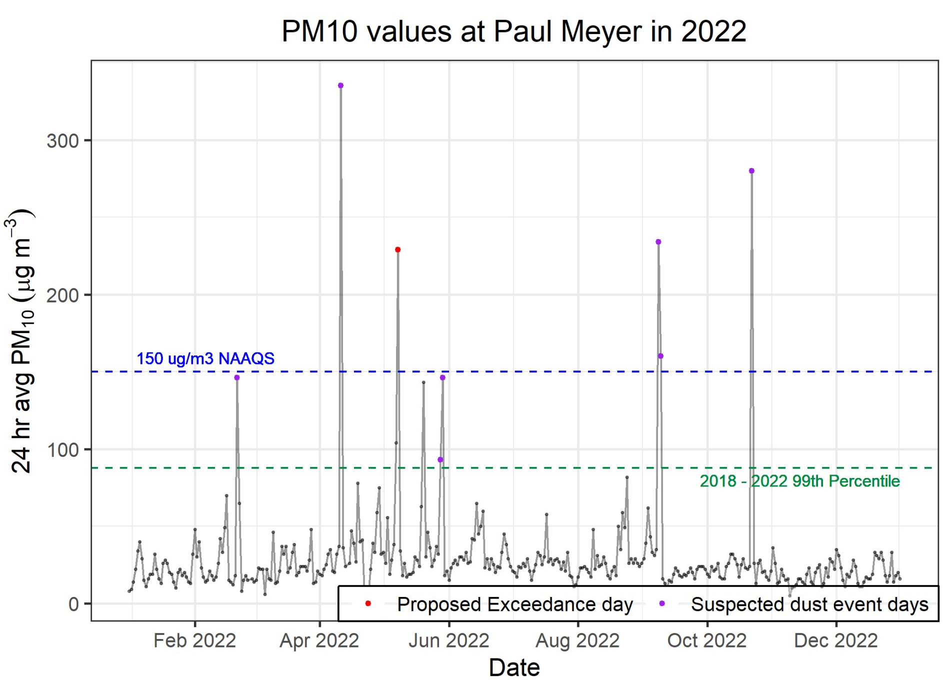


Figure 3.4-9. Paul Meyer monitoring site 24-hour PM_{10} measurements in µg/m^3 for 2022, showing the (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day.

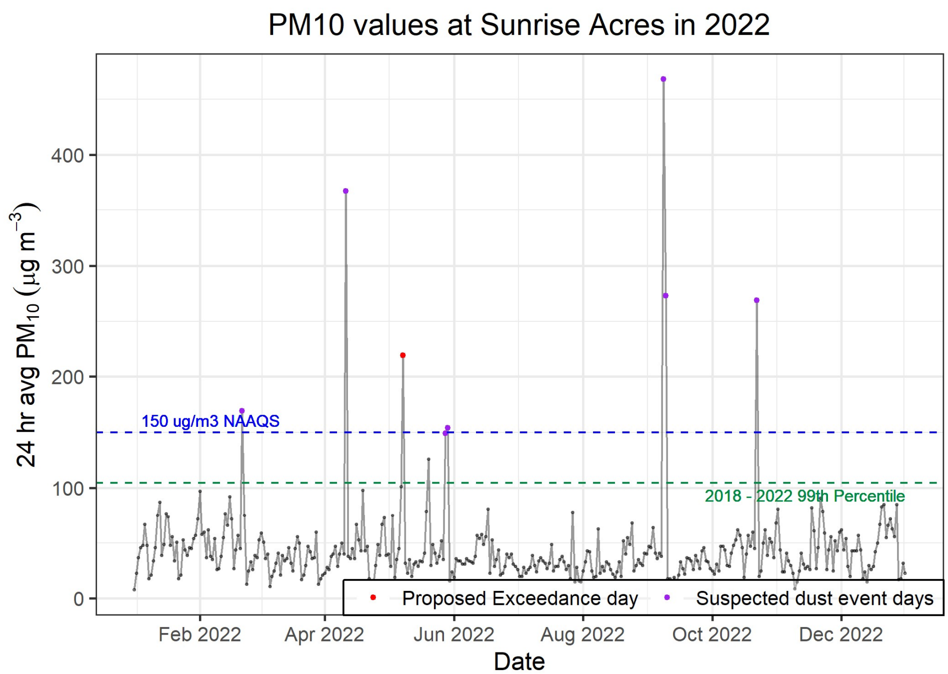


Figure 3.4-10. Sunrise Acres monitoring site 24-hour PM_{10} measurements in µg/m³ for 2022, showing the (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day.

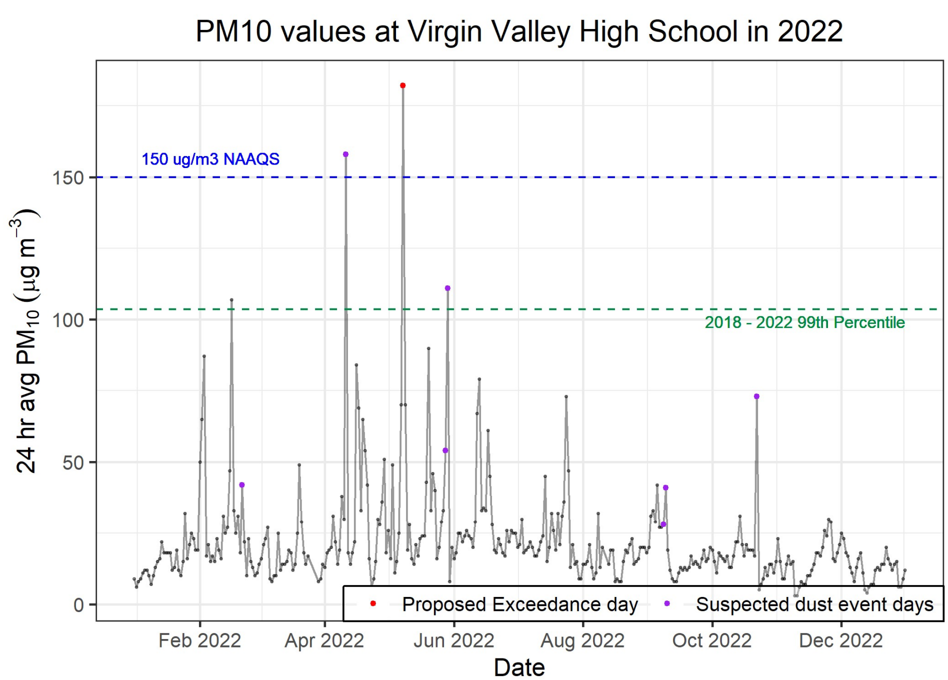


Figure 3.4-11. Virgin Valley High School monitoring site 24-hour PM_{10} measurements in µg/m³ for 2022, showing the (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day.

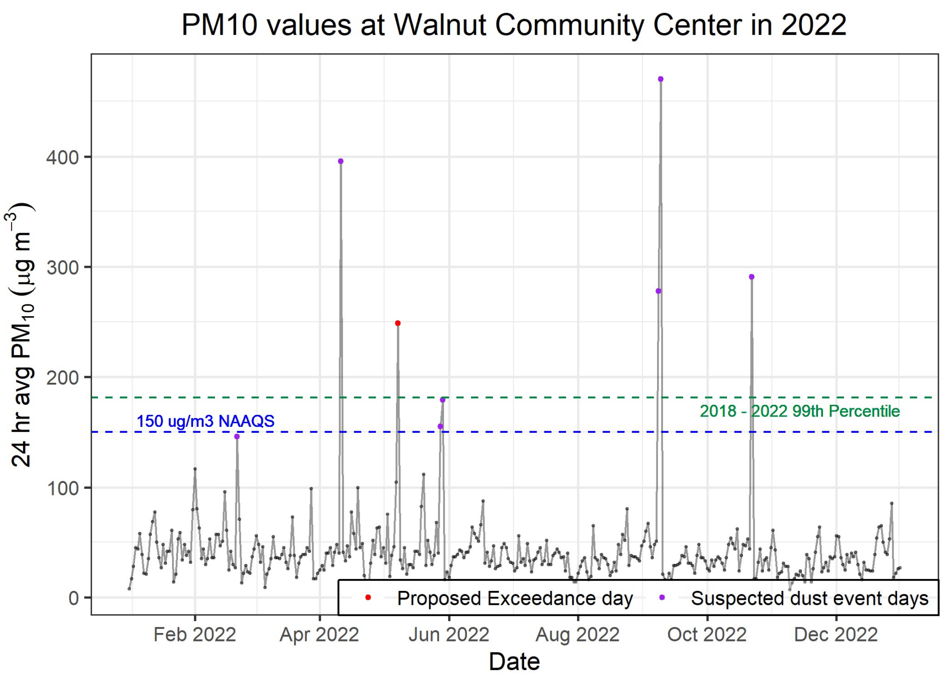


Figure 3.4-12. Walnut Community Center monitoring site 24-hour PM_{10} measurements in μg/m^3 for 2022, showing the (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day.

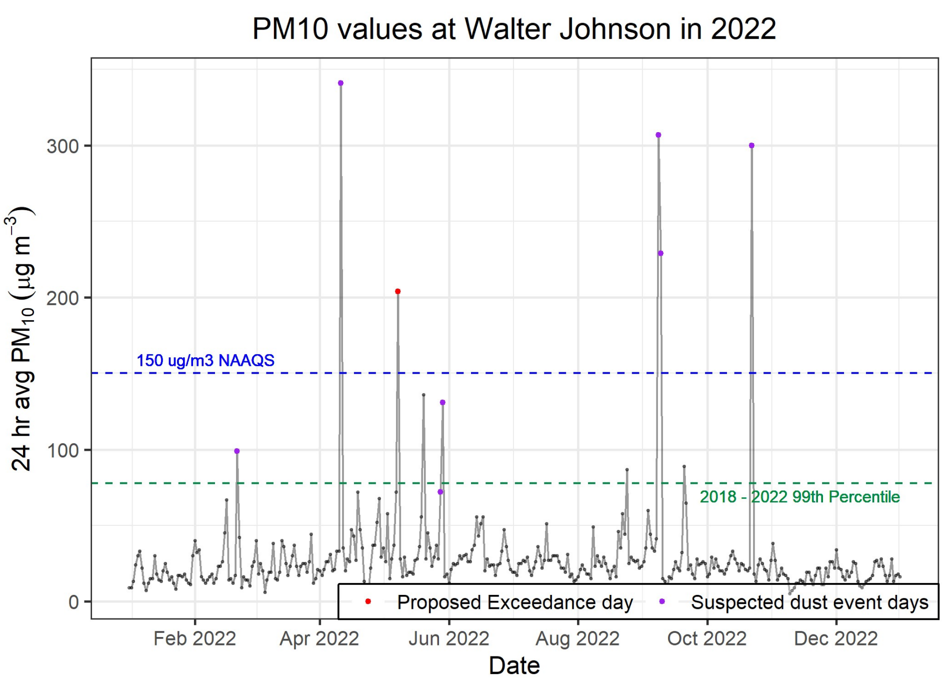


Figure 3.4-13. Walter Johnson monitoring site 24-hour PM_{10} measurements in μg/m^3 for 2022, showing the (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day.

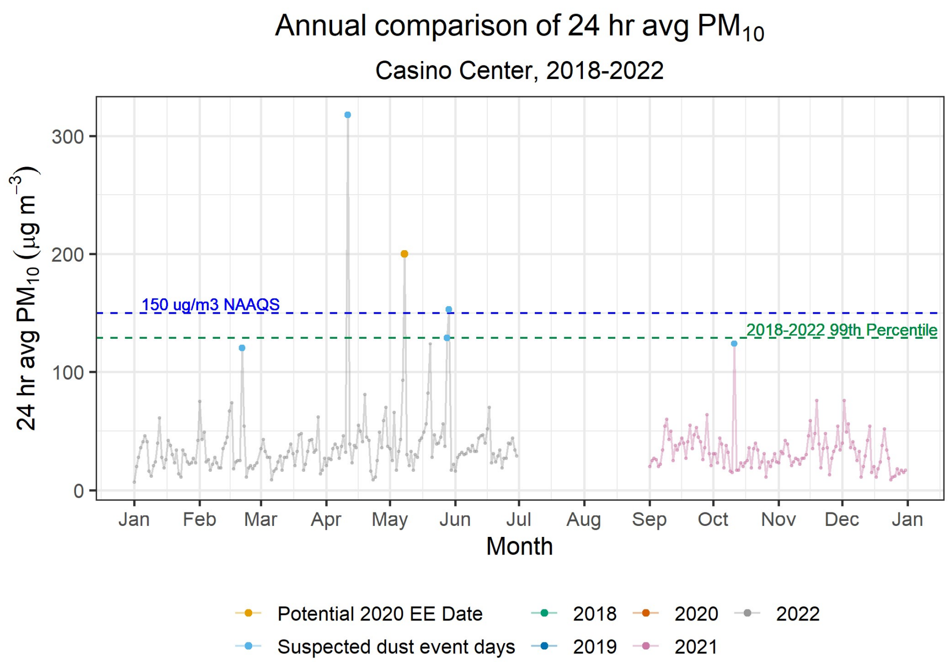


Figure 3.4-14. Casino Center monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with the 99th percentile (green dash) and NAAQS (grey dash) indicated.

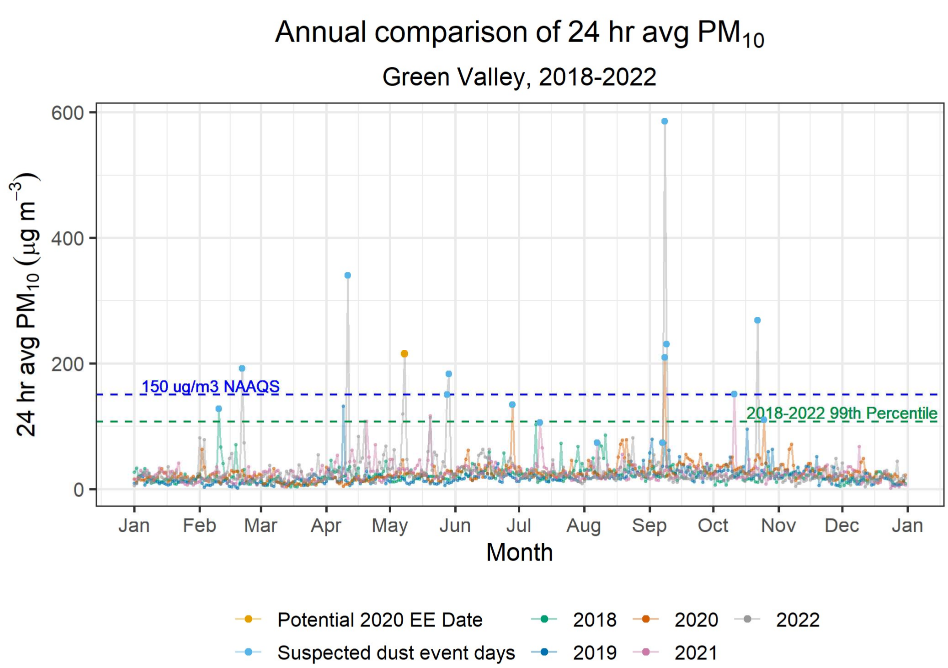


Figure 3.4-15. Green Valley monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with the 99th percentile (green dash) and NAAQS (grey dash) indicated.

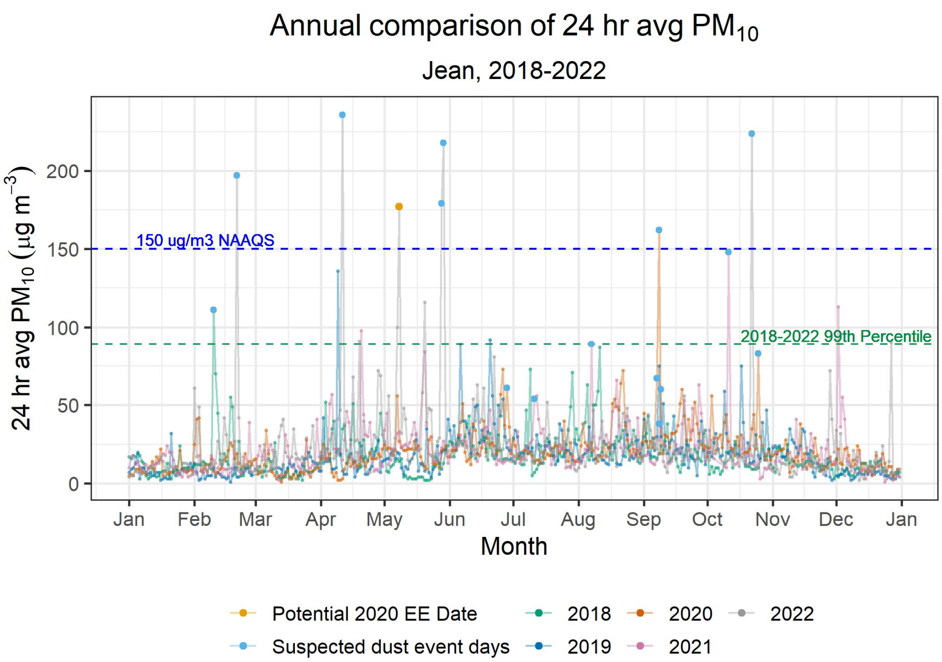


Figure 3.4-16. Jean monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with the 99th percentile (green dash) and NAAQS (grey dash) indicated.

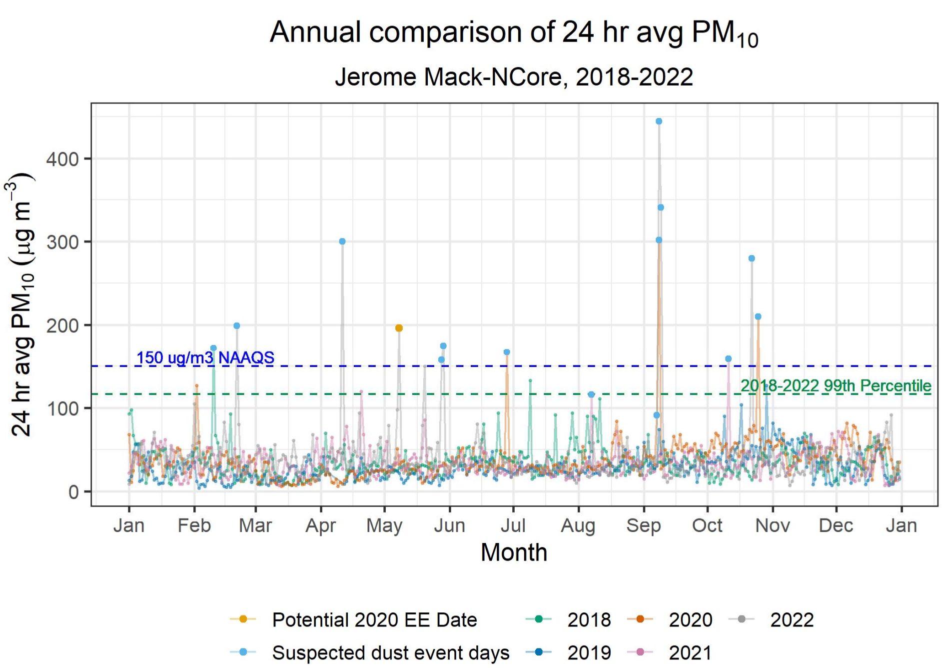


Figure 3.4-17. Jerome Mack monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with the 99th percentile (green dash) and NAAQS (grey dash) indicated.

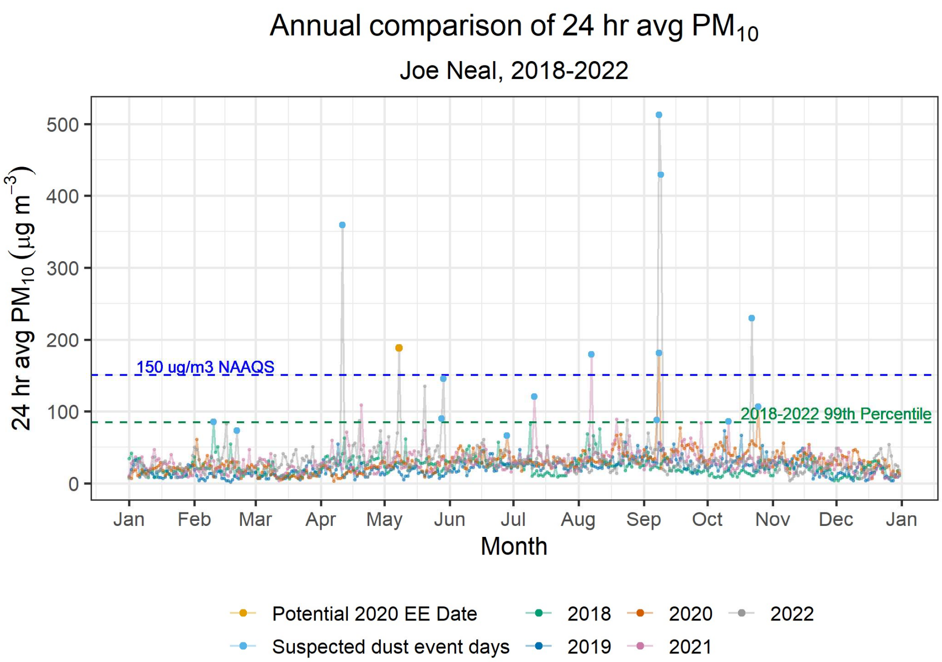


Figure 3.4-18. Joe Neal monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with the 99th percentile (green dash) and NAAQS (grey dash) indicated.

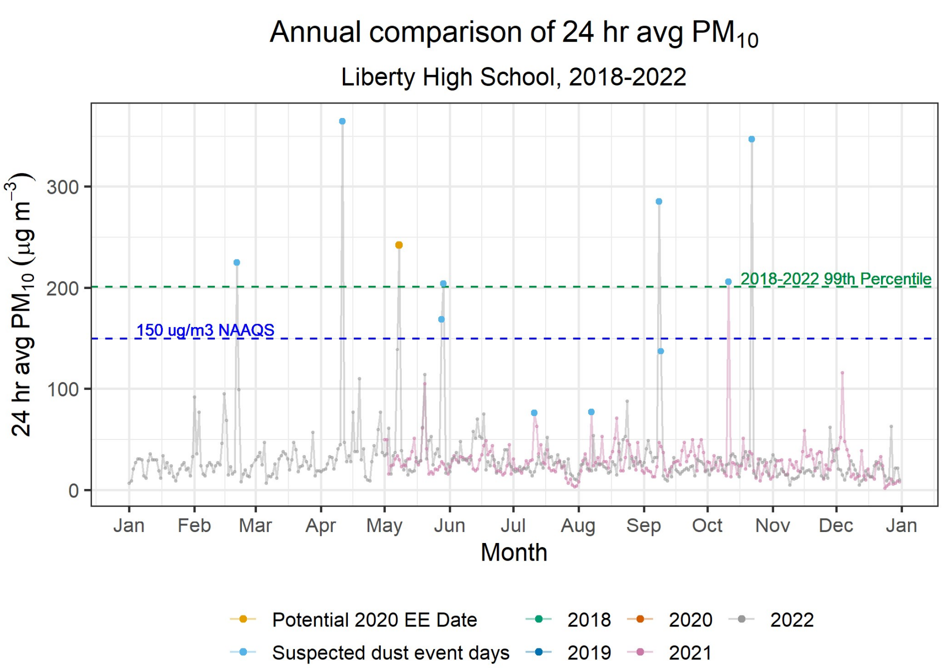


Figure 3.4-19. Liberty High School monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with the 99th percentile (green dash) and NAAQS (grey dash) indicated.

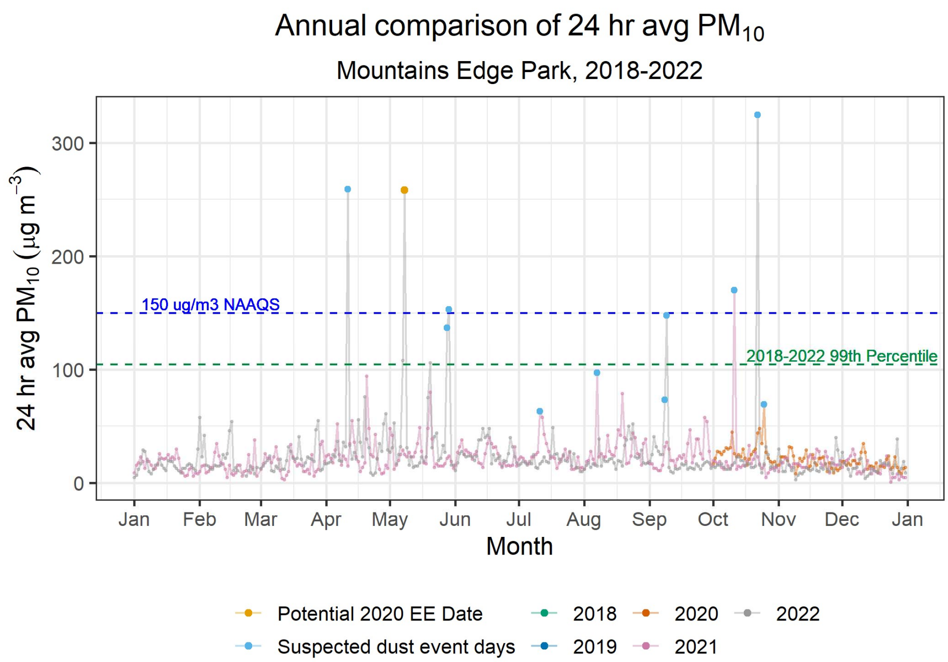


Figure 3.4-20. Mountains Edge Park monitoring site 24-hour PM_{10} measurements in μg/m^3 from 2018-2022 by month with the 99th percentile (green dash) and NAAQS (grey dash) indicated.

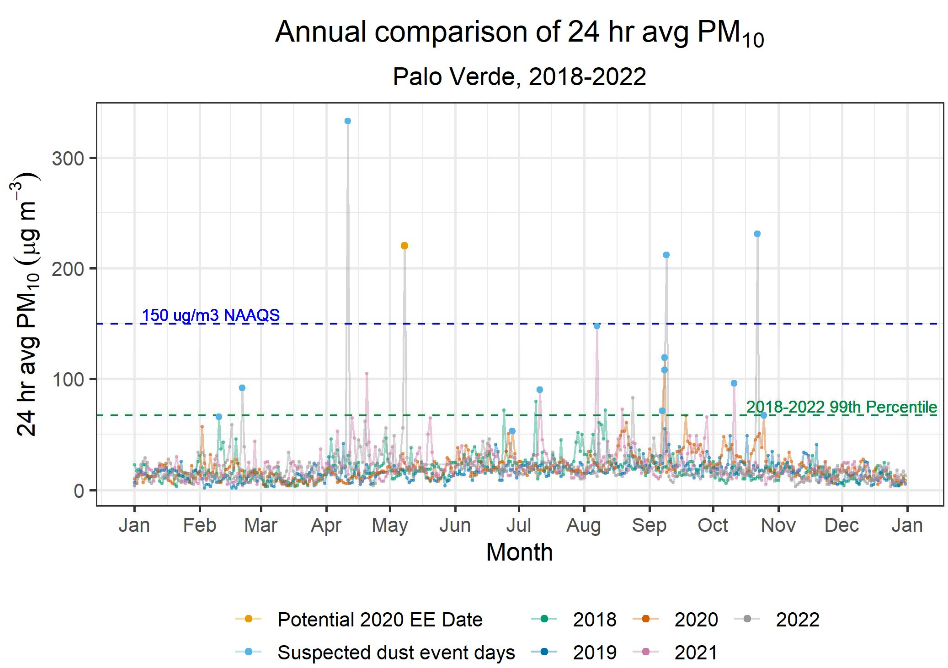


Figure 3.4-21. Palo Verde monitoring site 24-hour PM_{10} measurements in μg/m^3 from 2018-2022 by month with the 99th percentile (green dash) and NAAQS (grey dash) indicated.

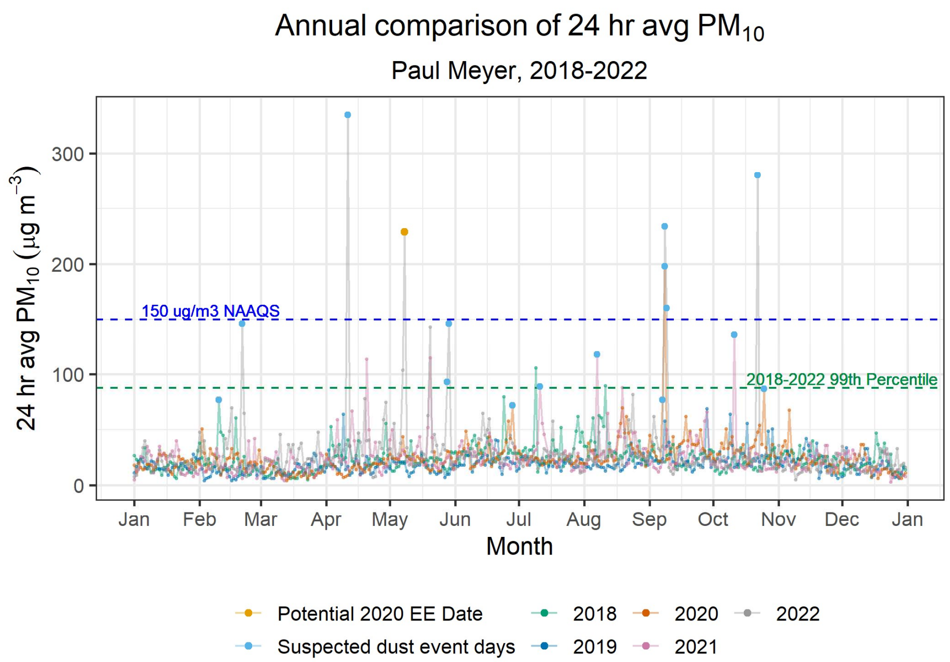


Figure 3.4-22. Paul Meyer monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with the 99th percentile (green dash) and NAAQS (grey dash) indicated.

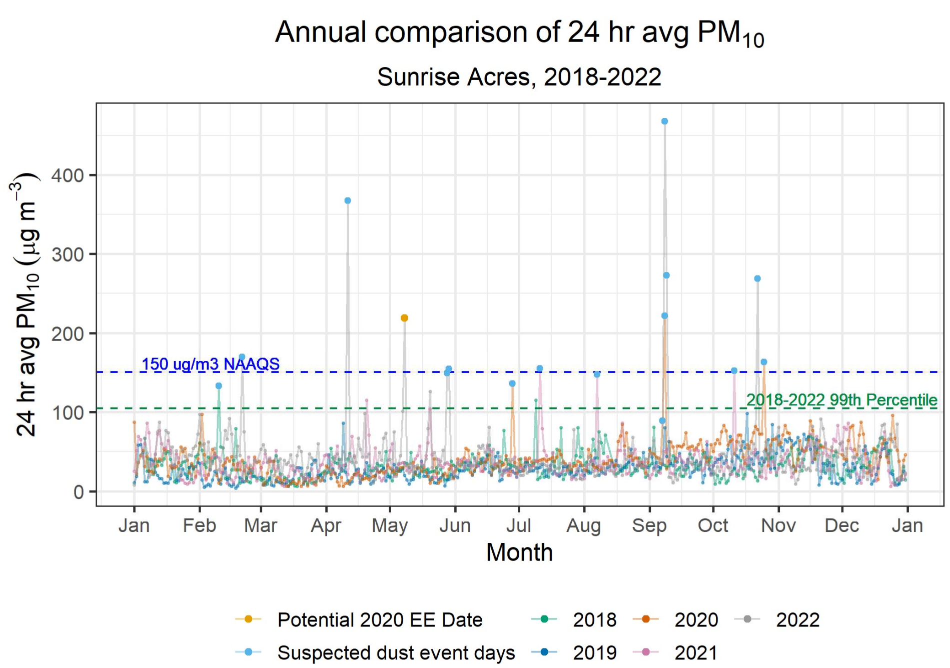


Figure 3.4-23. Sunrise Acres monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with the 99th percentile (green dash) and NAAQS (grey dash) indicated.

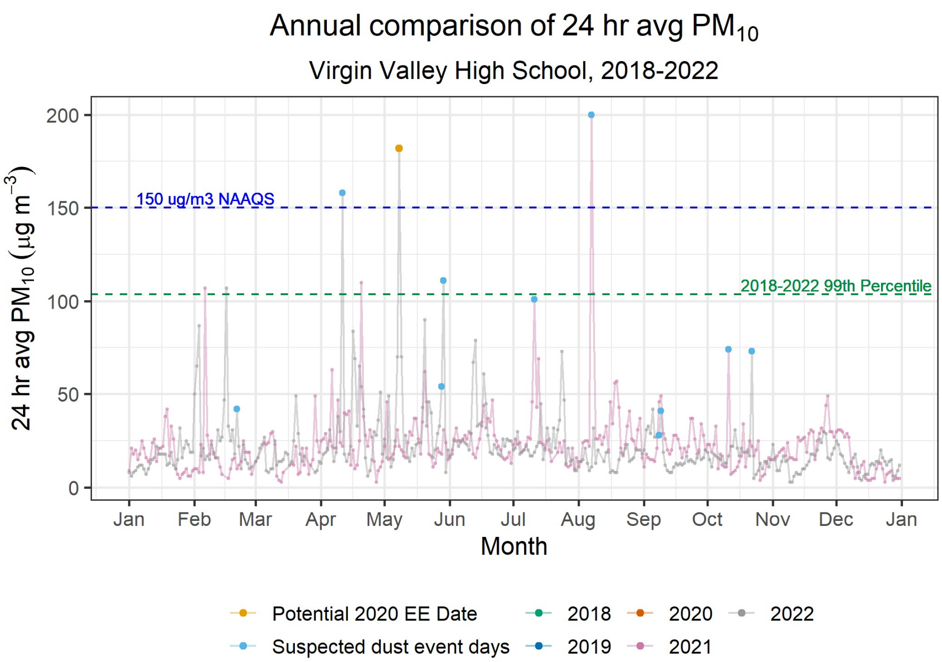


Figure 3.4-24. Virgin Valley High School monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with the 99th percentile (green dash) and NAAQS (grey dash) indicated.

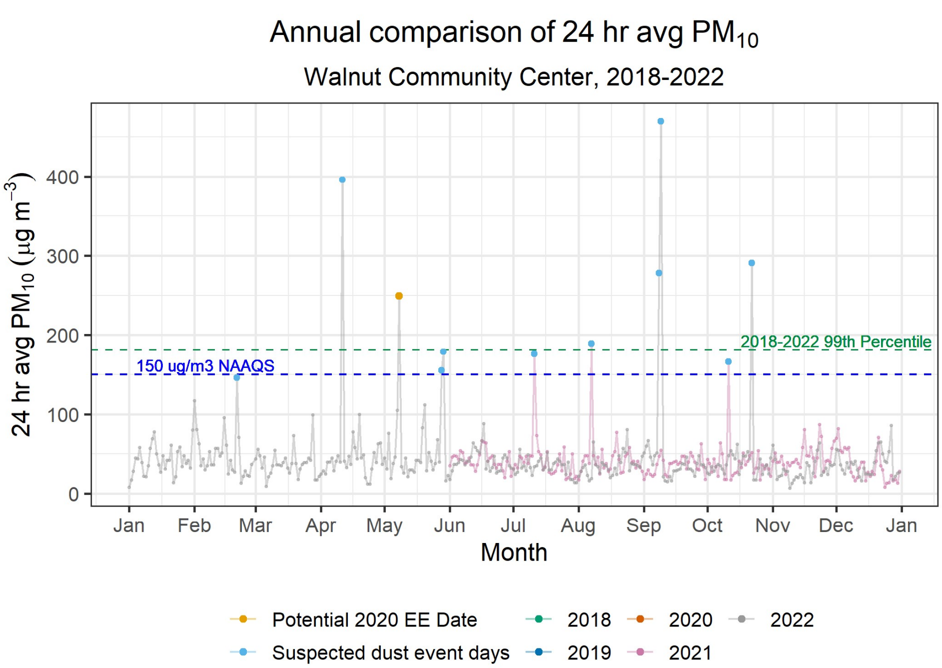


Figure 3.4-25. Walnut Community Center monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with the 99th percentile (green dash) and NAAQS (grey dash) indicated.

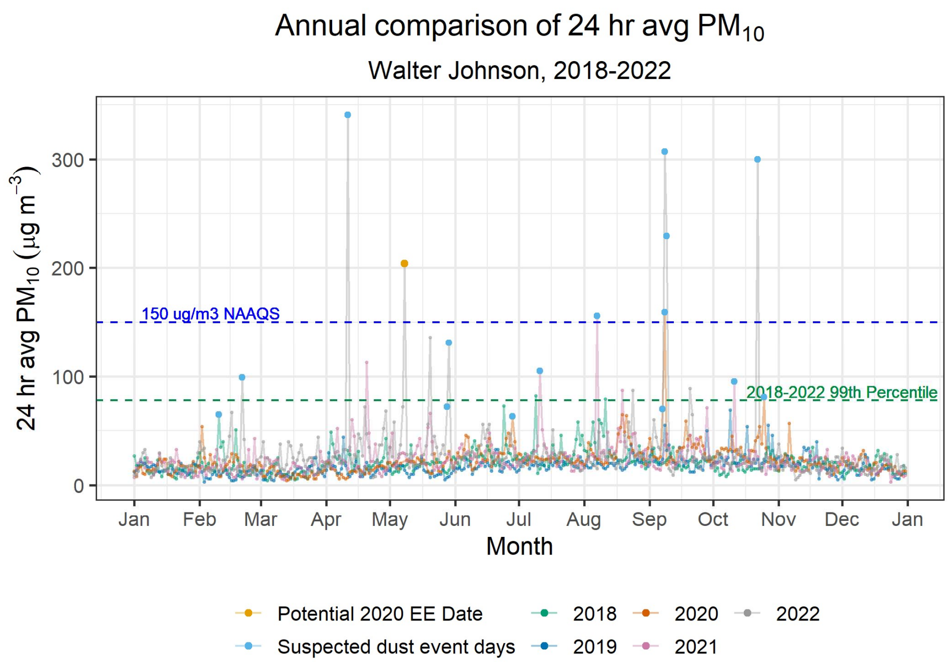


Figure 3.4-26. Walter Johnson monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with the 99th percentile (green dash) and NAAQS (grey dash) indicated.

3.4.2 Event Comparison with Diurnal/Seasonal Patterns

The 24-hour average PM_{10} concentrations were compared to five-year (2018-2022) monthly and seasonal averages, and the boxplots of these trends are shown in **Figure 3.4-27** and **Figure 3.4-28**. The lower and upper edges of the boxes correspond to the interquartile range (the 25th and 75th percentiles, respectively), and the middle bar is the median value. The whiskers extend to the smallest and largest value within 1.5 times the interquartile range. Points beyond this range are considered outliers. The concentrations recorded on May 8, 2022, are shown to be the highest recorded outliers for May and second highest outliers in the spring season (only higher on April 11, 2022) during the entire five-year period.

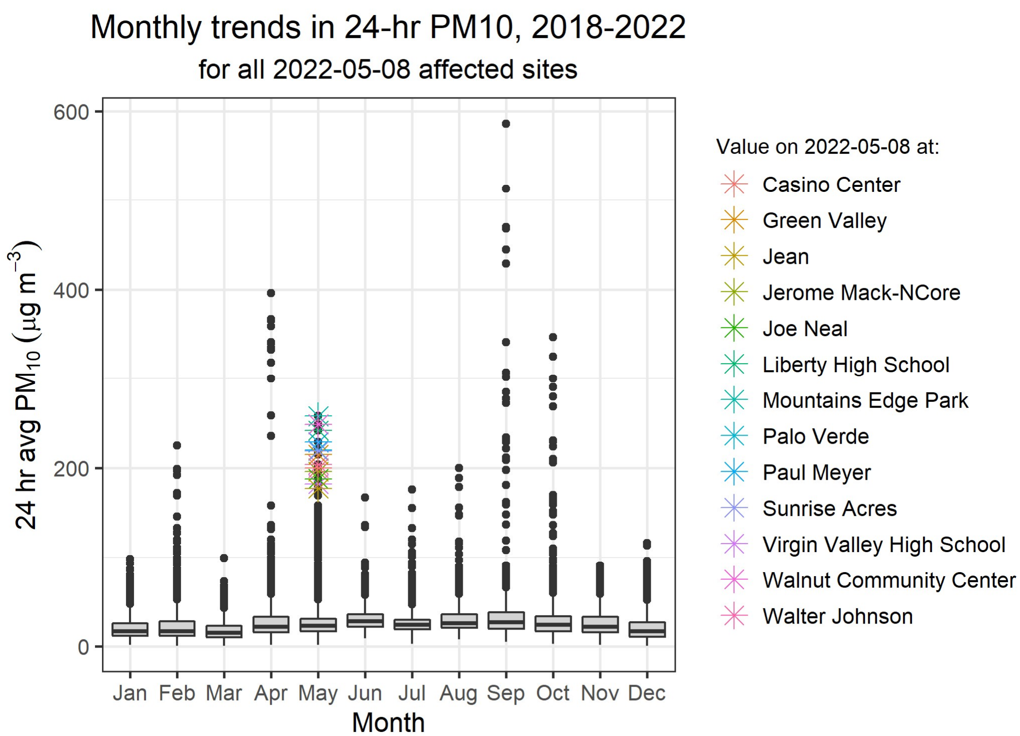


Figure 3.4-27. Monthly trend in 24-hour PM_{10} concentrations for 2018-2022, including outliers; the highlighted values indicate the potential exceedance event day.

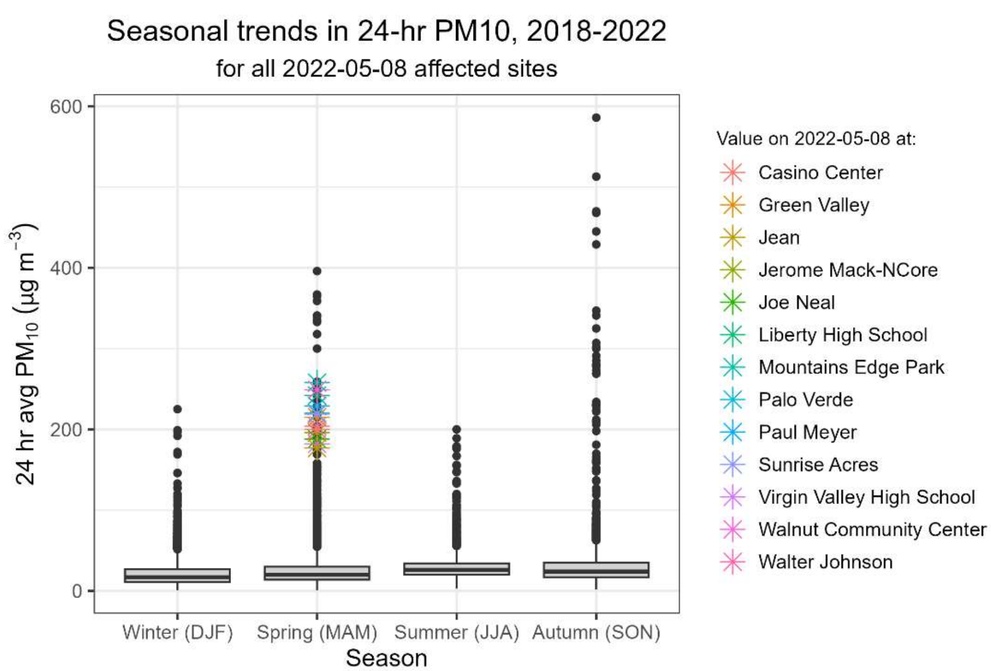


Figure 3.4-28. Seasonal trend in 24-hour PM_{10} concentrations for 2018-2022, including outliers; the highlighted values indicate the potential exceedance event day.

The hourly PM_{10} concentrations on May 8, 2022, were also compared to five-year (2018-2022) hourly averages. A summary of the maximum value observed at each monitoring site compared to the five-year (2018-2022) 95th percentile values at each site is shown in Table 3.4-2, and time series are shown in Figure 3.4-29 through Figure 3.4-41. At the Paul Meyer site, for example, the hourly PM_{10} concentration reached a maximum of 931 µg/m^3 at 16:00, which is 21 times the five-year 95th percentile of 45 µg/m^3. Similar trends were seen across the other sites.

Table 3.4-2. Summary of max hourly PM_{10} measurements compared to the five-year hourly PM_{10} 95th percentile values.

Site Name	Time of hourly PM_{10} max (PST)	Hourly PM_{10} (µg/m^3)	Five-year hourly PM_{10} 95th percentile (µg/m^3)	Hourly/five-year 95th percentile
Casino Center*	5/8/2022 16:00	750	66	11
Green Valley	5/8/2022 13:00	987	51	19
Jean	5/8/2022 12:00	644	56	12
Jerome Mack	5/8/2022 16:00	726	54	14
Joe Neal	5/8/2022 15:00	599	51	12
Liberty High School*	5/8/2022 13:00	1058	62	17
Mountains Edge Park*	5/8/2022 17:00	1204	67	18
Palo Verde	5/8/2022 17:00	890	43	21
Paul Meyer	5/8/2022 16:00	931	45	21
Sunrise Acres	5/8/2022 16:00	771	57	14
Virgin Valley High School*	5/8/2022 18:00	467	84	6
Walnut Community Center*	5/8/2022 16:00	923	87	11
Walter Johnson	5/8/2022 16:00	674	43	16

*Sites that began data collection less than five years ago.

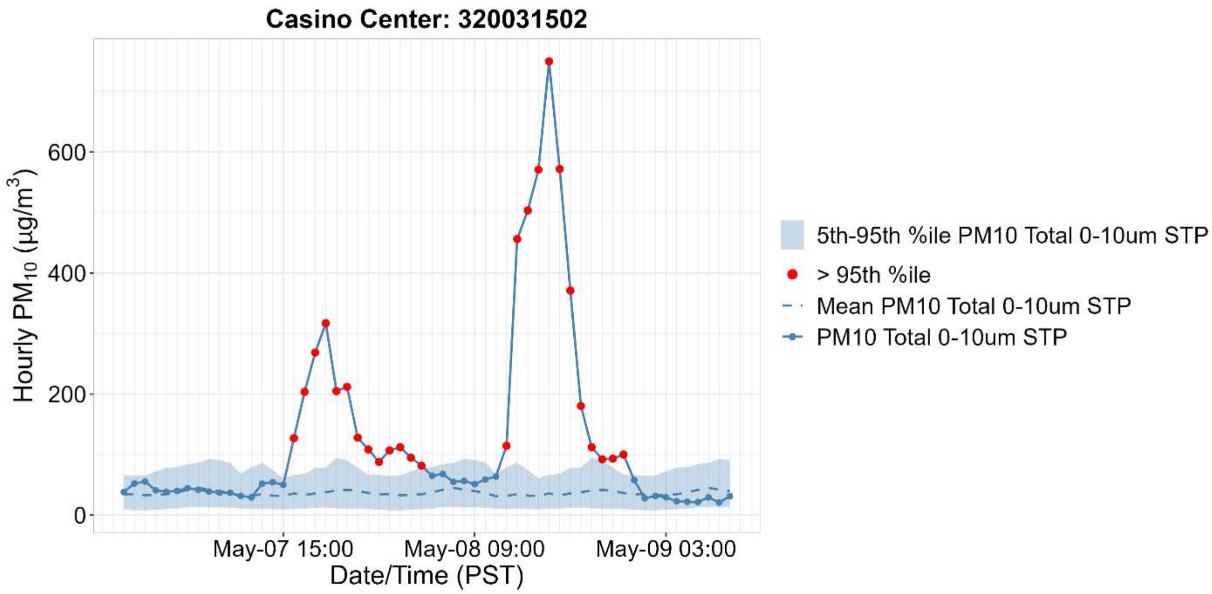


Figure 3.4-29. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th to 95th percentile (shaded area) in 1-hour PM_{10} values at the Casino Center site from 2018-2022. *Data collection began less than five years ago at this site.

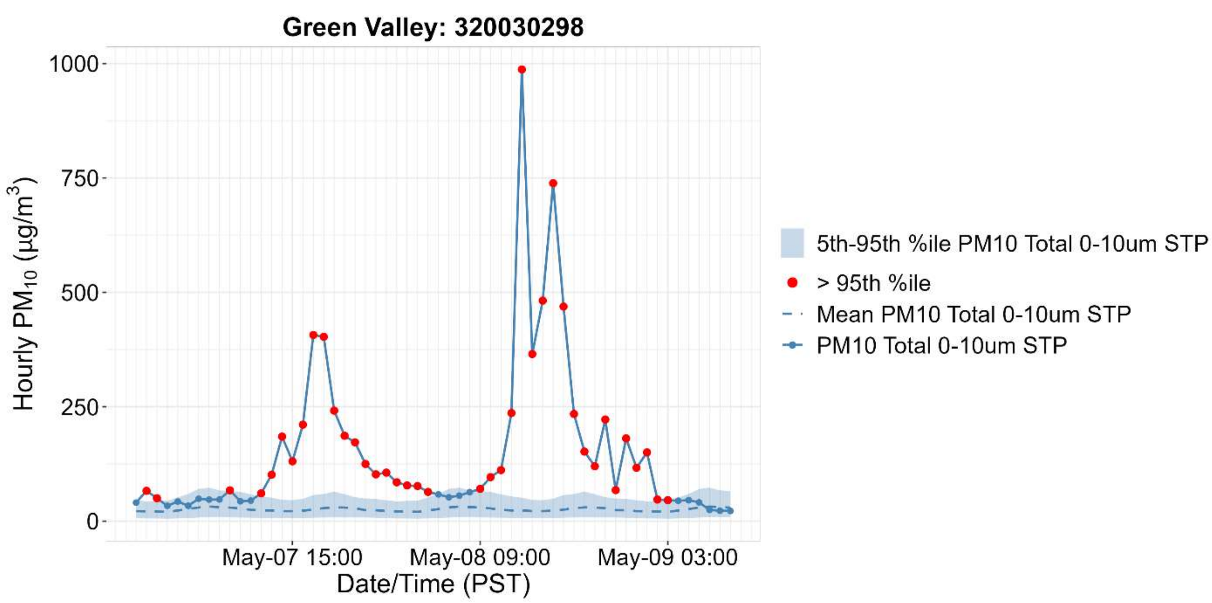


Figure 3.4-30. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th to 95th percentile (shaded area) in 1-hour PM_{10} values at the Green Valley site from 2018-2022.

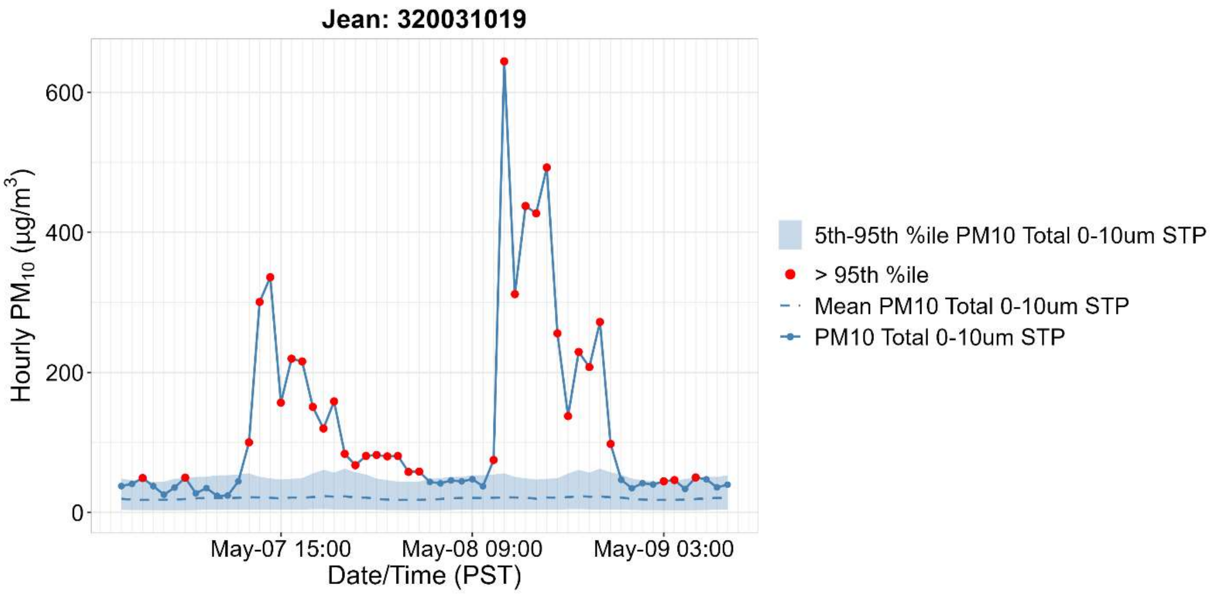


Figure 3.4-31. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th to 95th percentile (shaded area) in 1-hour PM_{10} values at the Jean site from 2018-2022.

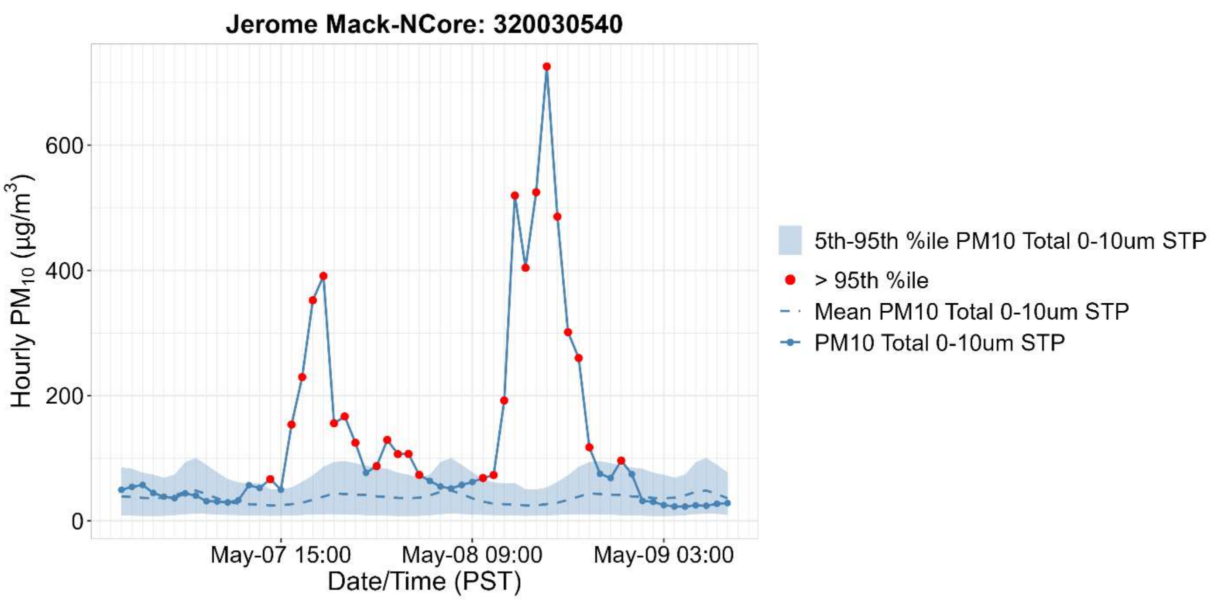


Figure 3.4-32. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th to 95th percentile (shaded area) in 1-hour PM_{10} values at the Jerome Mack site from 2018-2022.

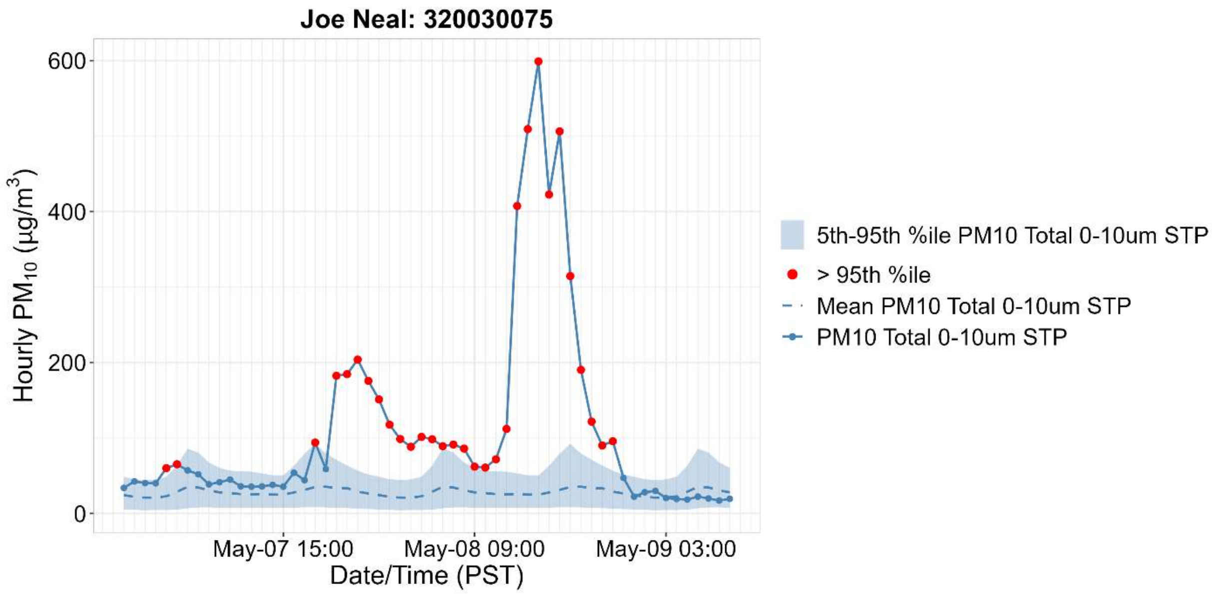


Figure 3.4-33. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th to 95th percentile (shaded area) in 1-hour PM_{10} values at the Joe Neal site from 2018-2022.

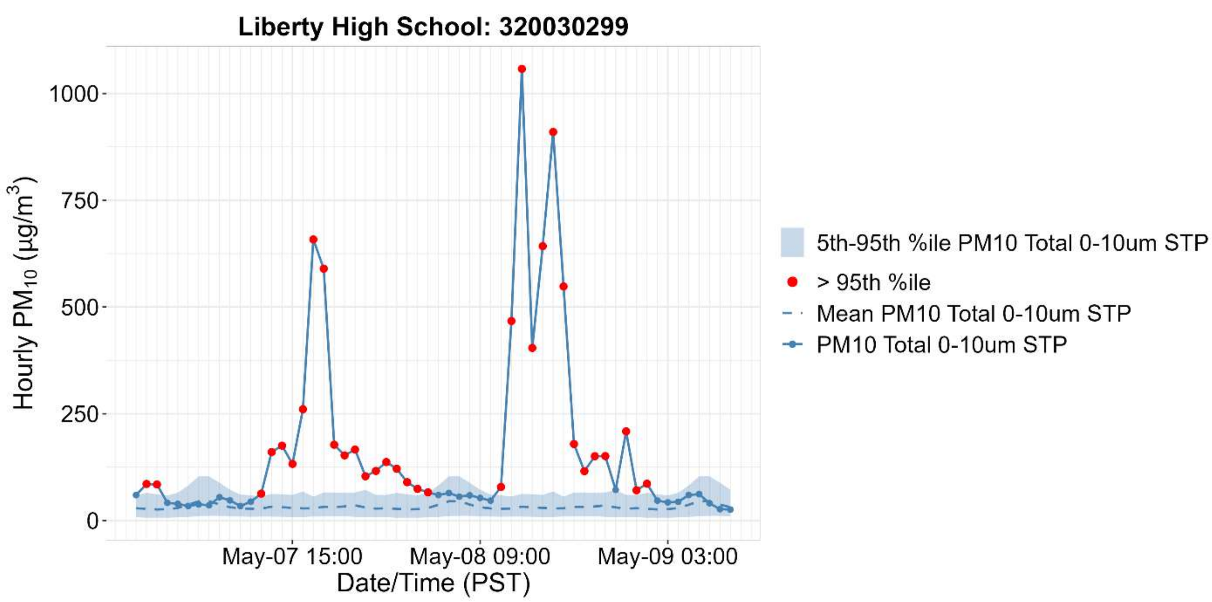


Figure 3.4-34. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th to 95th percentile (shaded area) in 1-hour PM_{10} values at the Liberty High School site from 2018-2022. Data collection began less than five years ago at this site.

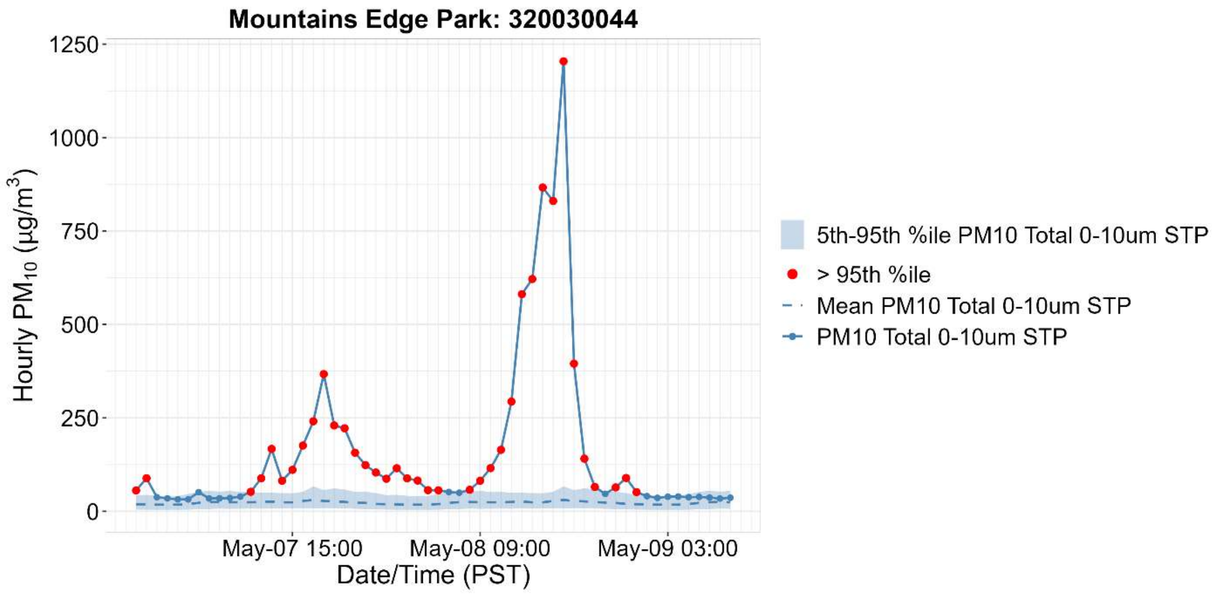


Figure 3.4-35. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th to 95th percentile (shaded area) in 1-hour PM_{10} values at the Mountains Edge Park site from 2018-2022. Data collection began less than five years ago at this site.

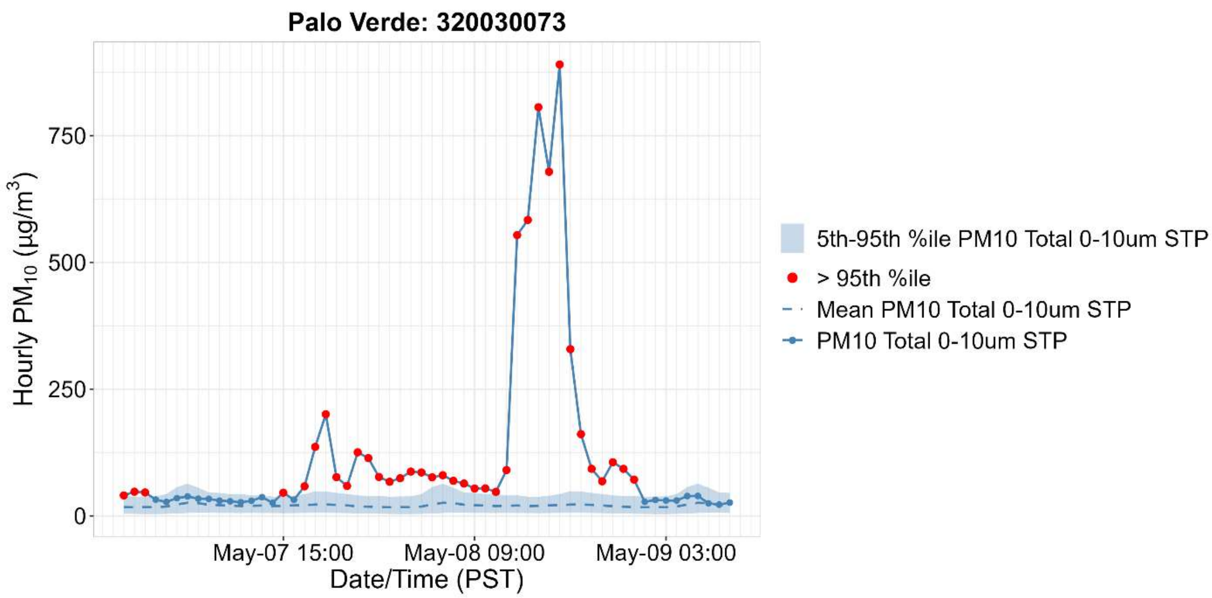


Figure 3.4-36. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th to 95th percentile (shaded area) in 1-hour PM_{10} values at the Palo Verde site from 2018-2022.

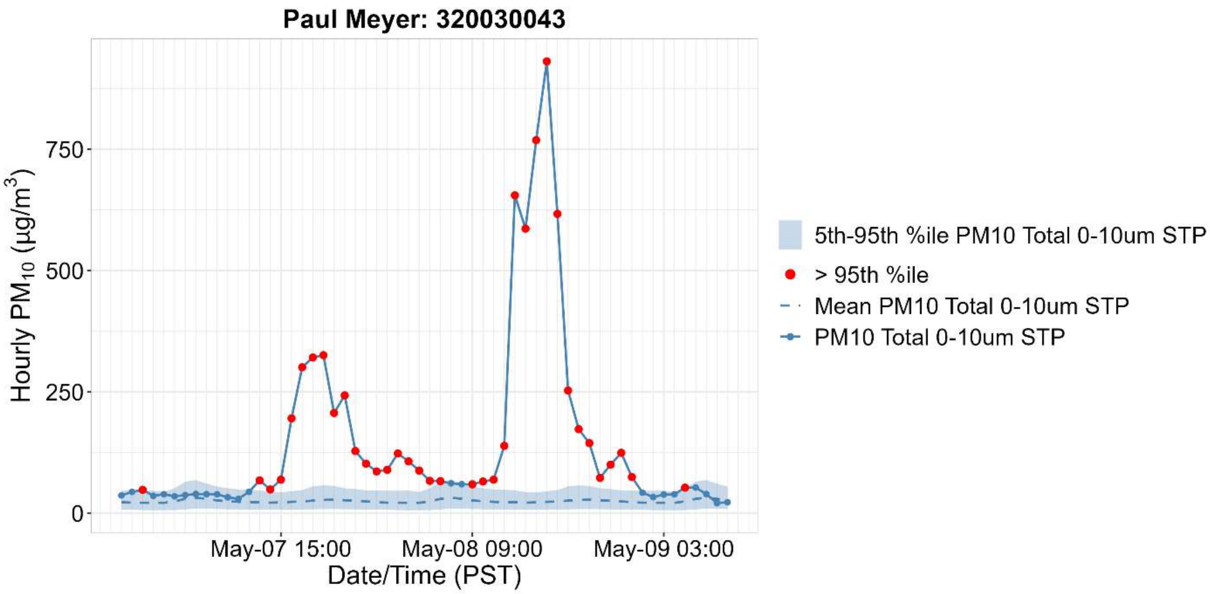


Figure 3.4-37. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th to 95th percentile (shaded area) in 1-hour PM_{10} values at the Paul Meyer site from 2018-2022.

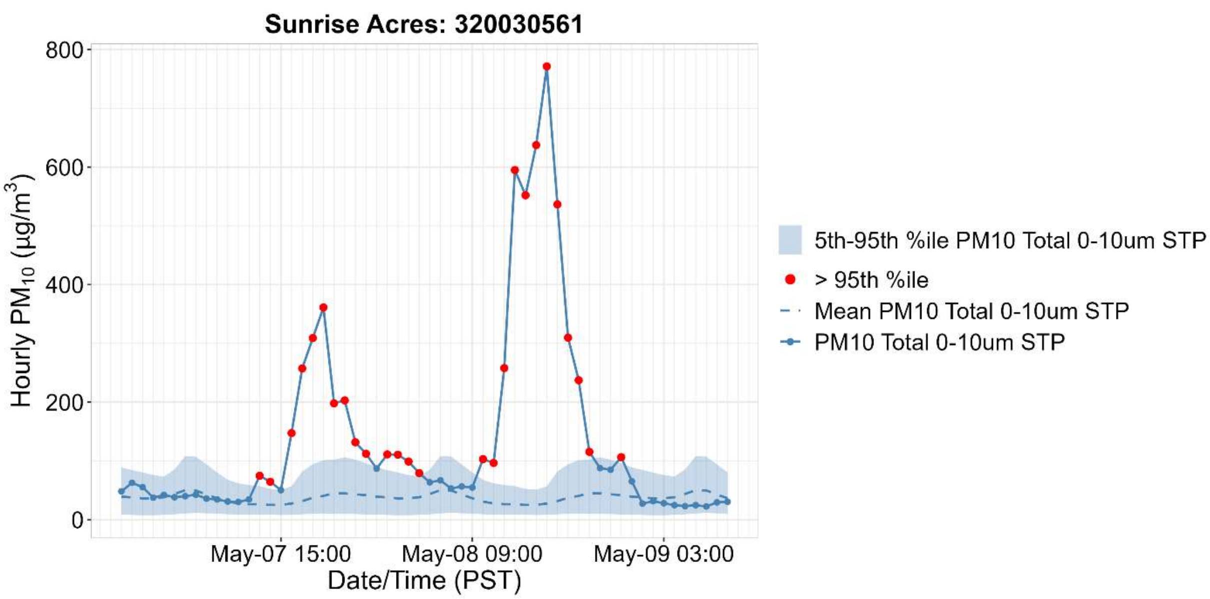


Figure 3.4-38. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th to 95th percentile (shaded area) in 1-hour PM_{10} values at the Sunrise Acres site from 2018-2022.

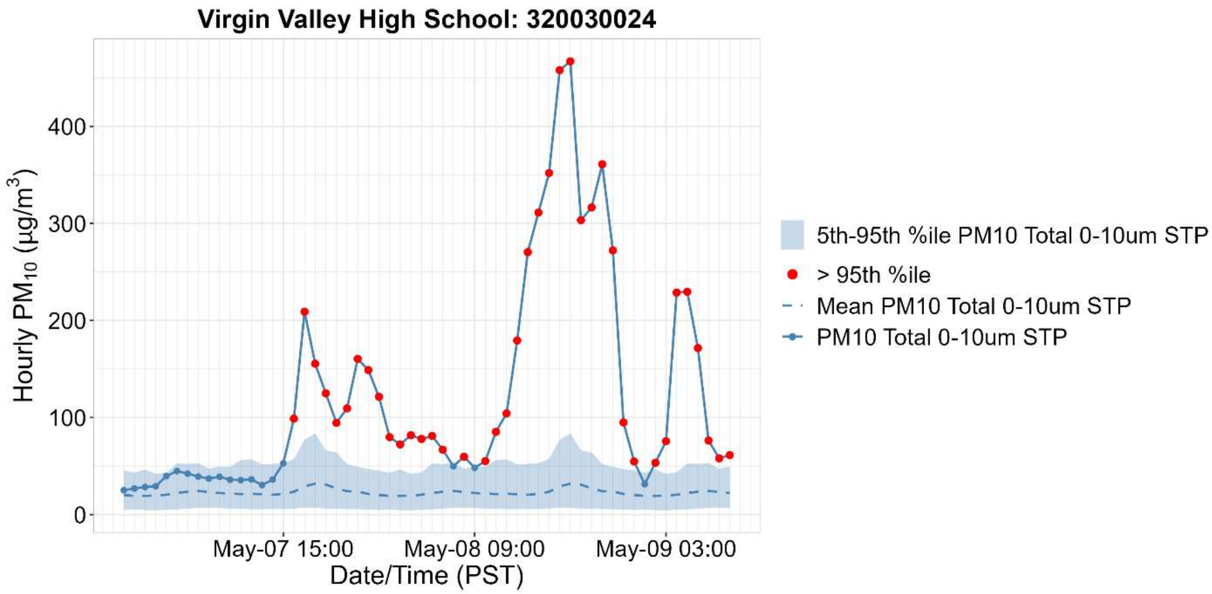


Figure 3.4-39. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th to 95th percentile (shaded area) in 1-hour PM_{10} values at the Virgin Valley High School site from 2018-2022. Data collection began less than five years ago at this site.

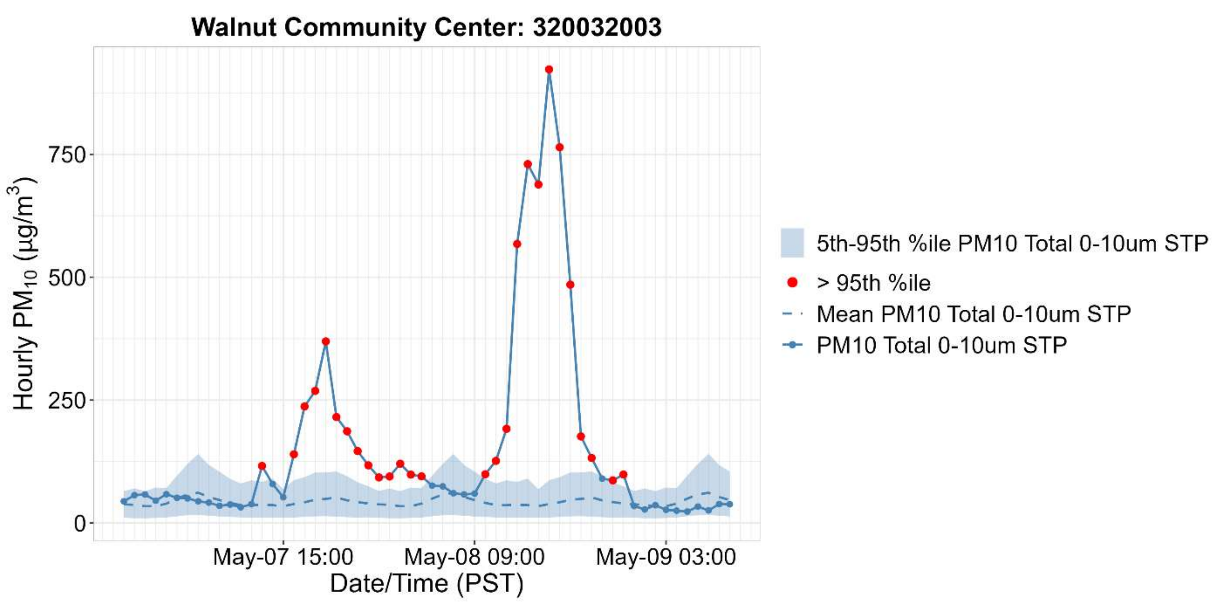


Figure 3.4-40. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th to 95th percentile (shaded area) in 1-hour PM_{10} values at the Walnut Community Center site from 2018-2022. Data collection began less than five years ago at this site.

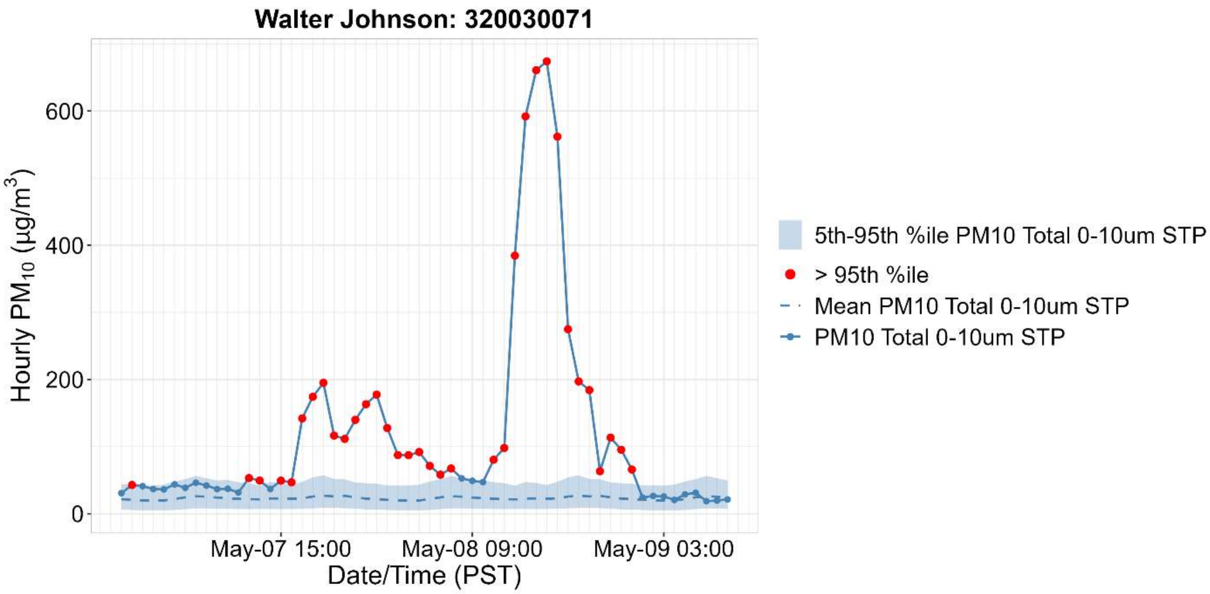


Figure 3.4-41. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th to 95th percentile (shaded area) in 1-hour PM_{10} values at the Walter Johnson site from 2018-2022.

3.4.3 Event Comparison with Climatology

Thirty-year seasonal climatology was created using European Environment Agency (ERA5) reanalysis at 0.25°x 0.25° horizontal resolution from 1993 through 2022 for both the source region and Clark County. Temperatures, volumetric soil moisture, and maximum winds speeds were chosen and modeled as the most likely variables to influence a windblown dust event in both the source region and Clark County. This analysis, shown in Figure 3.4-42 and Figure 3.4-43, shows the seasonal March-April-May thirty-year average for each variable in the top panel and the event date departure from the seasonal climatology in the bottom panel. Figure 3.4-42 shows the climatological conditions compared with the event date for the Mohave Desert source region. On the event date, the source region experienced ground level temperatures at or greater than 10 °F above the long-term average, lower-to-normal soil moisture, and well above average max ground level wind speeds. Figure 3.4-43 shows the climatological conditions compared with the event date for Clark County. On the event date, Clark County experienced ground level temperatures greater than 10 °F above the long-term average, lower-to-normal soil moisture, and max ground level wind speeds that exceeded 5 m/s (11 mph) above the typical climatological average. This climatological evidence provides proof that the conditions on the event date were abnormally hot, dry, and windy in both the source region and Clark County, leading to a windblown dust event.

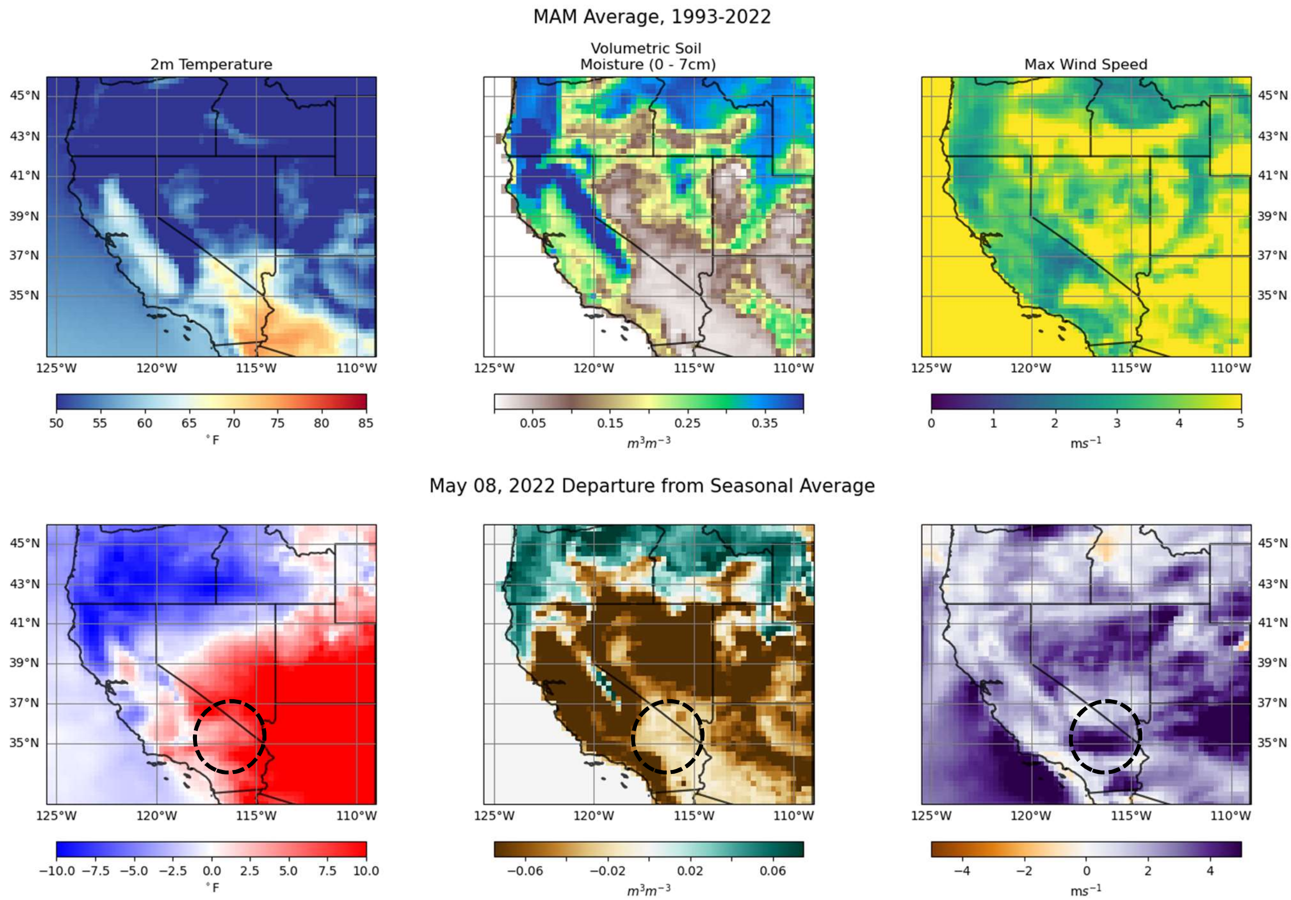


Figure 3.4-42. The thirty-year March-May seasonal climatological average based on ERA5 reanalysis for 2-meter temperature, volumetric soil moisture of the first 7 centimeters, and maximum 10-meter wind speed (top row) and the daily departure for May 8, 2022 from the 30-year average (bottom row). The Mojave Desert source region is circled.

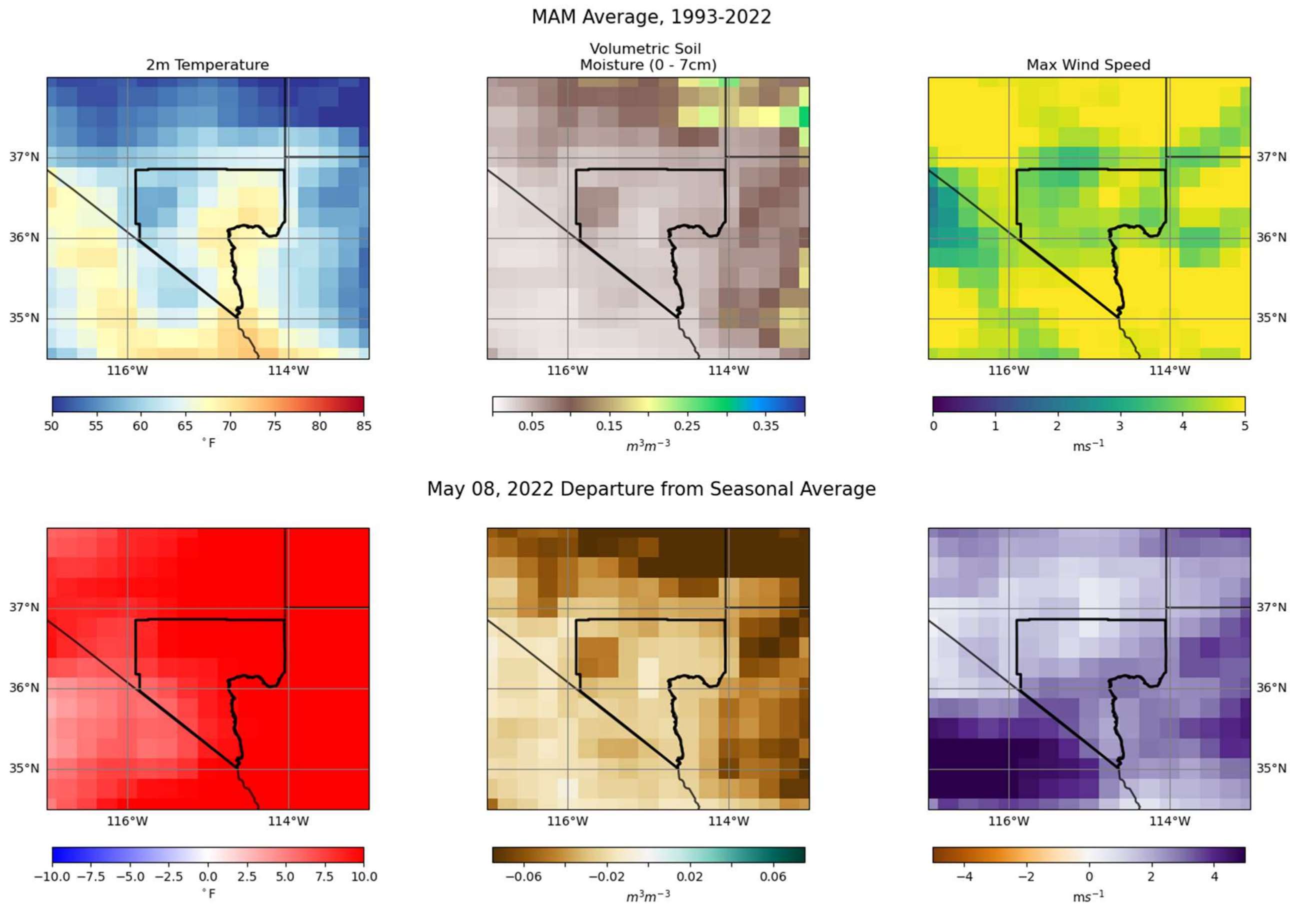


Figure 3.4-43. The thirty-year March-May seasonal climatological average for Clark County based on ERA5 reanalysis for 2-meter temperature, volumetric soil moisture of the first 7 centimeters, and maximum 10-meter wind speed (top row) and the daily departure for May 8, 2022 from the 30-year average (bottom row). Clark County is outlined in black.

Overall, we find overwhelming evidence that the May 8, 2022, high-wind dust event in Clark County was well outside normal conditions. This suggests that Clark County was impacted by a high-wind dust exceptional event. The evidence corroborating this assertion includes (1) the event rank was at or above the 99th percentile for both regulatorily significant sites and sites that exceeded the NAAQS, (2) the abrupt increase in PM_{10} was well outside the typical diurnal profile, (3) the PM_{10} 24-hour average event concentration was well outside the typical monthly or seasonal norms, and (4) thirty-year climatology data shows higher temperatures, lower soil moisture, and higher winds on the event date in the source region and Clark County compared with climatological averages.

3.5 Meteorological Similar Analysis

Enhanced surface-level wind speeds and frequent wind gusts on May 8, 2022, created prime conditions to maintain the suspension of fine dust particles in the air in the midst of regional drought. The resultant daily average wind speed was high at 16.8 mph, and ten wind gusts greater than 40 mph were observed. Sustained wind speeds reached a maximum of 29.9 mph, the maximum gust for the day reached 46 mph, and the strongest winds came from the southwest direction. The timing of highest wind speeds and wind gusts aligns with the timing of enhanced PM_{10} concentrations. Visibility at LAS dropped to 4 miles on the afternoon of May 8 during peak wind gusts.

The following sections compare surface-level wind and visibility conditions on May 8, 2022, to dates that show (1) comparable wind profiles that did not show PM_{10} concentrations above the NAAQS, and (2) a PM_{10} concentration above the NAAQS but a lack of notable wind speeds. All wind speed, wind direction, and visibility values in the subsequent two sections were measured at LAS and downloaded from the Iowa Environmental Mesonet (IEM) data portal (**http://mesonet.agron.iastate.edu/**).

3.5.1 Wind Event Days without High Concentration

The comparison of the event date to specific non-event high-wind days without enhanced PM concentrations shows key differences between comparable wind events and the event date of May 8, 2022. All dates in the years 2016-2020 were considered when identifying days with a wind event comparable to the event date. Four criteria descriptive of the intensity of the wind event on May 8 were applied to identify comparable dates: (1) daily average wind speeds greater than 16 mph, (2) peak daily wind gusts greater than or equal to 45 mph, (3) at least eight hourly observations with sustained wind speeds greater than 20 mph, and (4) at least ten measured wind gusts greater than 40 mph. Additionally, dates were filtered to those without enhanced PM_{10} concentrations (<100 $\mu g/m^3$) at monitors in Clark County. A single date was identified as a comparable wind event without high PM_{10} concentrations, and is listed in **Table 3.5-1**.

Table 3.5-1. Days with similar meteorological conditions to the event day without enhanced PM_{10} concentrations. PM_{10} concentrations are reported at the Jerome Mack (JM), Paul Meyer (PM), Walter Johnson (WJ), Palo Verde (PV), Joe Neal (JN), Green Valley (GV), Jean (J), Sunrise Acres (SA), Mountains Edge (ME), Walnut Community Center (WC), Virgin Valley (VV), and Casino Center (CC) monitoring sites.

			Daily PM_{10} (µg/m³)											
Date	Daily Wind Speed (mph)	Peak Wind Gust (mph)	JM	PM	WJ	PV	JN	GV	J	SA	ME	WC	VV	CC
2022-05-08 (event date)	17	46	196	229	204	220	188	215	177	219	258	249	182	200
2022-03-20	17	62	41	38	37	21	47	29	19	50	21	38	49	48

A comparison between the meteorological conditions on the event date of May 8, 2022, and March 20, 2022, is outlined below. **Figure 3.5-1, Figure 3.5-2, and Figure 3.5-3** compare surface-level wind and visibility conditions on the event date and March 20. The wind profile on March 20 exceeds the intensity of the wind event that occurred on the event date with higher-speed wind gusts and a longer period of sustained winds above 20 mph (Figure 3.5-1). Figure 3.5-2 shows that the highest wind speeds, between 20-40 mph, came from the southwest on the event date, and from the northwest on March 20. On March 20, visibility remained at the maximum value of 10 miles throughout the day (Figure 3.5-3). The maintenance of high visibility on March 20 confirms that the high-winds event did not dramatically affect levels of suspended dust particles, a claim supported by the fact that daily PM_{10} concentrations were relatively low, 50 µg/m³ or less at all examined sites. In contrast, visibility on the event date reached a minimum of 4 miles during peak winds. A key difference between the event date and March 20 is displayed in **Figure 3.5-4**, which shows the spatial distribution of peak sustained wind speeds centered on the Las Vegas NWS forecast office (VEF). On May 8, peak sustained winds exceeded 30 mph in every direction surrounding Las Vegas and were especially enhanced towards the southwest along the path of air transport. In contrast, on March 20, some of the highest peak winds occurred within the Las Vegas metropolitan area. Wind speeds in the scrubland/bare-ground regions surrounding Las Vegas were notably lower on March 20 compared to wind speeds on the event date, particularly in the direction of air transport to the northwest. This difference in regional wind profiles may account for the discrepancy in daily PM_{10} concentrations between the event day of May 8 and March 20 under comparable local wind conditions.

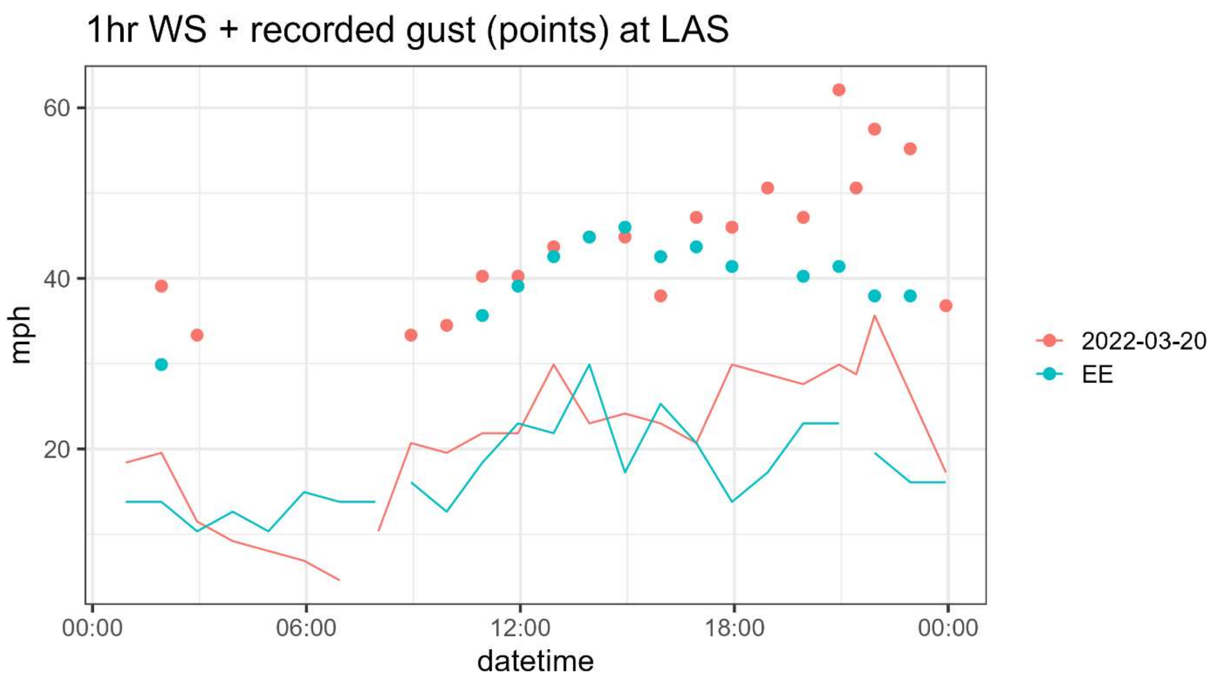


Figure 3.5-1. Wind speeds and maximum hourly wind gusts in mph at LAS for March 20, 2022, (pink) and the May 8, 2022, suspected exceptional event day (teal).

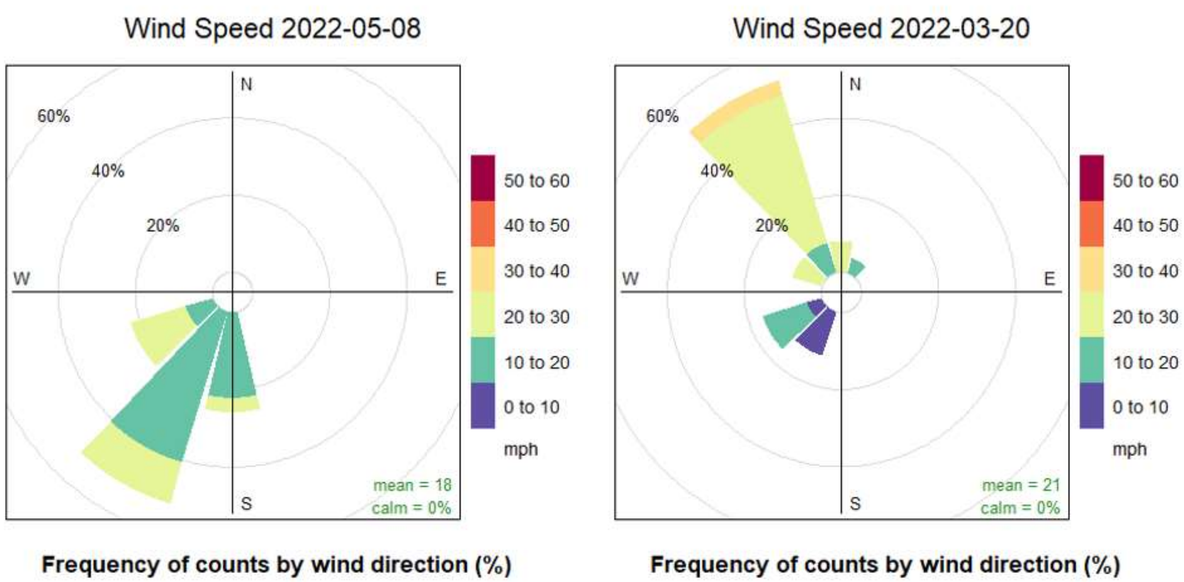


Figure 3.5-2. Wind speed (mph) and direction frequency for (left) May 8, 2022, the suspected exceptional event day, and (right) March 20, 2022.

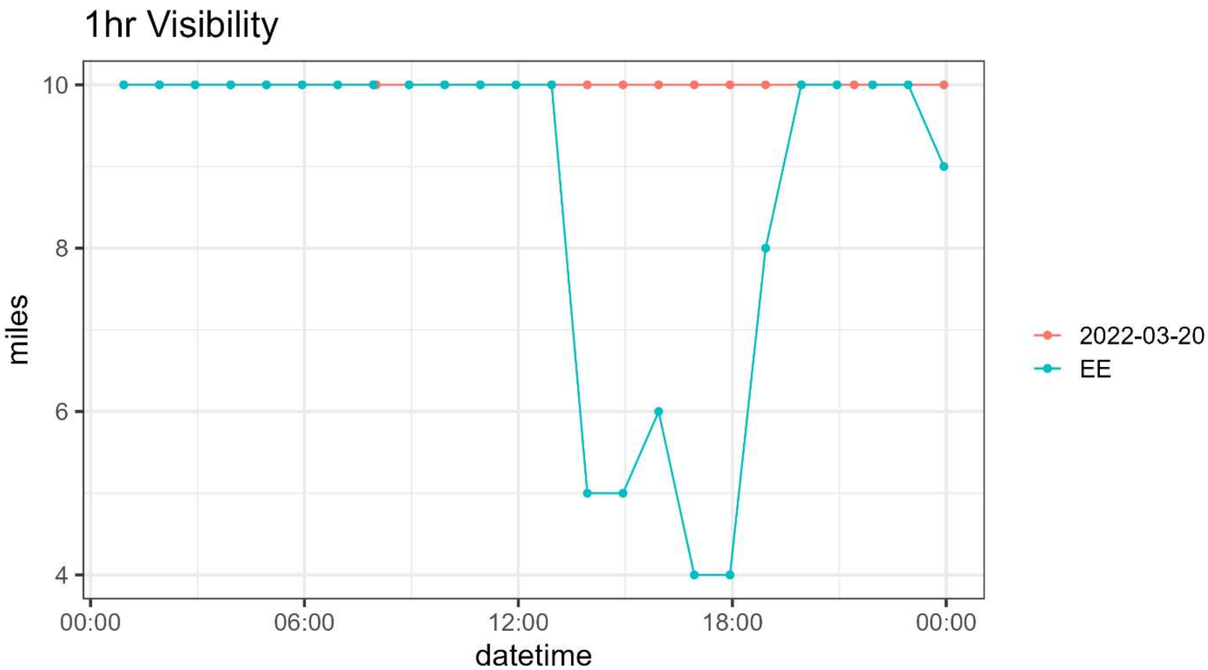


Figure 3.5-3. Hourly-reported visibility in miles at LAS for March 20, 2022 (pink), and the May 8, 2022, suspected exceptional event day (teal).

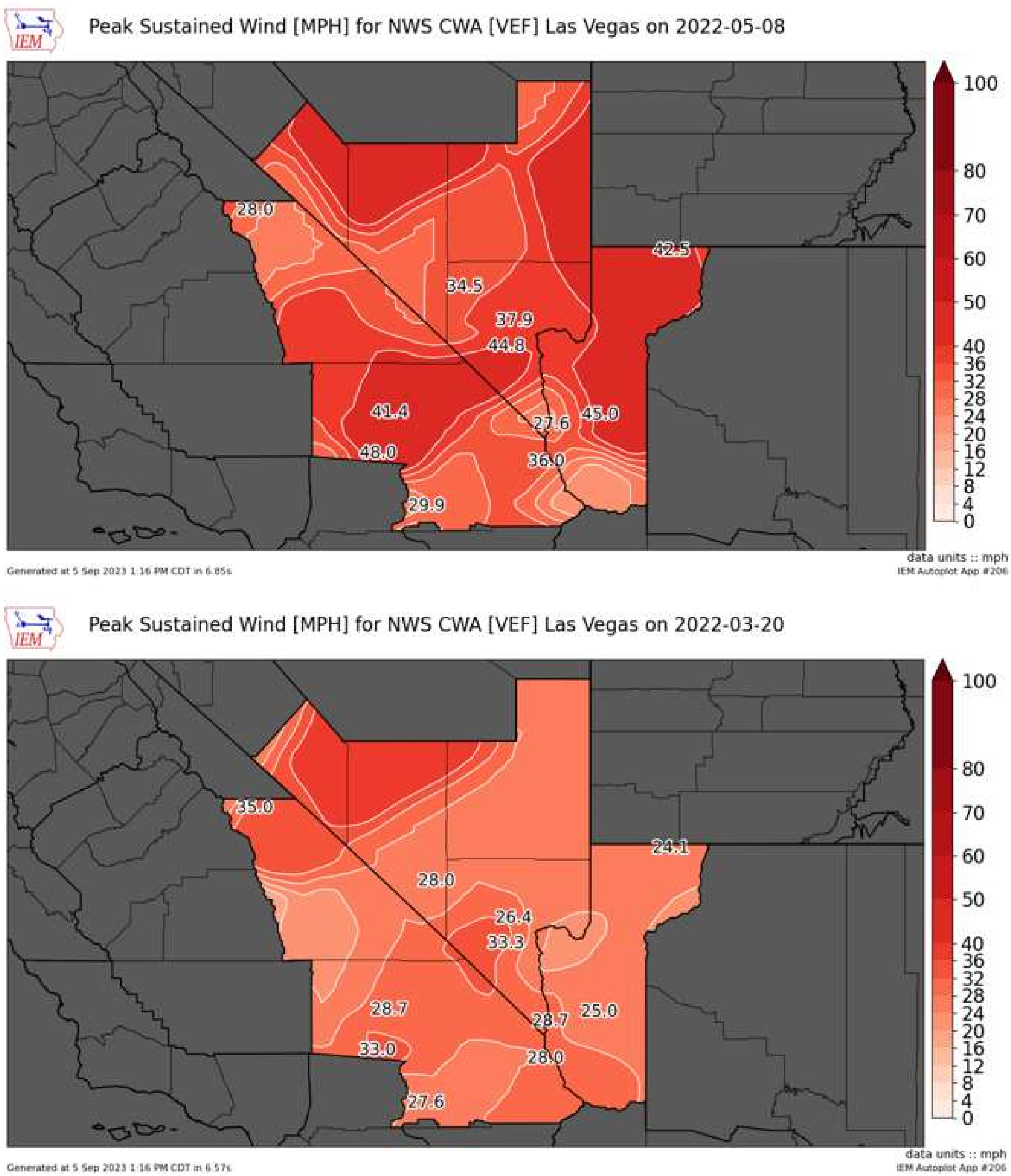


Figure 3.5-4. Spatial distribution of peak sustained wind speeds on May 8, 2022 (top), and March 20, 2022 (bottom), in Clark County and the surrounding regions. Generated from automated ASOS data using the Iowa Environmental Mesonet's plotter tool (https://mesonet.agron.iastate.edu/plotting/auto).

3.5.2 High Concentration Days in the same Season

Dates in the same season as the suspected exceptional event were screened by daily PM_{10} concentrations to find dates with similar surface meteorological conditions to those on the event date.

All dates between March and July 2022 were screened. The only other days during this period when PM_{10} concentrations exceeded the NAAQS were April 11, May 8, and May 28-29, 2022 which are also suspected high-wind dust events.

4. Not Reasonably Controllable or Preventable

4.1 Other Possible Sources of PM_{10} in Clark County

According to the EPA 2019 High Wind Dust Event Guidance document (and quoted Code of Federal Regulations [CFR] therein), agencies are required to (1) identify natural and anthropogenic sources of emissions contributing to the monitored exceedance, including contributions from local sources; (2) identify a relevant State Implementation Plan (SIP) for sources identified as natural and anthropogenic sources of emissions contributing to the monitored exceedance, including contributions from local sources and the implementation of these controls; and (3) provide evidence of effective implementation to satisfy the nRCP criterion.

Section 2.2.3 provides evidence for natural and anthropogenic sources of PM_{10} near the Green Valley, Jerome Mack, Joe Neal, Liberty High School, Mountains Edge, Palo Verde, Paul Meyer, Sunrise Acres, Walnut Community Center, and Walter Johnson monitoring sites that could have contributed to the May 8, 2022, exceedance. As shown in Section 3.2, however, the main source of PM_{10} is the large bare ground/land area to the southwest of Clark County (identified in the rest of the document as the Mojave Desert source region), which is outside of the jurisdiction of Clark County and, therefore, not subject to control measures. Additional conclusions from this analysis indicate that anthropogenic point sources were unlikely to contribute to a PM_{10} exceedance event and BACM are in place to control fugitive sources such as construction emissions. According to the 2012 "Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10})," the main sources of enhanced PM_{10} emissions in Clark County, Nevada, are (1) wind-blown dust, (2) re-entrained road dust, and (3) construction emissions. These nonpoint emission sources contribute approximately 98% of total annual PM_{10} emissions in the county and are often amplified by dry arid conditions. Control measures have been implemented and enforced to mitigate emissions from the sources listed above within the jurisdiction of Clark County. Therefore, since natural bare ground was identified as the most likely source that contributed to the May 8, 2022, event (fulfilling nRCP part 1), in this section we focus on providing information on control measures used in Clark County to mitigate emissions from construction sites and possible dust sources in both the SIP (fulfilling nRCP part 2), and providing evidence of effective implementation (fulfilling nRCP part 3).

4.2 PM_{10} Control Measures in Clark County

For an air quality episode to qualify as a high-wind exceptional event, Clark County DES must show that all anthropogenic sources of PM_{10} are reasonably controlled (40 CFR 50.14(b)(5)(ii)). The

Exceptional Event rule provides that enforceable control measures that EPA approved into the SIP within five years of the date of the event (40 CFR 50.14(b)(8)(v)) are presumptively reasonable. Controls adopted into the SIP more than five years before the event date may also be reasonable (81 FR 68238), and EPA will also consider other control measures not approved into the SIP if the air pollution control agency is implementing and enforcing the control measures (81 FR 68238-9).

Clark County DES operates one of the most robust fugitive emissions control programs in the country to reduce ambient air concentrations of PM_{10}. The 2001 PM_{10} SIP details emission sources and BACM that have been coded into the Clark County Air Quality Regulation (AQR). These include (1) stabilization of open areas and vacant lands (Section 90); (2) stabilization of unpaved roads and paving of unpaved roads when traffic volume is equal to or greater than 150 vehicles per day (Section 91); (3) stabilization of unpaved parking areas, including material handling and storage yards, and generally prohibiting the construction of new unpaved parking lots in the nonattainment area (Section 92); (4) requirements for paved roads, street sweeping equipment, and other dust-mitigating devices (Section 93); and (5) permitting and dust control requirements for construction activities (Section 94). These BACM are updated and continued in the most recent 2012 Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10}) (2012 Maintenance Plan) document for Clark County, Nevada, which was approved by EPA and extends through 2023. The 2012 updated SIP and AQR document are provided as evidence in **Appendix B**.

The 2012 Maintenance Plan also identified the Natural Events Action Plan for High-Wind Events: Clark County, Nevada (DES 2005) as a control measure. Since submission of the 2012 Maintenance Plan, DES replaced this action plan with the Clark County Mitigation Plan for Exceptional Events (DES 2018). DES developed this revised plan in response to EPA's 2016 EER (81 FR 68216) that required areas with historically documented or known seasonal exceptional events to develop mitigation plans (40 CFR 51.930(b)). EPA does not require this plan to be included in the SIP or be federally enforceable, but did review each plan to assure that the required elements were included. The revised plan includes practices from the first action plan:

- A high-wind event notification system that includes an early warning procedure.
- Education and outreach programs.
- Enhanced enforcement and compliance programs to reduce emissions.
- Submittal of required documentation to EPA in the event of an exceedance.

The new plan includes more sophisticated air quality advisories and alerts, and commits to maintaining an open line of communication with neighboring areas involved in high PM_{10} ambient air concentration events. The new plan also references the Clark County flood control system (Clark County 2018) and street sweeping schedule for Las Vegas Valley, Hydrological Area 212 (HA 212) referenced in Appendix J of the 2001 PM_{10} SIP (DES 2001). This system maintains a robust flood control system that minimizes silt deposition from flood waters onto roads, parking areas, and undeveloped land. The system undergoes continuous expansion to accommodate new development in the Las Vegas Valley, with the following recent plan changes:

- Duck Creek – Gilispie System: March 2023;
- Harry Reid Airport Peaking Basin Outfall and Van Buskirk System: Feb. 2022;
- Monson Channel-Jimmy Durant to Boulder Highway: Apr. 2022;
- Blue Diamond 02 Channel, Decatur-Le Baron to Richmar: July 2020;
- Gowan Outfall Facilities-Simmons to Clayton: May 2021;
- Pittman Wash-Interstate Channel: June 2020.[1]

The Nevada Department of Transportation, Clark County, the City of Las Vegas, the City of North Las Vegas, and the City of Henderson maintain policies requiring rapid removal of silt deposits from paved roads after storm events.

In addition to regulating direct releases of PM_{10} to the atmosphere, DES' control measures includes requirements to reduce precursors, including VOC, NO_x, and SO_x, which can react in the atmosphere to form PM_{10} emissions under certain meteorological conditions. The control measures also regulate mercury emissions. Mercury emissions are a source of PM pollution when emitted in a non-gaseous form or when adsorbed by PM to form particulate mercury. Thus, standards designed to control mercury emissions also reduce PM_{10} ambient air concentrations.

The following section explains the reasonable control measures that collectively assure that all local sources of anthropogenic sources impacting HA 212 were reasonably controlled before and after the event. The measures include controls that are presumptively reasonable because EPA approved the control measure into the SIP within five years of the event, along with other reasonable measures.

4.2.1 Presumptively Reasonable Controls

The following measures are reasonable because EPA approved the control measures into the SIP within five years of the event date:

Section 12.0-12.6 Permitting Programs – Sections 12.0 and 12.1 originally adopted November 3, 2009; last amended February 20, 2024, and awaiting SIP approval. Section 12.2 originally adopted May 18, 2010; last amended March 14, 2014, and SIP-approved October 17, 2014. Sections 12.3 and 12.4 originally adopted May 18, 2010; last amended July 20, 2021, and awaiting SIP-approval. Section 12.5 originally adopted May 18, 2010 and awaiting SIP-approval. Section 12.1 requires all minor stationary sources to obtain a permit to construct and operate if they have the potential to emit 5 tons per year (tpy) or more of a regulated pollutant, or if they are subject to another AQR, such as a control technique guideline (CTG) Reasonable Available Control Technologies (RACT) rule, that requires a minor source to obtain a permit. Some emissions units at these minor stationary sources must comply with RACT requirements when proposing an emissions increase that meet or

[1] The flood plan and updates are available at https://www.regionalflood.org/programs-services/document-library/master-plan-documents.

exceed the significance thresholds. Sections 12.2-12.5 requires all major stationary sources to obtain a permit to construct and operate. Some emissions units must comply with RACT requirements when they are the subject of an emissions increase in PM_{10} or its precursors that meets or exceeds the minor New Source Review (NSR) significance thresholds. In addition, these rules implement the federally mandated NSR Program for attainment, unclassifiable, and nonattainment areas. New major sources and existing major sources undertaking a modification that results in a significant increase in PM_{10} emissions or its precursors must install and operate Best Available Control Technology (BACT) or Lowest Achievable Control Technology (LAER).

Section 26 Emissions of Visible Air Contaminants – Amended April 26, 1983; last amended May 5, 2015; and SIP-approved June 16, 2017. This rule requires all sources to generally maintain an average opacity below 20%, with certain sources subject to a lower 10% average opacity standard.

Section 41 Fugitive Dust – Originally adopted June 25, 1992; last amended January 21, 2020; and SIP-approved May 19, 2022. This rule requires fugitive emissions abatement to prevent airborne PM emissions during construction and deconstruction activities, and during use of unpaved parking lots, agricultural operations, and raceways. The rule includes notice, registration, and permitting requirements.

Section 90 Fugitive Dust from Open Areas and Vacant Lots – Originally adopted June 22, 2000; last amended January 21, 2020; and SIP-approved May 19, 2022. This rule requires certain owners of land to take measures to prevent access of trespassers operating motor vehicles on the land. Owners must also create a stable surface area, including gravel installation that provides a 20% non-erodible cover. Landowners of large parcels must develop and submit a dust mitigation plan.

Section 93: Fugitive Dust from Paved Roads and Street Sweeping Equipment – Originally adopted June 22, 2000; last amended January 21, 2020; and SIP-approved May 19, 2022. This rule requires construction and reconstruction of roads in accordance with road shoulder widths and drivable median stabilization requirements. It also establishes an opacity standard for unpaved shoulders and medians, and for the use of road cleaning equipment. The rule requires road wetting when using rotary brushes and blowers to clean roads and allows only vacuum type crack cleaning seal equipment.

Section 94 Permitting and Dust Control for Construction and Temporary Commercial Activities – Adopted June 22, 2000; amended January 21, 2020; SIP-approved May 19, 2022; last amended August 3, 2021; and awaiting further revision before SIP approval. This rule applies to all construction and temporary commercial activities that disturb or have the potential to disturb soil. It requires a dust control permit and maintenance of a dust mitigation plan.

4.2.2 Other Reasonable Control Measures

The following identifies additional reasonable control measures that assure that all anthropogenic sources of PM_{10} emissions were controlled before and after the event. The controls fall into one of three categories: (1) EPA approved the control measures into the SIP more than five years before the event date; (2) the state submitted revisions that EPA has not yet approved into the SIP; or, (3) the Clean Air Act (CAA) and EPA do not require states to submit the type of control measure for SIP approval. As explained below, these control measures are reasonable because they meet or exceed CAA requirements, enhance enforcement efforts, and are equal or more stringent than control programs found in other state SIPs.

State Control Measures

Nevada Regional Haze State Implementation Plan – Originally adopted October 2009 and partially SIP approved March 26, 2012, and August 28, 2013, awaiting SIP approval. Prepared by the Nevada Division of Environmental Protection (NDEP) and codified by DES in AQR Section 12.14 on June 7, 2022. This plan requires reductions in visibility impairing pollutants, and thereby reduces the potential for PM_{10} formation. The plan specifically required Reid Gardner (a point source in Clark County) to meet PM control requirements by June 30, 2016, or to shutdown Units 1, 2, 3 by this date. The 2022 revised plan, which should become effective during the second maintenance period, requires the installation of low NO_x burners and selective non-catalytic reduction control equipment to reduce visibility impairing pollution on lime kilns operating in Clark County. This rule is reasonable because the controls imposed met the CAA's Best Available Retrofit Technology (BART) standard.

NAC 445B.737-774, Heavy-Duty Vehicle Program – adopted October 22, 1992; last amended October 18, 2002. The NDEP and Nevada Department of Motor Vehicles (DMV) jointly developed this rule to reduce motor vehicle related pollution by limiting excessive tailpipe or smokestack emissions from any gasoline or diesel-powered vehicle with a manufacturer's gross vehicle weight rating (GVWR) of 14,001 lbs. or more. Enforcement inspectors pull over heavy-duty vehicles for random roadside testing to determine if the exhaust from their vehicle exceeds state opacity standards. Violators must repair and retest the vehicle within 30 days. Fleets may also request opacity testing in their fleet yard. Fleet managers voluntarily repair and re-test vehicles failing the inspection. This regulation is reasonable because it exceeds EPA's inspection and maintenance program requirements, and actively prevents smoking vehicles from operating on roads.

NAC 445B.400-735, Inspection and Maintenance Program – adopted September 28, 1988; subsequently amended and SIP-approved July 3, 2008; last amended October 18, 2022. The NDEP and the Nevada DMV jointly developed this rule, administered by the DMV, to control vehicle emissions. The rule reduces motor vehicle-related NO_x and VOC emissions through the vehicle inspection and emissions-related repairs. Clark County requires annual emissions testing before renewing a vehicle's registration. All gasoline-powered vehicles must be tested, with limited exceptions, as well as diesel-powered vehicles weighing up to 14,000 lbs. gross vehicle weight rating (GVWR). EPA approved the inspection and maintenance program as part of the Carbon Monoxide State Implementation Plan: Las Vegas Valley Nonattainment Area, Clark County, Nevada (CO SIP[2]), in September 2004 (69 FR 56351). This inspection and maintenance program is reasonable because it (1) exceeds EPA's requirements for a basic inspection and maintenance program, and (2) follows a standard that qualifies as a low-enhanced performance standard.

NAC 445B.3611-3689 Nevada Mercury Control Program – Originally adopted May 4, 2006; last revised November 2, 2016. Mercury emissions can also be a source of PM pollution when emitted as in non-gaseous form a particulate or when adsorbed by PM to form particulate mercury. Thus, standards designed to control mercury emissions also reduce PM_{10} ambient air concentrations. The rule requires particulate emissions control technologies to reduce mercury emissions from thermal units located in precious metal mines. The CAA does not require states to submit hazardous air pollutant control measures for SIP approval. These measures are reasonable because they reduce the ambient air concentration of PM_{10} by requiring use of the Maximum Achievable Control Technology (MACT) and apply in addition to the federal standards at 40 CFR Part 63, Subpart E.

County Air Quality Regulations

Section 14 New Source Performance Standards (NSPS) - Originally adopted September 3, 1981; last amended March 15, 2022. Regulations in this section are reasonable because they implement EPA's federal PM and total suspended particulate (TSP) emissions limitations in 40 CFR Part 60 "New Source Performance Standards" (NSPS) that apply to a variety of stationary sources. EPA has delegated implementation and enforcement of the federal standards to DES. The CAA does not require states to submit NSPS control measures for SIP approval.

Section 13 National Emissions Standards for Hazardous Air Pollutants (HAP) – Originally adopted September 3, 1981; last amended March 15, 2022. Regulations in this section are reasonable because they implement federal HAP emissions limitations in 40 CFR Part 63 that apply to a variety of stationary sources that emit particulate emissions in the form of metal HAP. These standards are based on Maximum Achievable Control Technology. EPA has delegated implementation and enforcement of the standards to DES. The CAA does not require states to submit HAP control measures for SIP approval.

Section 27 Particulate Matter from Process Weight Rate – Originally adopted September 3, 1981 (SIP approved June 18, 1982); last amended July 1, 2004. Establishes process weight restrictions for PM emissions for all operations. This regulation is reasonable because it establishes maximum rates for PM emissions from stationary sources that are more stringent than any specific CAA or SIP

[2] https://webfiles.clarkcountynv.gov//Environmental%20Sustainability/SIP%20Related%20Documents/Carbon_Monoxide_State_Implementation_Plan_Revision-without_Appendices.pdf

requirement, and comparable to limits found in other state SIPs. Compare the rule, for example, to Chapter 1200-3-7 "Process Emission Standards" in the Tennessee SIP.[3]

Section 28 Fuel Burning Equipment – Originally adopted December 28, 1978; SIP-approved August 27, 1981; last amended July 1, 2004. This rule applies to fuel burned for the primary purpose of producing heat or power by indirect heat transfer. It regulates the burning of coke, coal, lignite, coke breeze, fuel oil, and wood, but not refuse. The regulation targets reductions in PM_{10} emissions, but by promoting good combustion practices, the rule also produces NO_x and VOC emissions reduction co-benefits that further reduce the potential for PM_{10} formation. The rule establishes PM emissions rates based on heat input. This regulation is reasonable because it establishes maximum rates for PM emissions from stationary sources that are more stringent than any specific CAA or SIP requirement and emissions limitations found in other states. Compare the rule, for example, to Chapter 13 "Emission Standards for Particulate Matter" in the Louisianna SIP.[4]

Section 42 Open Burning – Originally adopted December 28, 1978; SIP-approved August 27, 1981; last amended July 1, 2004. This rule requires preauthorization to burn any combustible material and prohibits open burning during air pollution episodes, which is consistent with the Nevada Emergency Episode Plan. This regulation is reasonable because it allows the Control Officer to assess and prevent any burning that could lead to a PM_{10} NAAQS exceedance. The rule also is comparable to similar control measures found in other SIPs. See, for example, South Coast Air Quality Management District's Rule 444[5].

Section 91 Fugitive Dust from Unpaved Roads, Unpaved Alleys, and Unpaved Easement Roads – Originally adopted June 22, 2000; last amended April 15, 2014; and SIP-approved October 6, 2014. This rule applies to unpaved roads, including unpaved alleys, unpaved road easements, and unpaved access roads for utilities and railroads. It requires PM emissions control measures including paving or application of dust palliatives. This regulation is reasonable because it targets and reduces emissions of event-related fugitive dust emissions using state-of-the-art emissions controls, which are more stringent than the best practices recommended by EPA. See "Fugitive Dust Control Measures and Best Practices," EPA, January 2022[6].

Section 92 Fugitive Dust from Unpaved Parking Lots and Storage Areas – Originally adopted June 22, 2000; amended April 15, 2014; SIP-approved October 6, 2014; last amended August 3, 2021. This rule applies to lot and storage areas greater than 5,000 ft^2. The rule generally requires owners of a lot or storage area to pave the area or cover it in two inches of gravel. It also prohibits visible dust plumes from crossing the property boundary. This regulation is reasonable because it targets and reduces emissions of event-related fugitive dust emissions using state-of-the-art emissions controls, which are more stringent than the best practices recommended by EPA. See "Fugitive Dust Control

[3] https://www.epa.gov/system/files/documents/2021-12/chapter-1200-3-7.pdf
[4] https://www.epa.gov/air-quality-implementation-plans/louisiana-lac-33iii-ch-13-section-1301-emission-standards
[5] https://ww2.arb.ca.gov/sites/default/files/2021-06/SouthCoastSMP.pdf
[6] https://www.epa.gov/system/files/documents/2022-02/fugitive-dust-control-best-practices.pdf

Measures and Best Practices," EPA, January 2022. The rule also regulates sources not typically regulated in other state SIPs.

Section 94 Permitting and Dust Control for Construction and Temporary Commercial Activities – Adopted June 22, 2000; amended January 21, 2020; SIP-approved May 19, 2022; last amended August 3, 2021. This rule applies to all construction and temporary commercial activities that disturb or have the potential to disturb soil. It requires a dust control permit and maintenance of a dust mitigation plan. This regulation is reasonable because it targets and reduces emissions of event-related fugitive dust emissions using state-of-the-art emissions controls, which are more stringent than the best practices recommended by EPA. See "Fugitive Dust Control Measures and Best Practices," EPA, Jan. 2022. The rule also regulates sources not typically regulated in other state SIPs.

Transportation Conformity – Clark County works closely with the Regional Transportation Commission of Southern Nevada (RTC) to assure that regional transportation plans and transportation improvement programs in HA 212 are consistent with and conform to Clark County's air quality program requirements, including the PM_{10} SIP and corresponding motor vehicle emissions budget (MVEB).

In this section (and in Appendix B), we have provided information on adopted presumptively and other reasonable control measures used in Clark County to mitigate emissions from construction sites and other possible dust sources, fulfilling part 2 of the nRCP criterion.

4.3 Reasonableness of Control Measures

Table 2 in the 2019 High-wind Dust Exceptional Event Guidance document provides example factors that an air agency and EPA may consider when assessing the reasonableness of controls as part of the nRCP criterion. This table details example factors, such as (1) control requirements based on area's attainment status, (2) the frequency and severity of past exceedances, (3) the use of widespread measures, and (4) jurisdiction. In this section, we address all the possible factors that evaluate the reasonableness of controls.

4.3.1 Historical Attainment Status

The 2012 Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10}) document for Clark County, Nevada, provides a comprehensive historical analysis of the Clark County nonattainment area. Briefly, after the passage of the 1990 Clean Air Act Amendments, EPA designated all areas previously classified as Group I areas as "moderate" nonattainment areas, including HA 212 (CAA §107(d)(4)(B)). EPA required these moderate nonattainment areas to submit a SIP by November 1991 that would demonstrate attainment of the PM_{10} NAAQS by December 1994. Because of unprecedented regional growth, high-wind events, and other factors, Clark County could not demonstrate attainment by the required date, and EPA reclassified HA 212 as a "serious" nonattainment area on January 8, 1993 (58 FR 3334). In 1997, a PM_{10} SIP revision was submitted. In December 2000, the Clark County Board of County Commissioners (BCC) requested that the state formally withdraw all previously submitted SIPs and addenda because none demonstrated attainment of the NAAQS.

After completing comprehensive research and work programs to address the problems identified in the 1997 PM_{10} SIP revision, Clark County submitted a new SIP to EPA in June 2001 that met federal requirements for remediating serious PM_{10} nonattainment areas. This new SIP demonstrated that the adoption and implementation of BACM for fugitive sources and continuation of controls for stationary sources would result in attainment of the annual average PM_{10} NAAQS by 2001, and attainment of the 24-hour NAAQS by December 31, 2006. Although the CAA required the SIP demonstrate attainment of the PM_{10} NAAQS no later than December 31, 2001, EPA granted Clark County a five-year extension for the 24-hour NAAQS attainment date. Clark County supported its extension request with a “Most Stringent Measure” control analysis that showed the emission control programs proposed for the valley were at least as stringent, if not more so, than control programs implemented in other nonattainment areas.

In June 2004, EPA published final approval of the Clark County PM_{10} SIP (69 FR 32273). In June 2007, Clark County submitted a milestone achievement report that described the county’s progress in implementing the SIP. In August 2010, EPA determined HA 212 had attained the PM_{10} NAAQS (75 FR 45485).

In August 2012, the Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10}) (i.e., 2012 Maintenance Plan) was formally approved, and EPA redesignated the Clark County PM_{10} nonattainment area to attainment for the 1987 24-hour NAAQS. To achieve attainment of the 1987 24-hour PM_{10} NAAQS, Clark County DES implemented emissions control measures that lead to a permanent and enforceable improvement in air quality, as required by CAA Section 107(d)(3)(E)(iii) (42 U.S.C. 7407). The 2012 Maintenance Plan explained that Clark County adopted comprehensive fugitive dust controls in the Section 90 series of the AQR, and implemented and enforced SIP and non-SIP regulations to control PM_{10} emissions from stationary and nonpoint sources. The maintenance plan summarized the progress in attaining the PM_{10} standard, demonstrated that all Clean Air Act and Clean Air Act Amendment requirements for attainment had been met, and presented a plan to assure continued maintenance over the next 10 years. The plan became federally enforceable and determined how Clark County maintained the 1987 PM_{10} NAAQS through 2023.

In 2022, Clark County began work on a Second PM_{10} Maintenance Plan. For this plan, Clark County DES must show attainment in the background and assessment design value periods, specified as the 2017-2019 background period and the 2021-2023 assessment period. This exceptional event demonstration and the associated demonstrations for the 2021-2023 design value period will show that Clark County’s HA 212 area is in attainment of the PM_{10} NAAQS but for the proven exceptional event dates. Approval and implementation of the Second PM_{10} Maintenance Plan is expected in 2024.

4.3.2 Historical Analysis of Past PM_{10} Exceedances

The 2012 Maintenance Plan document for Clark County, Nevada, provides historical context of regulatory efforts by Clark County to achieve attainment of PM_{10} NAAQS over the past 30 years, and a robust weight-of-evidence trend analysis for PM_{10} concentrations from 2001-2010. With the implementation of the PM_{10} SIP control measures, evidence shows a decreasing trend in PM_{10} design values, especially after BACM implementation (Figure 4.3-1). The decrease in wind erosion from vacant lands has driven the decreasing trend of PM_{10} emissions as construction within the Las Vegas Valley overtakes vacant lands. Given that the Las Vegas Valley was designated as being in "moderate" and later "serious" nonattainment for the PM_{10} NAAQS in the early 1990s, PM_{10} emissions before 1999 were likely high relative to the 2008-2010 period shown in Figure 4.3-1. This confirms that PM_{10} emissions have decreased over the past 30 years since the implementation of BACM from anthropogenic sources.

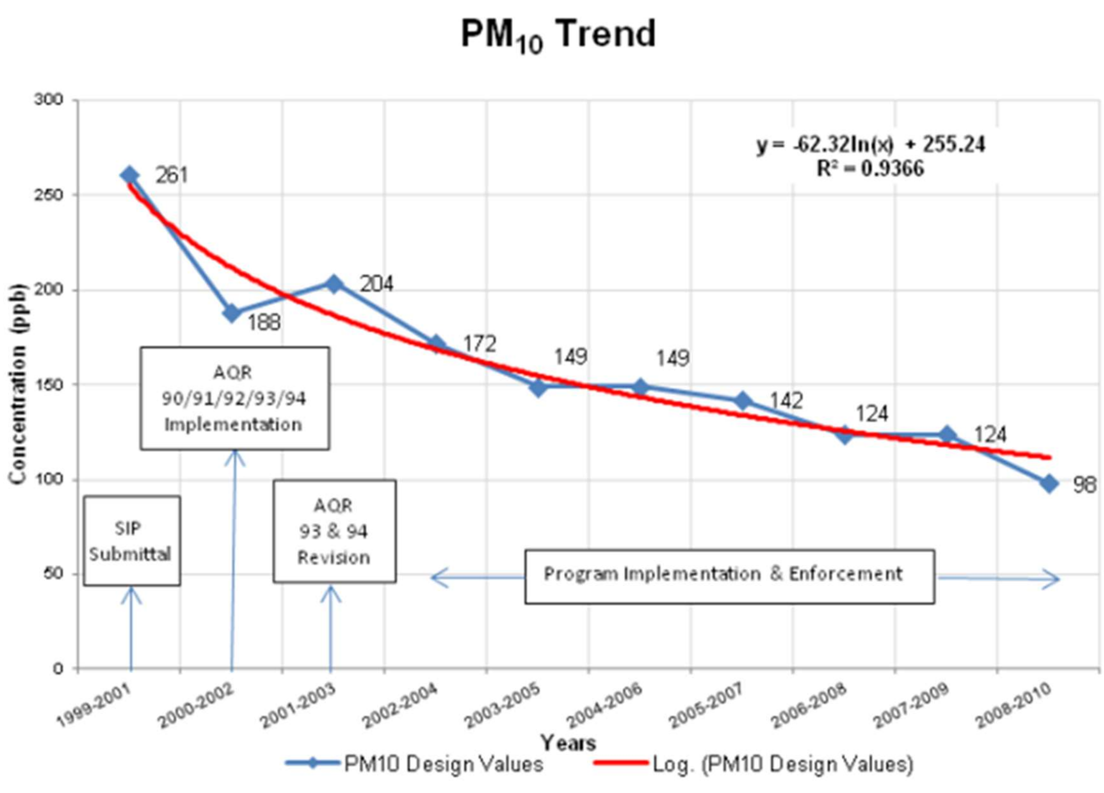


Figure 4.3-1. PM_{10} trends from the 2012 Maintenance Plan.

Continuing this evaluation through 2022, Figure 4.3-2 shows the three-year running average concentration at a long-running PM_{10} monitoring site in Clark County (Paul Meyer: AQS ID 32-003-0043) (orange line), along with the three-year running average of drought conditions in Nevada (blue bars). Drought conditions are categorized on a scale of D0 (abnormally dry) to D4 (exceptional), and Figure 4.3-2 shows the three-year running average of D2 (severe) conditions. We see that the typical five-year cyclical drought pattern in Nevada has increased in magnitude in the most recent years and this has corresponded to an uptick in average PM_{10} concentrations. This suggests that the control measures put in place via the 2012 SIP have been at least partially counterbalanced by increasing drought throughout the state of Nevada, affecting PM_{10} concentrations. Figure 4.3-3 shows the D0 - D4 drought conditions for 2000-2023, highlighting the increase in D3 (extreme) and D4 drought conditions through the most recent years. According to NLCD 2019 data, 87% of Nevada's land cover is bare ground or land that has little vegetation cover. The expansion in magnitude of severe-to-exceptional drought conditions will disproportionately affect natural areas prone to dust lofting, entrainment, and transport, ultimately enhancing PM_{10} concentrations.

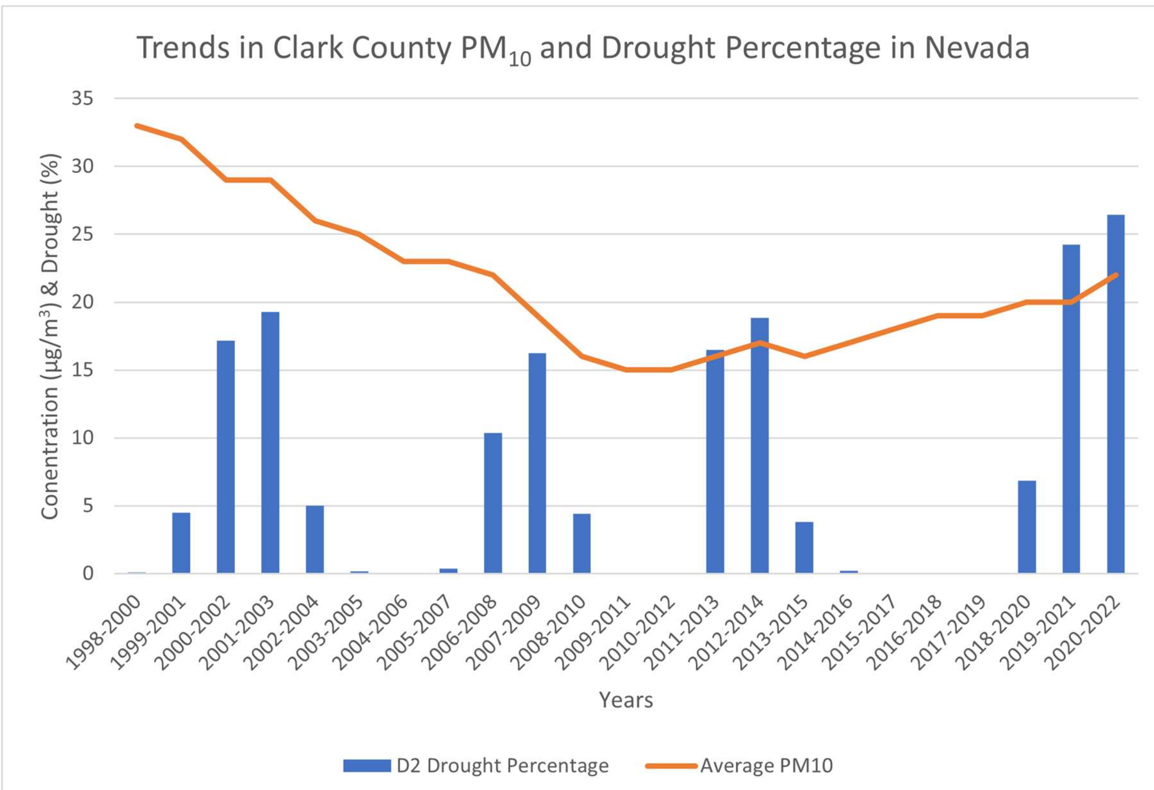


Figure 4.3-2. Three-year running average of PM_{10} concentrations ($\mu g/m^3$) at the long-running Paul Meyer monitoring site (AQS: 32-003-0043) (orange line) and the D2 (severe) drought percentage of Nevada (blue bars). Source: https://www.drought.gov/states/nevada.

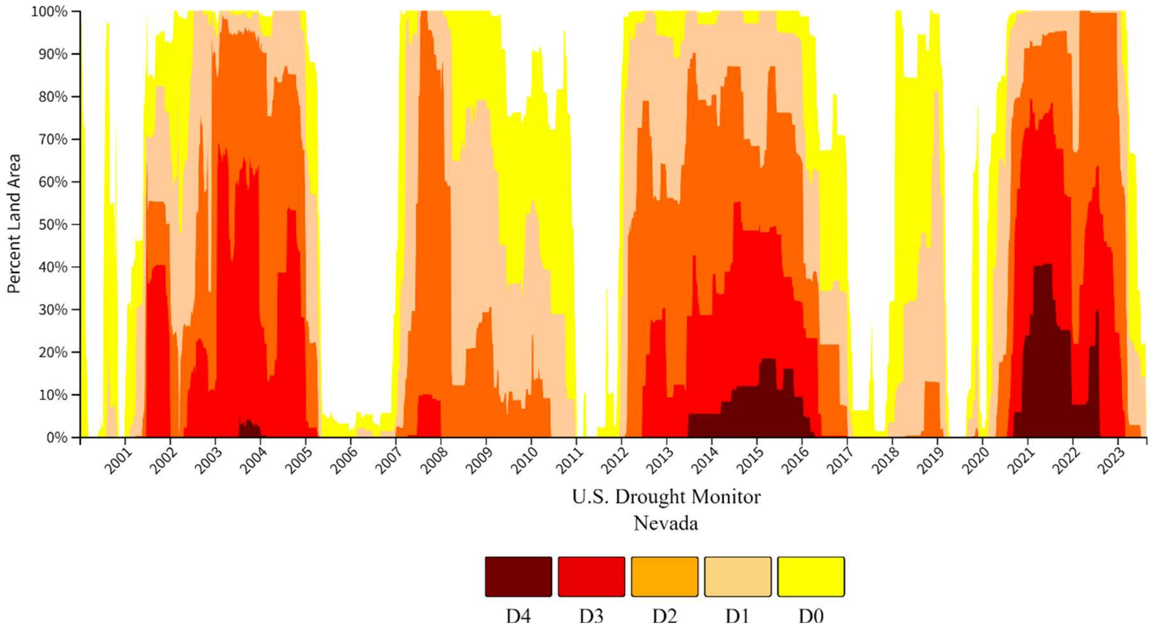


Figure 4.3-3. Drought statistics for Nevada from 2000-2023, colored by drought severity for D0 to D4. Source: **https://www.drought.gov/states/nevada**.

Historical PM_{10} exceedance frequency in Clark County has varied among air quality monitoring sites since the late 1990s and early 2000s. **Figure 4.3-4 and Figure 4.3-5** show historical 24-hour PM_{10} exceedance count and concentration and design values at site in HA212 with at least 20 years of data. PM_{10} exceedances at the Joe Neal and Green Valley sites occurred at a greater frequency (≥1 exceedance per year) in the late 1990s and early 2000s followed by a drop to no exceedances per year in the mid-2000s coinciding with BACM implementation and less severe drought conditions. Other sites show one exceedance every few years before 2022. The number of exceedances per year increased in the 2010s for most long-term sites, coinciding with more widespread and severe drought conditions in Nevada. The number of exceedances rose significantly for all long-term sites in 2022 and 2023 due to the wind-blown dust exceptional events. Without these 2022 and 2023 events, the number of exceedances would more closely align with the mid-2000s period. These observations are consistent with the historical PM_{10} and drought analysis presented in the 2012 Maintenance Plan.

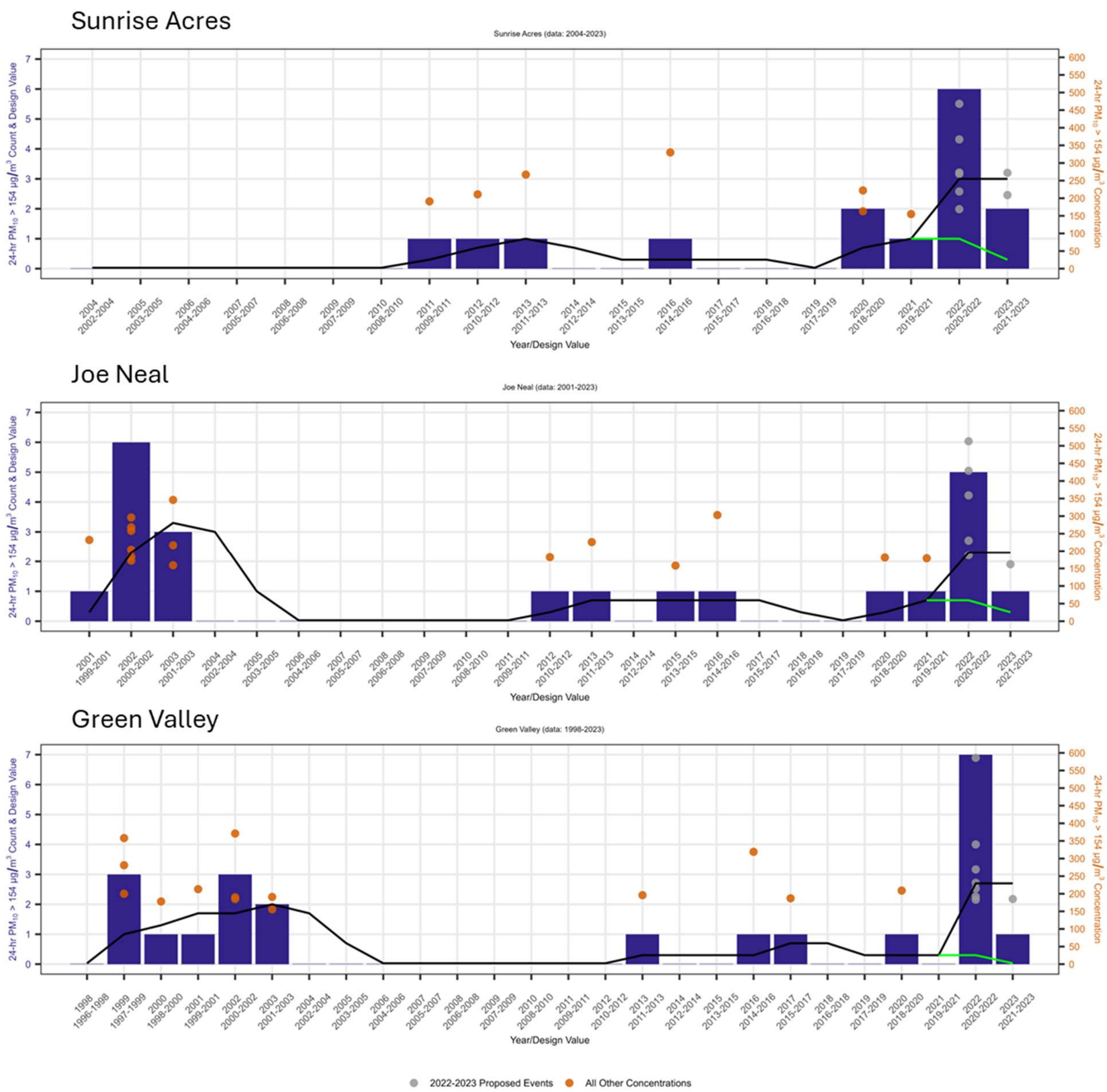


Figure 4.3-4. Historical 24-hour PM_{10} exceedance count (purple bars) and concentration (orange dots) per year/design value period at the Sunrise Acres, Joe Neal, and Green Valley monitoring sites (AQS: 32-003-0561; 32-003-0075; 32-003-0298). The gray dots represent the proposed 2022-2023 PM_{10} exceptional events, the black line represents the design value for all periods with all PM_{10} exceptional events included, and the green line represents the design value for the period with the 2022-2023 PM_{10} exceptional events excluded.

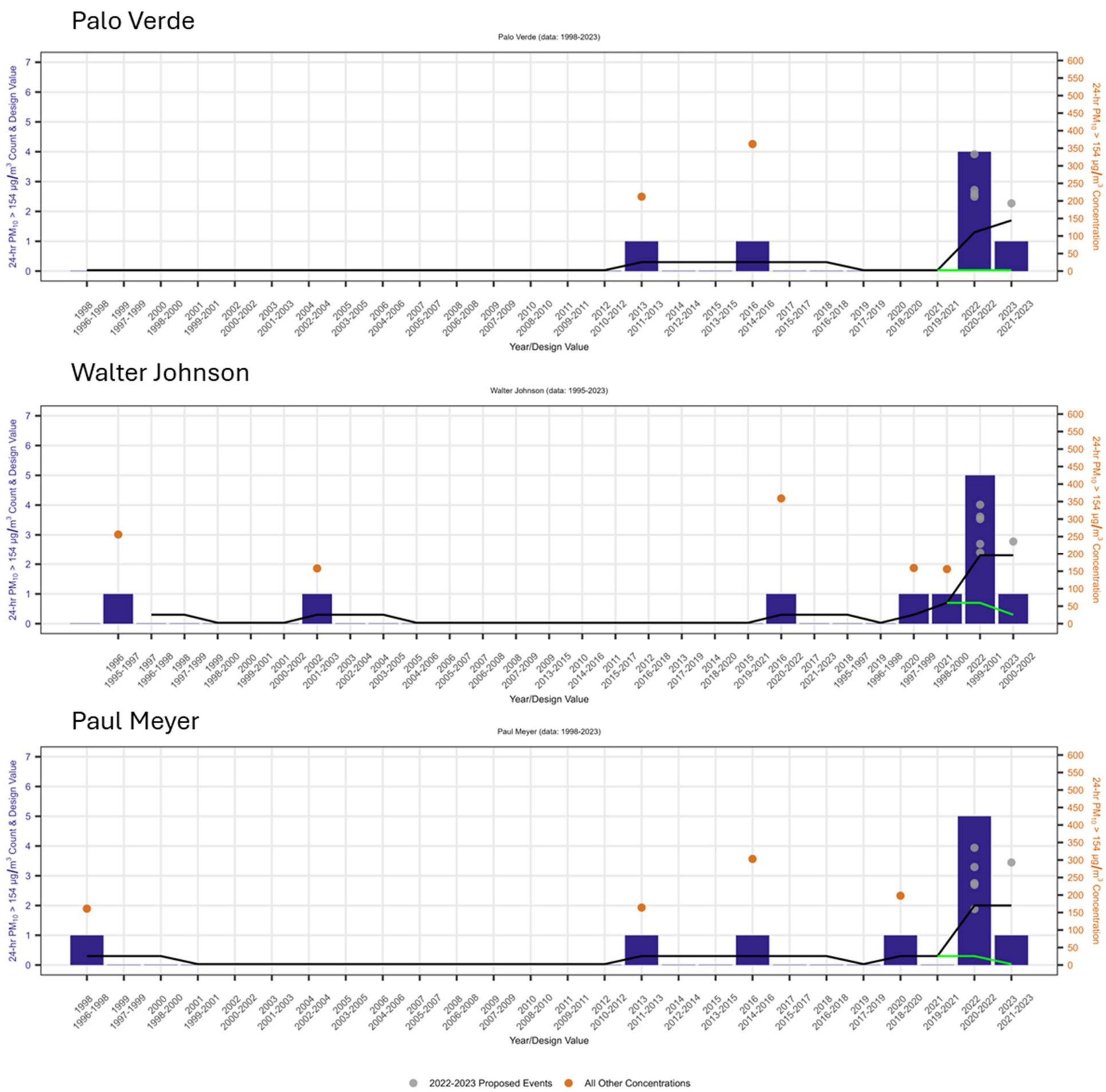


Figure 4.3-5. Historical 24-hour PM_{10} exceedance count (purple bars) and concentration (orange dots) per year/design value period at the Palo Verde, Walter Johnson, and Paul Meyer monitoring sites (AQS: 32-003-0073; 32-003-0071; 32-003-0043). The gray dots represent the proposed 2022-2023 PM_{10} exceptional events, the black line represents the design value for all periods with all PM_{10} exceptional events included, and the green line represents the design value for the period with the 2022-2023 PM_{10} exceptional events excluded.

4.3.3 Widespread Use of Controls

In addition to the similar controls listed per rule in Section 4.2, Clark County's dust control measure regulatory framework is similar to that of nearby jurisdictions. Rule 403 in the Rules and Regulations of the Mojave Desert Air Quality Management District (MDAQMD)[7] and Rule 310 of Maricopa County's (Arizona) Air Pollution Control Regulations[8] describe the regulations and enforcement of fugitive dust control measures. Like the fugitive dust controls outlined in Clark County's AQR, MDAQMD and Maricopa County provide definitions of control measures that dust-producing operations in the air agency's jurisdiction must apply to prevent, reduce, or mitigate fugitive dust. The control measures implemented by Clark County, MDAQMD, and Maricopa County emphasize the stabilization of site surfaces, and have requirements for equipment usage, permitting, and enforcement. The rules of the respective jurisdictions provide differing levels of detail and requirements regarding fugitive dust control measures. Further, the rules of the respective jurisdictions are tailored to fit the specific dust control challenges each jurisdictions faces.

The stabilization of site surfaces is defined similarly across Clark County, MDAQMD, and Maricopa County as the reduction of dust-producing capability of a disturbed surface through the treatment of the surface using methods such as watering, paving, manual compacting, or chemical treatment. Stabilization of site surfaces—where a portion of the earth's surface or material placed on the earth's surface is disturbed and has the potential to produce fugitive dust emissions—is required across all three jurisdictions. Stabilization is a critical component of dust control measures across the three jurisdictions. During high-wind events, all three jurisdictions must ensure that site surfaces are stabilized to prevent wind-blown dust. Maricopa County and Clark County specify in their respective rules that, during high-wind events, certain operations that destabilize surfaces such as blasting must cease, whereas MDAQMD requires that "non-essential" destabilizing operations must be reduced.

Specific rules regarding equipment use vary slightly across the three jurisdictions in requirements and level of detail, but generally include requirements such as speed limits for equipment while on site and limits on hauling vehicles (e.g., covers over dust-producing material). For example, MDAQMD requires that hauling vehicles working at a mining, stone, asphalt, or clay facility maintain at least six inches of freeboard (i.e., the distance between the hauled material and the top of the hauling container) on haul vehicles when transporting material on public roads, whereas Maricopa County requires that hauling vehicles working off-site in areas accessible to the public maintain at least three inches of freeboard on haul vehicles when transporting material. Maricopa County also provides detail on hauling truck operations working under other circumstances, such as on-site and not accessible to the public.

Dust control plans required across the three jurisdictions vary slightly, but are integral parts of the permitting process that detail control measures that will be implemented. All dust control plans require basic information such as site details, control measures, contingency control measures, and a summary of general day-to-day operations. The circumstance under which a dust-generating operation must submit a dust control plan differs between the jurisdictions. For example, there are seven circumstances that would require the submittal of a dust control plan to MDAQMD, such as a

[7] https://www.mdaqmd.ca.gov/home/showpublisheddocument/8482/637393282546170000

[8] https://www.maricopa.gov/DocumentCenter/View/5354/Rule-310---Fugitive-Dust-from-Dust-Generating-Operations-PDF?bidId=

"Residential Construction/Demolition Activity with a Disturbed Surface Area of at least ten (10) acres." Maricopa County, however, requires the submittal of a dust control plan for any potential dust-generating operation that would meet or exceed 0.10 acres. Clark County, under Section 94 of the AQR, requires the submittal of a dust control plan for "Construction and Temporary Commercial Activities" under four circumstances (e.g., Construction Activities that disturb soils 0.25 acres or greater in overall area).

Enforcement of dust control regulations and dust control plan compliance are also similar, but differ in level of detail and stringency between the three jurisdictions. Clark County's enforcement activities are extensive and detailed. For example, per Section 94 of the AQR, Clark County requires that, under certain circumstances, a Dust Control Monitor (i.e., a construction superintendent or other on-site representative) is given power to ensure the dust-generating operation is compliant with dust control regulations and follows the dust control plan. Maricopa County has similar rules regarding an official monitor of dust control regulation and dust control plan compliance. Officials in charge of monitoring dust-producing activities are trained in dust control practices and are generally responsible for managing and enforcing dust control practices at the dust-producing site. Dust-producing operations in violation of regulations and their dust control plan are subject to penalties.

The prevalence of similar standard fugitive dust control practices employed by Clark County, MDAQMD, and Maricopa County provide a benchmark for reasonable dust controls for similar environments in the southwest U.S.

4.3.4 Jurisdiction

As detailed in **Section 3.1.1**, on May 8, 2022, dense blowing dust from the Mojave Desert source region impacted the Las Vegas metropolitan area. Due to the strengthening pressure gradient caused by an associated cold front, surface wind speeds increased in Clark County and the Mojave Desert, which produced blowing dust in the late morning/early afternoon hours southwest of Las Vegas on May 8, 2022. Strong winds in the Mojave Desert source region were well above 25 mph from the frontal passage, which lofted, entrained, and transported dust from the source region to Clark County. As detailed in **Section 3.2.2**, sites in the Las Vegas Valley exceeded 500 µg/m^3 from 13:00 to 17:00 PST. Ground-based evidence, including particulate matter analysis (**Section 3.3.4**) and visibility monitors (**Section 3.3.5**), provide additional strong evidence that PM_{10} control measures within Clark County were overwhelmed and unable to prevent an exceedance event on May 8, 2022. The timeline shown in this exceptional event demonstration highlights the progression of extremely high concentrations of PM_{10} from the source region into Clark County (and HA 212) within a very short period of time. This progression clearly indicates an upwind source of windblown dust. As the strong winds lofted, entrained, and transported dust from the Mojave Desert in southeastern California and southern Nevada, this source region was outside the jurisdiction of Clark County and the implemented control measures.

4.4 Effective Implementation of Control Measures

In addition to the SIP and AQR documentation previously provided, the Clark County DES is responsible for monitoring and forecasting air quality and enforcing dust mitigation measures before, during, and after an exceptional event. Clark County issues “advisories” and “Construction Notices” when weather conditions are forecast to be favorable for a wind-blown dust event. Advisories consist of health-based notifications disseminated to the public that provide educational materials on how to limit exposure and mitigate emissions for dust, $PM_{2.5}$, seasonal ozone, ozone, and/or smoke. Construction Notices are notifications to stationary sources, dust control permit holders, and contractors that detail mitigation measures. The issuance of Construction Notices may not meet the wind threshold for a potential high-wind dust event, but if weather conditions change to prompt a public advisory or alert, stationary sources are sent a detailed form of the public advisory or an alert with language specific to their operations and dust abatement requirements.

Dust Advisories are issued for forecasts of sustained wind speeds of 25 mph or more, or wind gusts of 40 mph or more. Construction Notices are issued for forecasts of sustained wind speeds of 20 mph or more, or wind gusts of 30-35 mph or more. Upon issuance of either a Construction Notice or an Advisory, the DES directs stationary sources to inspect their site(s), cease blasting operations, and employ BACM to stabilize all disturbed soils and reduce blowing dust. Recipients of a Construction Notice are informed that the DES officials will inspect sites to ensure BACM is being implemented.

Specific construction-related control measures include required dust control classes for construction superintendents or other on-site representatives.[9] Clark County also collects air quality complaints (including dust complaints) submitted online, over the phone, or via email, and responds to all complaints within 24 hours or the next business day.[10] Expansive rules and BACM for dust control at construction and temporary commercial activities are included in AQR Section 94. These include requirements for dust control monitors, soil stabilization standards, testing methods, and rules for non-compliance or violations if a permit or Dust Mitigation Plan has been violated. During high-wind dust periods, Clark County compliance officers inspect construction and stationary source sites to ensure BACM are being implemented, and any observed violation may receive a Notice of Non-Compliance or a Notice of Violation.

A Dust Advisory was issued for May 8, 2022, by Clark County to all dust control permit holders, contractors, and stationary sources, instructing them to immediately inspect their site(s) and employ BACM to stabilize disturbed soils and reduce blowing dust (see **Appendix D**). In the case of a Dust Advisory, compliance officers inspect construction and stationary source sites during the episode to ensure BACM are being implemented, where any observed violation may receive a Notice of Violation. This and other Clark County public-facing alerts shown in **Section 3.3.1** indicate the

[9] https://www.clarkcountynv.gov/government/departments/environment_and_sustainability/compliance/dust_classes.php
[10] https://www.clarkcountynv.gov/government/departments/environment_and_sustainability/division_of_air_quality/air_quality_complaints.php

implementation of BACM and enforcement procedures. **Appendix C** also provides all inspection information and notices of violation from the May 8, 2022, event.

The Clark County DES is comprised of Monitoring, Compliance and Enforcement, and Planning divisions. The Monitoring Division is primarily responsible for weather and air quality monitoring, forecasting Air Quality Index (AQI) levels and coordinating with other divisions and Clark County more broadly on the issuance of Construction Notices or Advisories. The Compliance and Enforcement Division is responsible for disseminating Construction Notices to appropriate stationary sources, dust control permit holders, and contractors. This department also disseminates Advisories to the public, conducts field inspections of sources before and during a dust event, alerts alleged violators of compliance statuses, and documents observations made in the field of enforcement actions. The Planning Division is responsible for coordinating with the other divisions to prepare exceptional event packages. Full details on these procedures can be found in Appendix D. Based on the implementation of increased control measures, as well as compliance and the enforcement of advisories for windblown dust, part 3 of the nRCP requirement is fulfilled.

The documentation and analysis presented in this demonstration and appendices demonstrate that all identified sources that caused or contributed to the exceedance were reasonably controlled, effectively implemented, and enforced at the time of the event; therefore, emissions associated with the May 8, 2022, PM_{10} event were not reasonably controllable or preventable.

5. Natural Event

The May 8, 2022, event is the result of a frontal passage and associated pressure gradient that caused high winds over the Mojave Desert source regions, which lofted, entrained, and transport dust into Clark County, Nevada. In the case when high-wind events pass over natural undisturbed lands, the EPA considers high-wind dust events natural. In addition, there were controls in place for anthropogenic sources (see **Section 4.2**) during the high-wind dust event. Therefore, we conclude that this event meets the EPA criteria for a natural event.

6. Conclusions

The evidence provided within this report demonstrates that the PM_{10} exceedance on May 8, 2022, was caused by a high-wind dust event where dust was lofted, entrained, and transported from the extremely dry Mojave Desert in southeastern California to Clark County, Nevada. Key elements and evidence associated with the event timeline include:

1. A cold front in northern California caused an enhanced west-to-east pressure gradient to form between southern California and Clark County, leading to a sharp rise in southwesterly wind speeds across an extremely dry desert source region in the Mojave Desert to the southwest of Clark County during the morning on May 8, 2022. Dust from the Mojave Desert was lofted, entrained, and transported to Clark County by 11:00-18:00 PST on May 8. Meteorological measurements in the source region and along the transport path show winds greater than the 25-mph threshold.

2. Back trajectories and meteorological data along the frontal passage confirm the Mojave Desert as the source region for the high-wind dust event. The strengthening of the pressure gradient between Clark County and the source region led to high winds bringing dust from the Mojave Desert within two to six hours of the exceedance. Satellite data, meteorological data, and visibility measurements all align to confirm the event transport from the Mojave Desert. PM_{10} measurements along the frontal passage increased as winds pushed through Kern, Inyo, and San Bernardino Counties in California, then through Nye and Clark Counties in Nevada, confirming high PM_{10} concentrations along the timeline and trajectories established.

3. The cold front entered northern California by approximately 11:00 PST on May 8, 2022. Along with the enhanced winds caused by the pressure gradient from the cold front, PM_{10} concentrations were extremely enhanced, dust and weather alerts were issued, visibility measurements indicated dusty conditions, and the $PM_{2.5}/PM_{10}$ ratio dropped (indicating windblown dust). PM_{10} concentrations began to drop after 18:00 PST on May 8, but stayed enhanced at most sites compared to normal concentrations throughout the rest of the day.

4. PM_{10} concentrations increased starting at approximately 11:00 PST and peaked in intensity by 13:00-18:00 PST on May 8, 2022. 24-hour PM_{10} concentrations were above the NAAQS threshold of 150 $\mu g/m^3$ at 13 sites (regulatory significance at ten sites: Green Valley at 215 $\mu g/m^3$, Jerome Mack at 196 $\mu g/m^3$, Joe Neal at 188 $\mu g/m^3$, Liberty High School at 242 $\mu g/m^3$, Mountains Edge at 258 $\mu g/m^3$, Palo Verde at 220 $\mu g/m^3$, Paul Meyer at 229 $\mu g/m^3$, Sunrise Acres at 219 $\mu g/m^3$, Walnut Community Center at 249 $\mu g/m^3$, and Walter Johnson at 204 $\mu g/m^3$). The other three sites also exceeded the 24-hour PM_{10} NAAQS and recorded concentrations above the 99th percentile, but were not regulatorily significant in this case. Hourly PM_{10} concentrations at almost all sites in Clark County peaked above 600 $\mu g/m^3$

through the event on May 8. The concurrent rise in PM_{10} concentrations at all sites around Clark County indicates a regional dust event.

5. All sites of regulatory significance exceeded the five-year 99th percentile and the NAAQS for 24-hour PM_{10} concentrations on May 8, 2022. Hourly PM_{10} concentrations are also significantly outside typical diurnal, monthly, and seasonal ranges.

6. Clark County, Nevada, and the surrounding source region was under increasingly severe drought conditions on and before the May 8, 2022, event. The 30-year climatology shows that temperatures and wind speeds were above normal, while soil moisture was below normal. The barren land cover in the Mojave Desert source region was primed for significant dust production during the high-wind event. PM_{10} control measures within Clark County were quickly overwhelmed and unable to prevent an exceedance event on May 8, 2022. Dust lofted and transported from this natural, undisturbed area experiencing severe drought conditions is considered to be a natural and not a reasonable or controllable event.

7. Analysis comparing another date similar to May 8, 2022, include dates with comparable wind profiles that did not show PM_{10} concentrations above the NAAQS. This analysis indicates that in the absence of an extremely dry source region and high surface winds, PM_{10} concentrations would not have been exceptionally high.

Within this document, the following requirements for the EER have been met:

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

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

3. Analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times,

4. A demonstration that the event was both not reasonably controllable and not reasonably preventable,

5. A demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event, and

6. Documentation that the air agency followed the public comment process (included in **Appendix E**).

The high-wind dust event that occurred on May 8, 2022, caused 24-hour PM_{10} NAAQS exceedances with regulatory significance at the Paul Meyer (Monitor AQS ID 32-003-0043, POC

1), Walter Johnson (Monitor AQS ID 32-003-0071, POC 1), Palo Verde (Monitor AQS ID 32-003-0073, POC 1), Joe Neal (Monitor AQS ID 32-003-0075, POC 1), Green Valley (Monitor AQS ID 32-003-0298, POC 1), Jerome Mack (Monitor AQS ID 32-003-0540, POC 1), Sunrise Acres (Monitor AQS ID 32-003-0561 POC 1), Liberty High School (Monitor AQS ID 32-003-0299 POC 1), Mountains Edge (Monitor AQS ID 32-003-0044 POC 1), and Walnut Community Center (Monitor AQS ID 32-003-2003 POC 1) monitoring sites. On May 8, the 24-hour PM_{10} concentration reached 215 µg/m^3 at the Green Valley site, 196 µg/m^3 at the Jerome Mack site, 188 µg/m^3 at the Joe Neal site, 242 µg/m^3 at the Liberty High School site, 258 µg/m^3 at the Mountains Edge site, 220 µg/m^3 at the Palo Verde site, 229 µg/m^3 at the Paul Meyer site, 219 µg/m^3 at the Sunrise Acres site, 249 µg/m^3 at the Walnut Community Center site, and 204 µg/m^3 at the Walter Johnson site. Seven additional suspected wind-blown dust events occurred between 2021 and 2023. Without EPA concurrence that the wind-blown dust event on May 8, 2022, and the other suspected events qualify as exceptional events, the 2021-2023 design value is 2.7 at Green Valley site, 3.7 at the Jerome Mack site, 2.3 at the Joe Neal site, 3.0 at the Liberty High School site, 1.7 at the Mountains Edge site, 1.7 at the Palo Verde site, 2.0 at the Paul Meyer site, 3.0 at the Sunrise Acres site, 4.0 at the Walnut Community Center, 2.3 and at the Walter Johnson site. This is outside of the attainment standard of 1.0. With EPA concurrence on the May 8, 2022, event, as well as the other suspected events, the 2021-2023 design value is 0.0 at Green Valley site, 0.3 at the Jerome Mack site, 0.3 at the Joe Neal site, 0.3 at the Liberty High School site, 0.3 at the Mountains Edge site, 0.0 at the Palo Verde site, 0.0 at the Paul Meyer site, 0.3 at the Sunrise Acres site, 1.0 at the Walnut Community Center, 0.3 and at the Walter Johnson site, all within the attainment standard. Within this demonstration, all elements of the EER have been addressed. Therefore, we request that the EPA consider the overwhelming evidence of windblown dust that occurred in Clark County on May 8, 2022, and agree to exclude the event from regulatory decisions regarding PM_{10} attainment.

7. References

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