Exceptional Event Demonstration for PM_{10} Exceedances in Clark County, Nevada – February 21, 2022

Final Report Prepared for

U.S. EPA Region 9
San Francisco, CA

June 2024

STi Sonoma Technology

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Exceptional Event Demonstration for PM_{10} Exceedances in Clark County, Nevada – February 21, 2022

Prepared by

Crystal McClure, PhD
Annie Anderson, PhD
Jeff Beamish
Kayla Besong, PhD
Melissa Chaveste
Cari Gostic
Samantha Kramer, PhD
Charles Scarborough
Ningxin Wang, PhD
Patrick Zahn
Steve Brown, PhD

Sonoma Technology
1450 N. McDowell Blvd., Suite 200
Petaluma, CA 94954
Ph 707.665.9900 | F 707.665.9800
sonomatech.com

Prepared for

Clark County Department of Environment and Sustainability
Division of Air Quality
4701 W. Russell Road, Suite 200
Las Vegas, NV 89118
Ph 702.455.3206
www.clarkcountynv.gov

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Cover graphic shows images taken from the M Resort Hotel on February 21, 2022, at 16:00 PST.

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1. Narrative Conceptual Model

In February 2022, a strong frontal passage traversed southward through central Nevada, driving a windblown dust event that lofted and entrained dust from the Mojave Desert. This increased particulate matter (PM) concentrations in Clark County, NV, on February 21, 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 the Jerome Mack, Sunrise Acres, Liberty High School, and Green Valley monitoring sites in Clark County. Two additional sites also experienced NAAQS exceedances, and all other sites throughout Clark County also experienced significantly enhanced hourly PM_{10} concentrations that were not regulatorily significant. The widespread impact on PM_{10} concentrations in Clark County indicates a regional dust event. The exceedances at Jerome Mack, Sunrise Acres, Liberty High School, and Green Valley 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 to Clark County, arriving in the late morning on February 21, 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 >25 mph in the Mojave Desert source region 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 February 21, 2022, PM_{10} concentrations at Jerome Mack, Sunrise Acres, Liberty High School, and Green Valley rank above the 99th percentile for all 2018-2022 PM_{10} events in Clark County and are 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 Jerome Mack, Sunrise Acres, Liberty High School, and Green Valley in Clark County, NV – designating the event on February 21, 2022, a High Wind Dust Exceptional Event.

Key narrative evidence and timeline elements are shown below and expanded on in **Section 3**:

Pre-Event Climatological Context

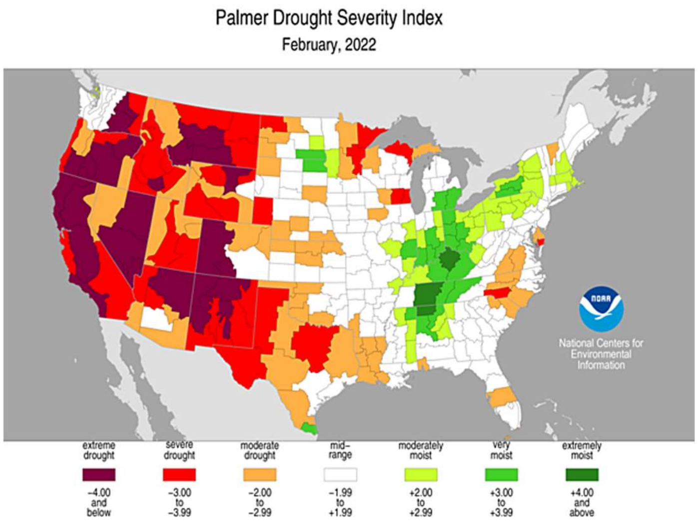


Figure 2.2-5

The Mojave Desert in southeastern California and Clark County, NV, were under extreme to exceptional drought conditions on and before the February 21, 2022, event. Temperatures were above normal and precipitation 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

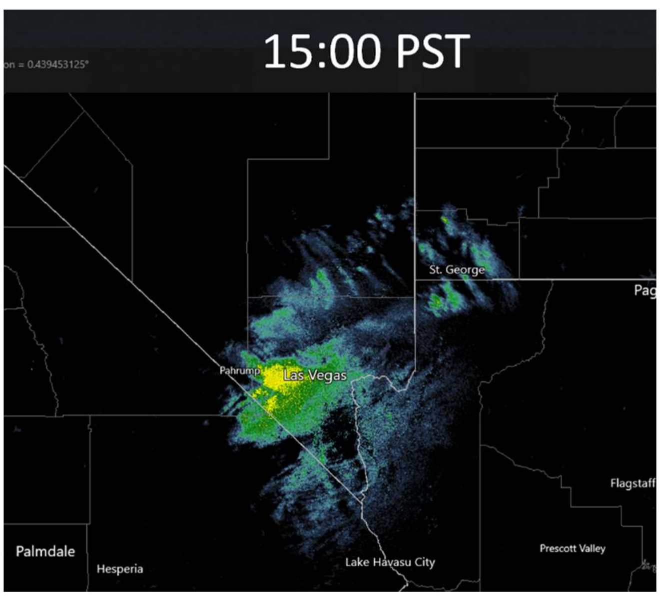


Figure 3.1-5

A frontal passage through central Nevada caused high wind speeds and gusts across the Mojave Desert between 07:00 and 10:00 PST on February 21, 2022. The meteorological analysis and radar images show the frontal passage (and associated dust) entering Clark County, NV, at 10:00 PST on February 21. 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

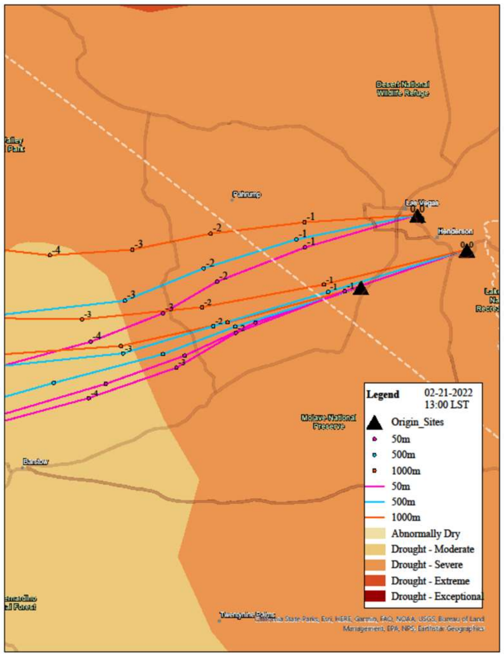


Figure 3.2-2

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 caused an increased pressure gradient over the Mojave Desert, which caused increased wind speeds through the source region. The transport time from the source region to Clark County, NV, was within 2-4 hours of the exceedance.

See Section 3.2

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

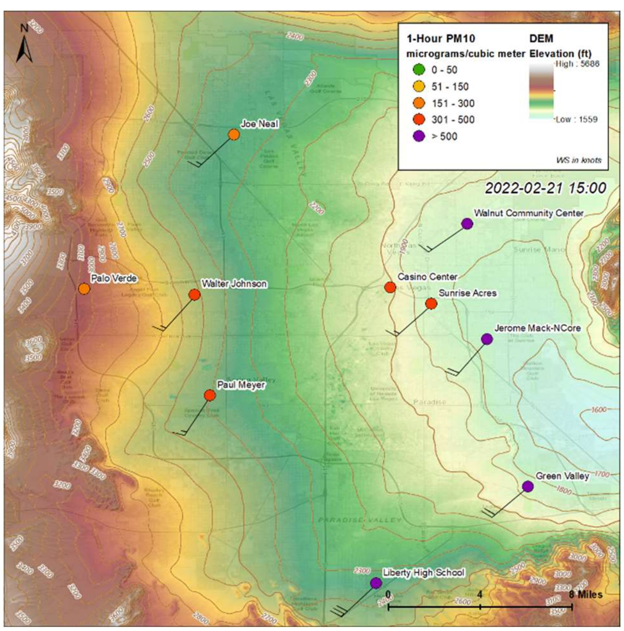


Figure 3.2-10

PM_{10} arrived in Clark County beginning at 11:00 PST on February 21, and peaked between 13:00 and 15:00, with a secondary peak between 20:00 and 21:00 PST. High PM_{10} concentrations at Jerome Mack, Sunrise Acres, Liberty High School, and Green Valley coincided with the frontal passage and high wind speed/gust measurements. Two other monitoring sites also exceeded the NAAQS. 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

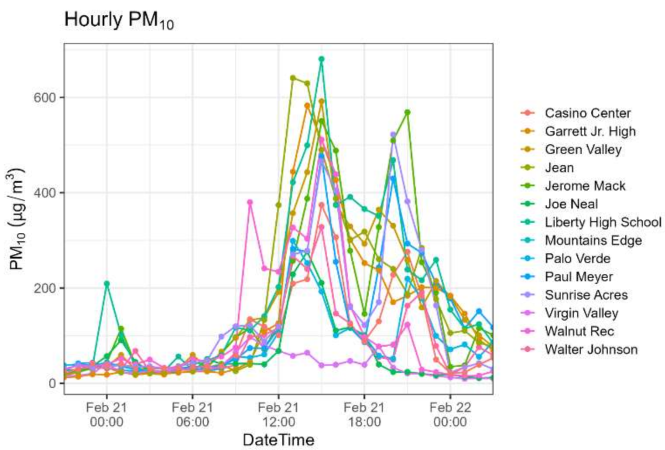
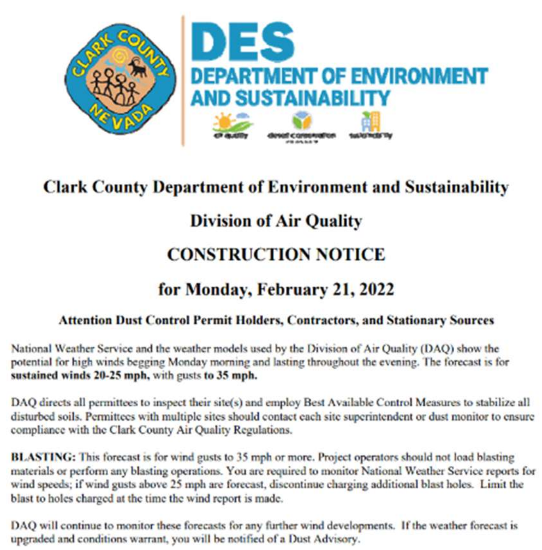


Figure 3.3-8

Six PM_{10} monitoring sites exceeded the NAAQS on February 21, 2022, though not all sites are regulatorily significant. All sites throughout Clark County showed peak hourly concentrations of PM_{10} >300 µg/m^3. The widespread high PM_{10} concentrations concurred with a regional high-wind exceptional event. PM_{10} concentrations at Jerome Mack, Sunrise Acres, Liberty High School, and Green Valley exceeded the 5-year 99th percentile and the NAAQS on February 21, 2022.

See Section 3.3.

High Wind PM_{10} Alerts Issued



DES
DEPARTMENT OF ENVIRONMENT AND SUSTAINABILITY

Clark County Department of Environment and Sustainability

Division of Air Quality

CONSTRUCTION NOTICE

for Monday, February 21, 2022

Attention Dust Control Permit Holders, Contractors, and Stationary Sources

National Weather Service and the weather models used by the Division of Air Quality (DAQ) show the potential for high winds begging Monday morning and lasting throughout the evening. The forecast is for **sustained winds 20-25 mph,** with gusts **to 35 mph.**

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

BLASTING: This forecast is for wind gusts to 35 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.

DAQ will continue to monitor these forecasts for any further wind developments. If the weather forecast is upgraded and conditions warrant, you will be notified of a Dust Advisory.

Figure 3.3-1

Clark County Nevada issued a Construction Notice in advance of the February 21 event, and a Dust Alert for February 22, 2022, due to high concentrations of dust in the wake of this windblown dust event. They advised residents and local construction sites that enhanced levels of blowing dust were possible due to high winds. The National Weather Service also issued several alerts and social media statements. Multiple news outlets reported on high wind and dusty conditions on February 21, 2022.

See Section 3.3

Comparison with Historical Data

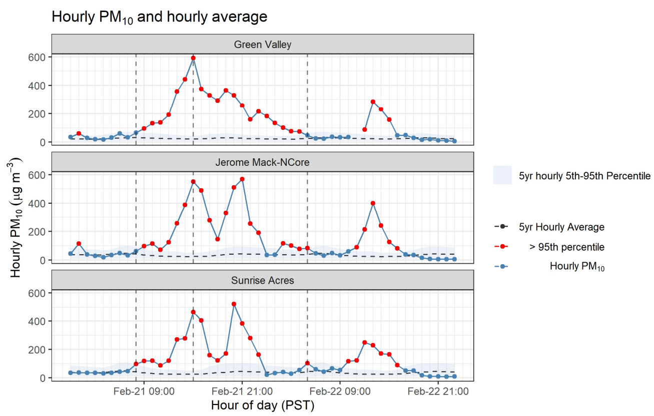


Figure 3.3-9

PM_{10} at Jerome Mack, Sunrise Acres, Liberty High School, and Green Valley exceeded the 5-year 99th percentile and the NAAQS on February 21, 2022. PM_{10} concentrations are also significantly outside typical seasonal and monthly ranges. Thirty-year climatology analyses show temperatures, wind speeds, and soil moisture in the Mojave Desert source region and Clark County were significantly outside of historical normal on the event date.

See Section 3.4.

Not Reasonably Controllable or Preventable

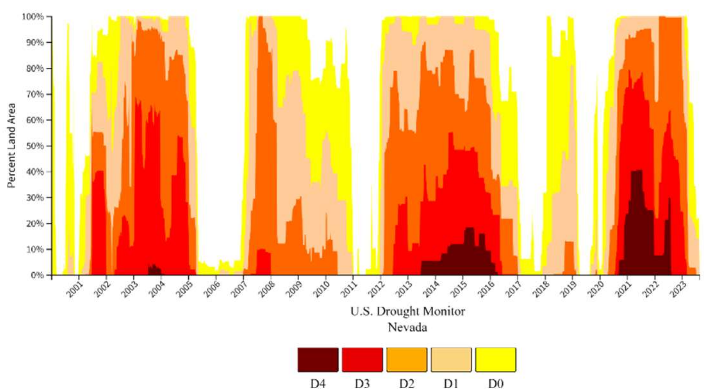


Figure 4.3-3

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

See Sections 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 the EER, exceptional events like 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 neither reasonably controllable nor 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 came from natural sources or all significant anthropogenic sources of windblown dust were 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" (nRCP) criterion. The winds causing the PM_{10} exceedance on February 21, 2022, met the 25-mph sustained wind speed threshold in the Mojave Desert dust source region and Clark County.

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" (EPA, 2019) 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 Tier 1 analysis is applicable when the exceptional event is associated with a large-scale dust storm with recorded visibility of ≤0.5 miles, sustained winds of ≥40 mph, and is a focus of a Dust Storm Warning.

- Tier 2 analysis is applicable when the impacts of the dust event on PM10 levels are less clear and require more supportive documentation than Tier 1 analysis. Tier 2 analysis is warranted when sustained winds are ≥25 mph but the event does not meet the other thresholds required in Tier 1 analysis.
- Tier 3 analysis is necessary when the impacts of the dust event on PM10 levels are more complicated than conditions described in the first two Tiers. This analysis is needed when sustained winds do not meet the 25-mph threshold and additional analysis, such as Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model trajectories from the source area or source-specific emissions inventories, may be required.

Table 2.1-1.

- Tier 1 analysis is applicable when the exceptional event is associated with a large-scale dust storm with recorded visibility of ≤0.5 miles, sustained winds of ≥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 are ≥25 mph but the event 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. This analysis is needed when sustained winds do not meet the 25-mph threshold and additional analysis, such as Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model trajectories from the source area or source-specific emissions inventories, may be required.

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."
	• Do not need justification to support the 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 ≥40 mph, and
	  - 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 ≤25-mph threshold.
	• Requirements are the same as Tier 2 with the addition of the following possible analyses:
	  - HYSPLIT trajectories of source area,
	  - Source-specific emissions inventories,
	  - Meteorological and chemical transport modeling, and/or
	  - PM filter chemical speciation analysis where filter-based monitors are used.

2.1.3 Demonstration Outline

The PM_{10} exceedance on February 21, 2022, qualifies for Tier 2 analysis since it is a high-wind dust event with sustained winds at or above the high-wind threshold of 25 mph. On February 21, 2022, a resultant hourly average wind speed greater than the 25-mph threshold was observed withing the Las Vegas metropolitan region. Additionally, 5-minute ASOS data from Harry Reid Int'l Airport shows multiple measurements of wind speeds >25 mph during the event period. Wind speed measurements in the source region showed speeds well above the high-wind threshold, confirming this case to be Tier 2.

Table 2.1-1 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 (Section 3.3.2) and ground images taken 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 February 21 (natural, undisturbed lands southwest of Las Vegas), including 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 analyses to show the "clear causal relationship" between the high-wind dust event and the PM_{10} exceedance event in Clark County, NV, on February 21, 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:

- Top-down meteorological analysis to trace the conditions between the surface and 250 mb that led to the high-wind event in southern Nevada,
- Compiled maps of aerosol optical depth (AOD) and regional wind speed from satellite data,
- HYSPLIT modeling to show the transport patterns and identify 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, and
- Compared diurnal patterns of PM_{10} during the event to historical measurements.

2.1.4 Regulatory Significance

The high-wind dust event that occurred on February 21, 2022, caused 24-hour PM_{10} NAAQS exceedances with regulatory significance at Green Valley (Monitor AQS ID 32-003-0298, POC 1), Liberty High School (Monitor AQS ID 32-003-0299, POC 1), Jerome Mack (Monitor AQS ID 32-003-0540, POC 1), and Sunrise Acres (Monitor AQS ID 32-003-0561 POC 1). Twenty-four-hour PM_{10} exceedance values are listed in Table 2.1-3.

Table 2.1-3. Twenty-four-hour PM_{10} concentrations for sites that exceeded the NAAQS on February 21, 2022.

Monitor AQS ID	Site Name	24-hour PM_{10} Exceedance Concentration
32-003-0298	Green Valley	192 μg/m^3
32-003-0299	Liberty High School	225 μg/m^3
32-003-0540	Jerome Mack	199 μg/m^3
32-003-0561	Sunrise Acres	169 μg/m^3

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 four 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 February 21, 2022, and other suspected events qualify as exceptional events.

Monitor Site Name	Design Value Without EPA Concurrence	Design Value With EPA Concurrence
Green Valley	2.7	0.0
Liberty High School	3.0	0.3
Jerome Mack	3.7	0.3
Sunrise Acres	3.0	0.3

Further details on the design values with and without concurrence, as well as monitor data completeness, may be found in the Initial Notification Summary Information (INI) submitted by Clark County Department of Environmental and Sustainability (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 February 21, 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 the 2019 National Land Cover Database (NLCD) (Dewitz, 2021) and Sentinel-2 satellite are shown for the approximate source region of the Mojave Desert in southeastern California (Figure 2.2-1). The primary land classifications, shown by the Sentinel-2 Land Use/Land Cover map, in this region 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 and natural sources of dust, which are predisposed to high-wind events.

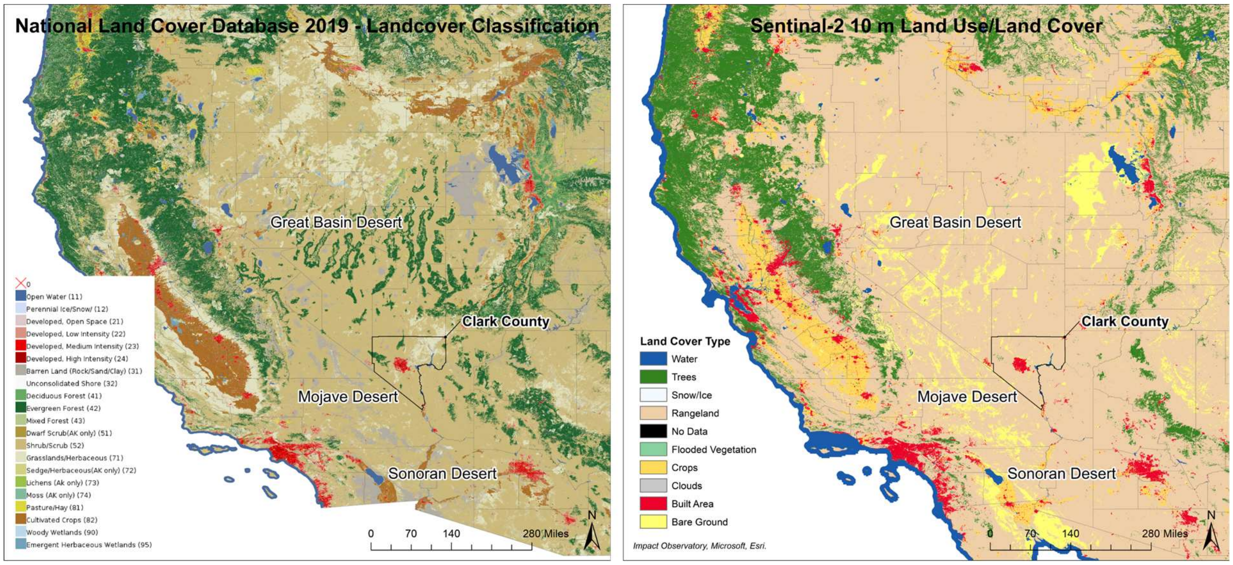


Figure 2.2-1. Land cover type for the western U.S. from (left) the National Land Cover Database-2019 and (right) Sentinel-2 satellite.

Figure 2.2-2 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 the surrounding communities) is mostly classified as built area with some small areas of bare ground, surrounded by rangeland.

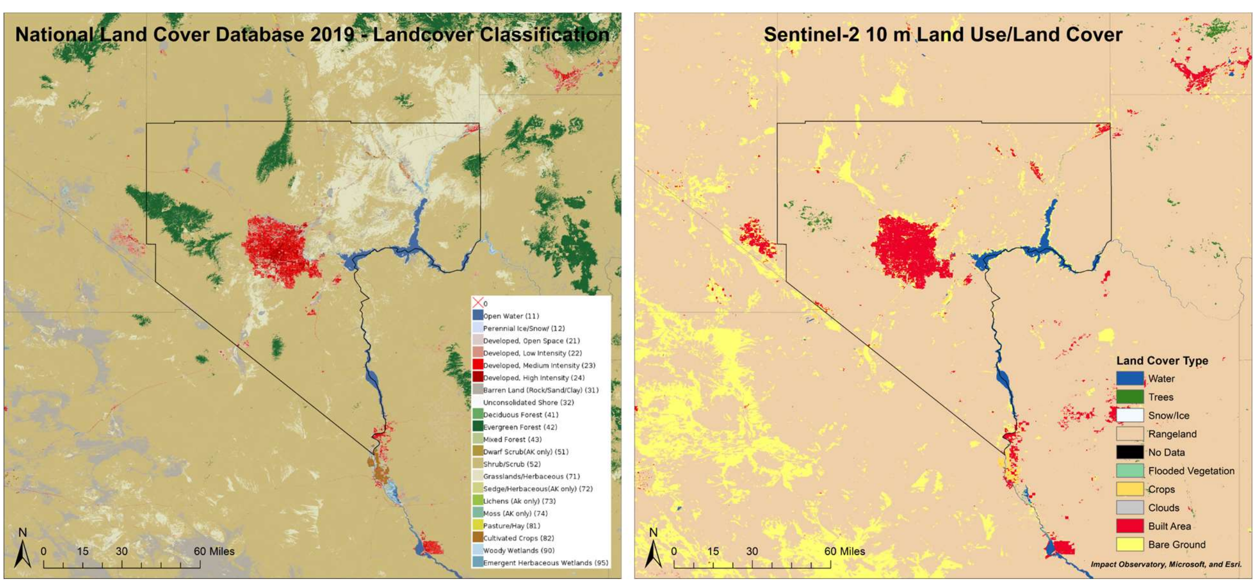


Figure 2.2-2. Land cover type for Clark County, NV, and the surrounding area from the (left) National Land Cover Database-2019 and (right) Sentinel-2 satellite.

2.2.2 Climatology for Source Region and Clark County

The source region is the southeastern California Mojave Desert, which is part of the Mojave Basin and Range Ecoregion 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). The ecoregion also includes other desert areas in southeastern California and southern Nevada, but the Mojave Desert is the driest desert in the greater North American Desert. This is partly due to the Sierra Nevada Mountain range to the west that produces 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).[1]

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 ~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 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 July-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, there was record or near record maximum daily temperatures, and the temperature range was above long-term normal in the weeks and days leading up to the February 21, 2022, exceedance. Concurrently, precipitation accumulation for the Las Vegas area was well below normal by late February (**Figure 2.2-3** and **Figure 2.2-4**).

[1] https://pubs.usgs.gov/of/2016/1021/ofr20161021_sheet1.pdf

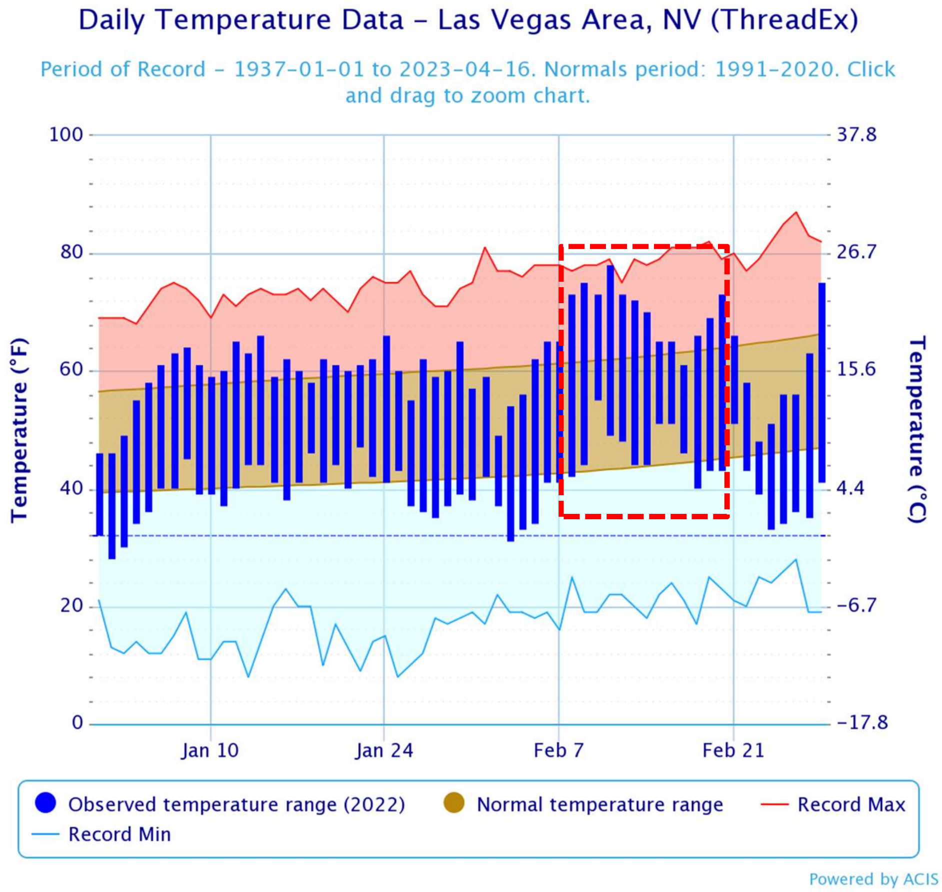


Figure 2.2-3. Las Vegas Area, NV, temperature records from January 1, 1937, through December 26, 2022, by day, including (dark blue) observed temperature range 2022, (brown) normal temperature range, (red) record maximum, and (light blue) record minimum. The red box indicates the dates of high and record heat before the February 21, 2022, event. Data from NWS: **https://www.weather.gov/wrh/Climate?wfo=vef**.

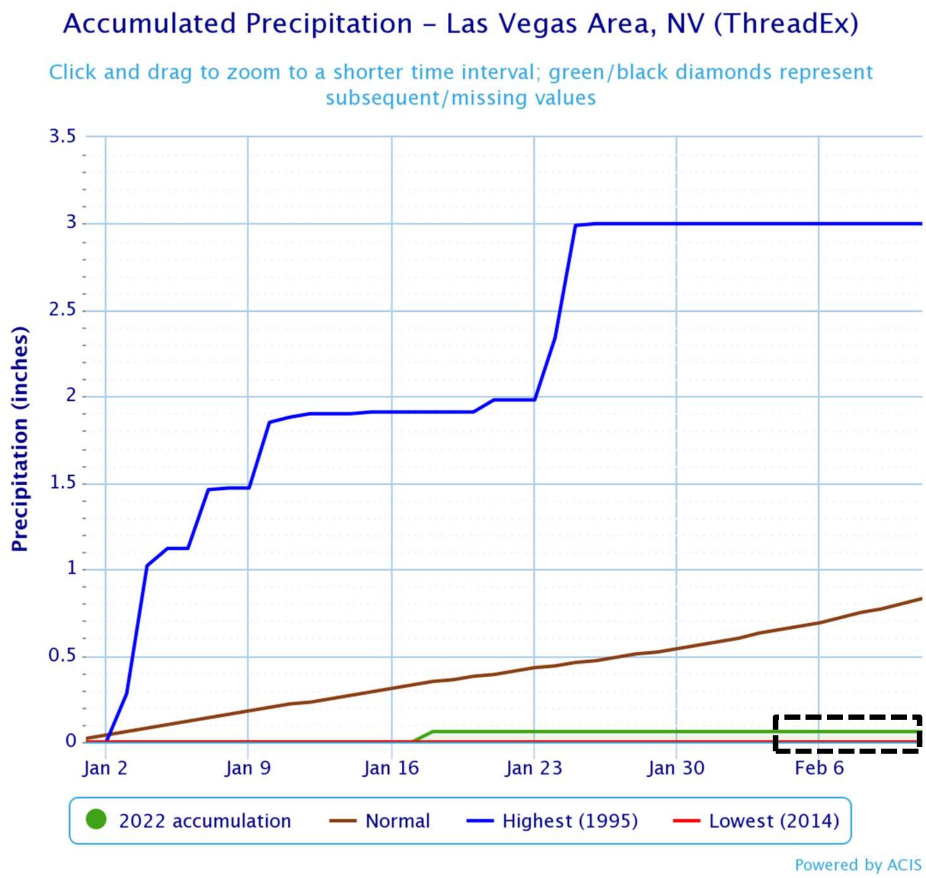


Figure 2.2-4. Las Vegas Area, NV, precipitation records by day, including (green) accumulation in 2022, (brown) normal, (blue) record maximum, and (red) record minimum. The black box indicates the period of low accumulated precipitation before the February 21, 2022, event. Data from NWS: **https://www.weather.gov/wrh/Climate?wfo=vef**.

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 western U.S. drought conditions progressively increased in area and severity in the months before the PM_{10} exceedance (Figure 2.2-5). By February 2022, all counties in Nevada were classified as moderate to extreme drought.

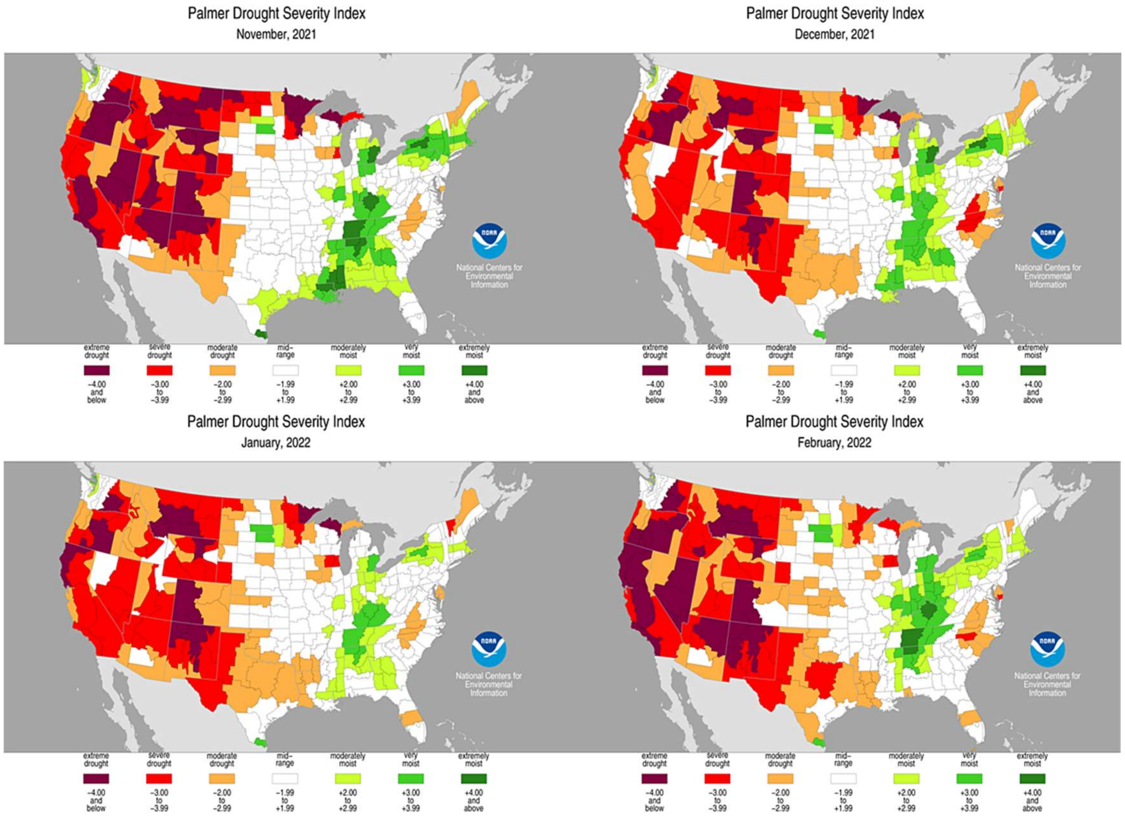
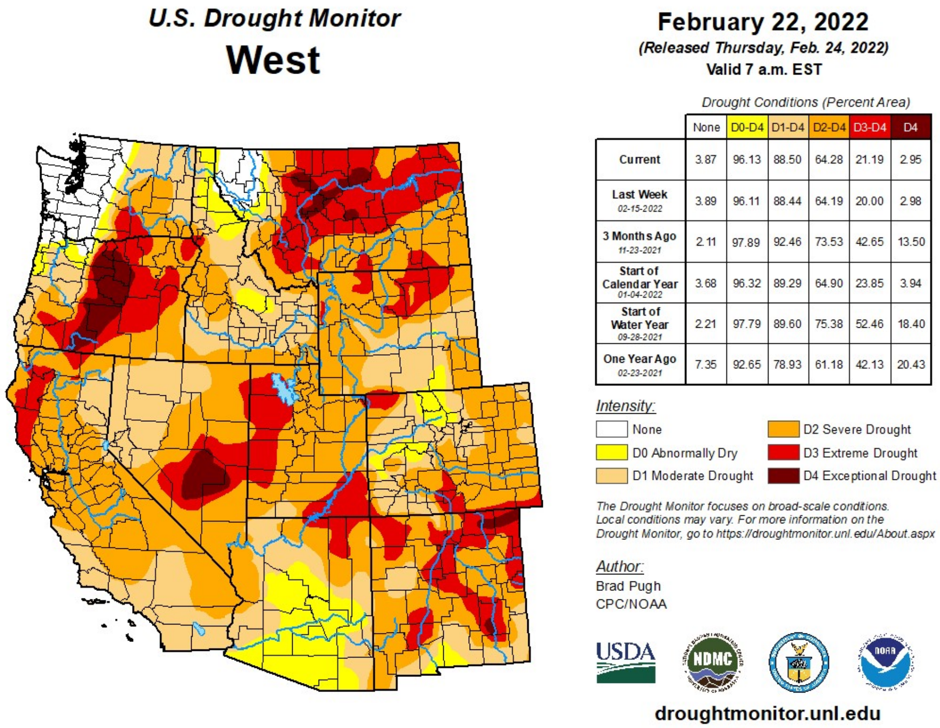


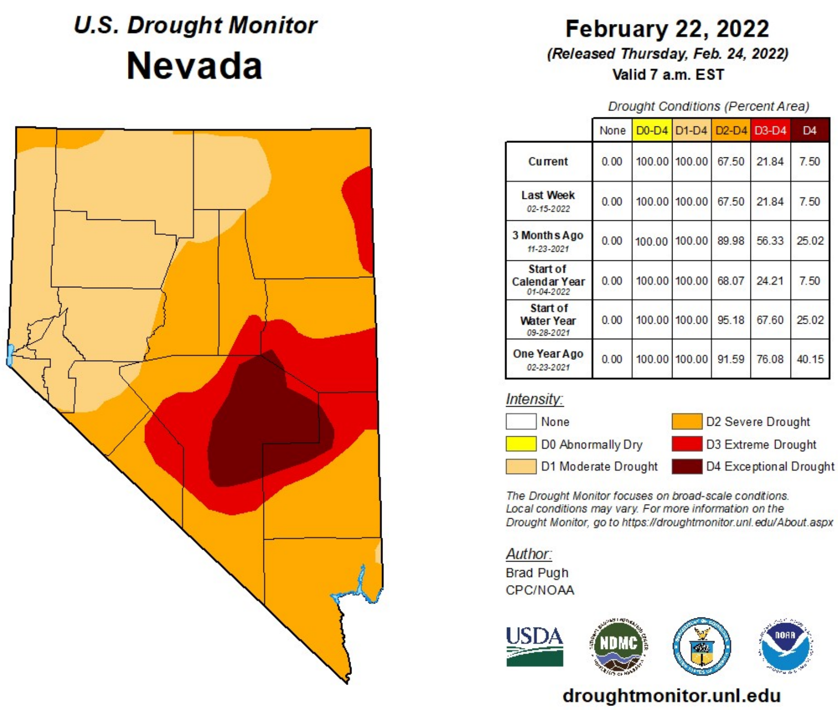
Figure 2.2-5. Palmer Drought Severity Index for November 2021 – February 2022.

On February, 22, 2022 (the closest date of drought conditions to the event date), the western U.S. was under widespread drought conditions (**Figure 2.2-6**) and the source region for this event was under moderate to severe drought (D1 – D3). The western U.S., including Nevada, had been under drought conditions that increased in area and severity in the year, months, and week before the PM_{10} exceedance. By February 22, 2022, all (100%) of Nevada was included in the drought (**Figure 2.2-7**).



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	3.87	96.13	88.50	64.28	21.19	2.95
Last Week 02-15-2022	3.89	96.11	88.44	64.19	20.00	2.98
3 Months Ago 11-23-2021	2.11	97.89	92.46	73.53	42.65	13.50
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 02-23-2021	7.35	92.65	78.93	61.18	42.13	20.43

Figure 2.2-6. U.S. Drought Monitor values for the western U.S. on February 22, 2022.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	67.50	21.84	7.50
Last Week 02-15-2022	0.00	100.00	100.00	67.50	21.84	7.50
3 Months Ago 11-23-2021	0.00	100.00	100.00	89.98	56.33	25.02
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 02-23-2021	0.00	100.00	100.00	91.59	76.08	40.15

Figure 2.2-7. U.S. Drought Monitor values for the Nevada on February 22, 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 February 20 and 21 (1991 – 2021). The median maximum daily temperatures recorded at all sites on February 20 and 21 (1991 – 2021) are between approximately 57 °F and 63 °F.

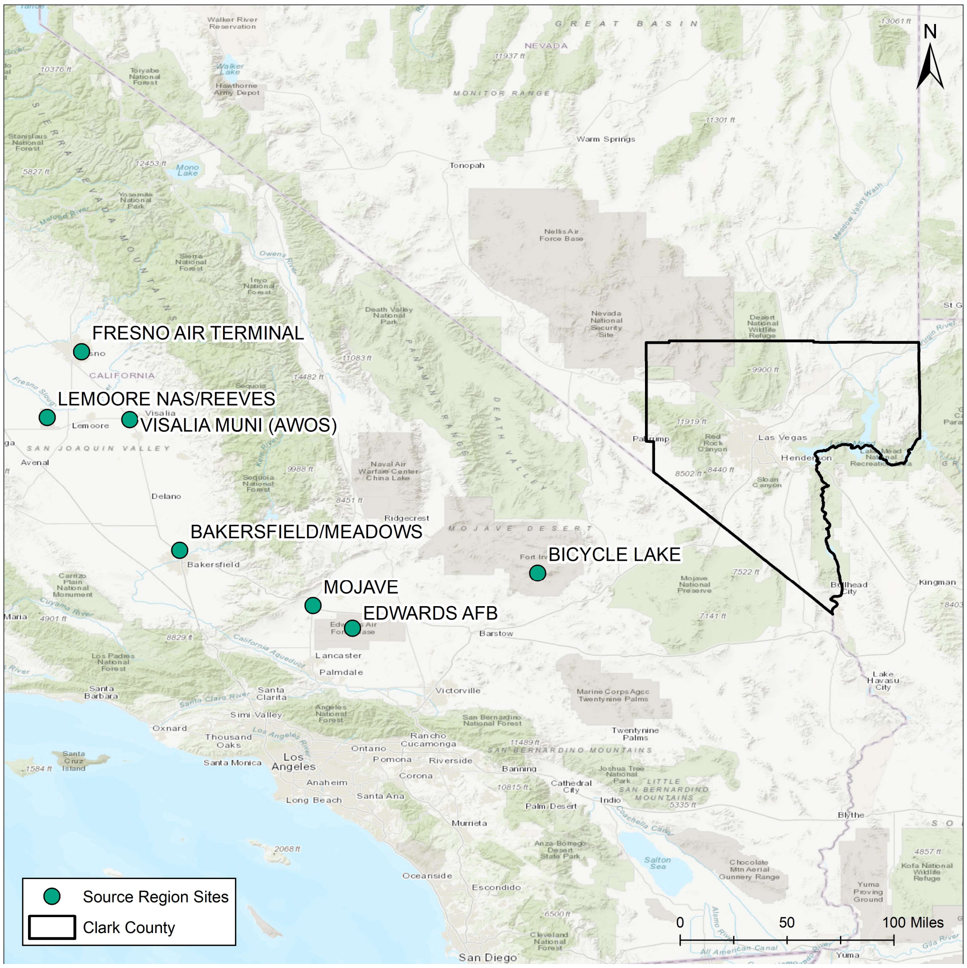


Figure 2.2-8. Location of ASOS measurement sites in the wind-blown dust source region.

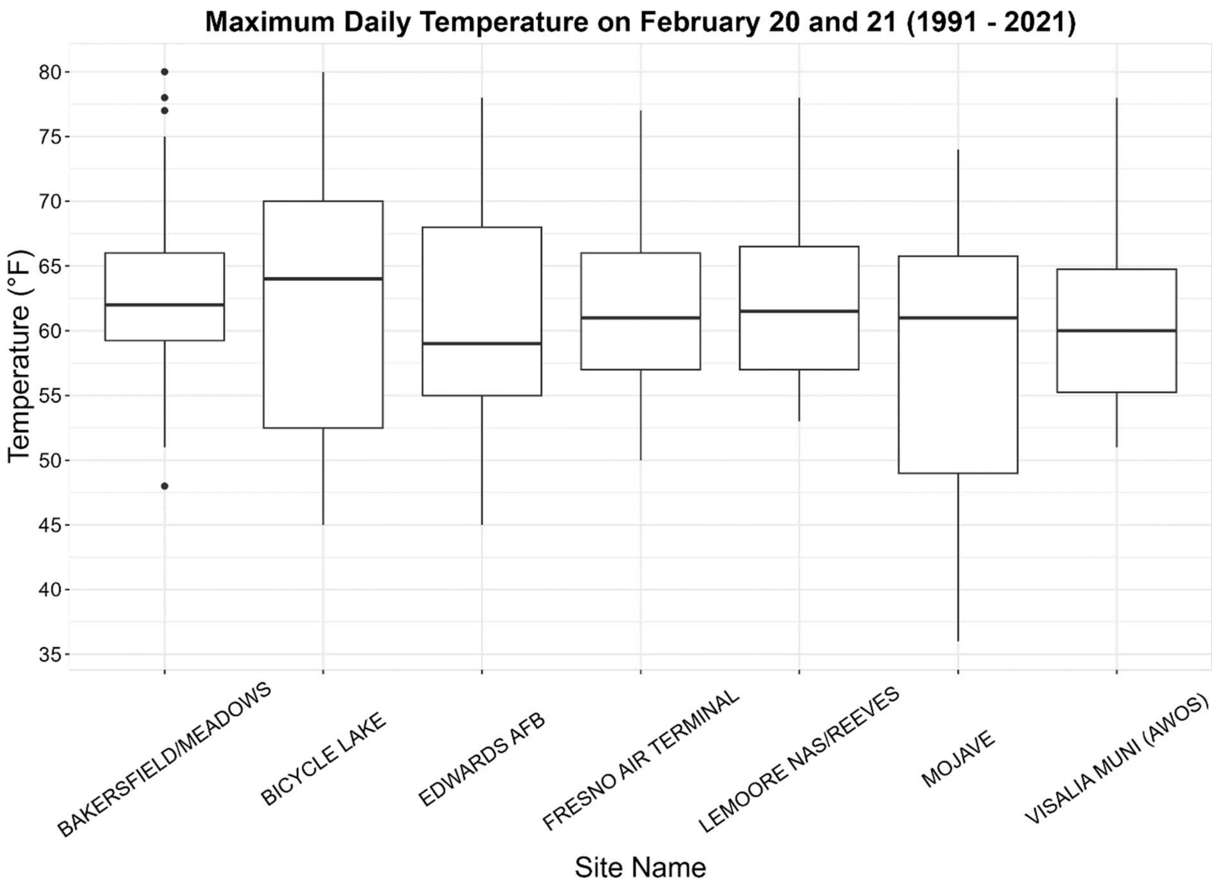


Figure 2.2-9. Maximum daily temperature on February 20 and 21, 1991-2021.

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.

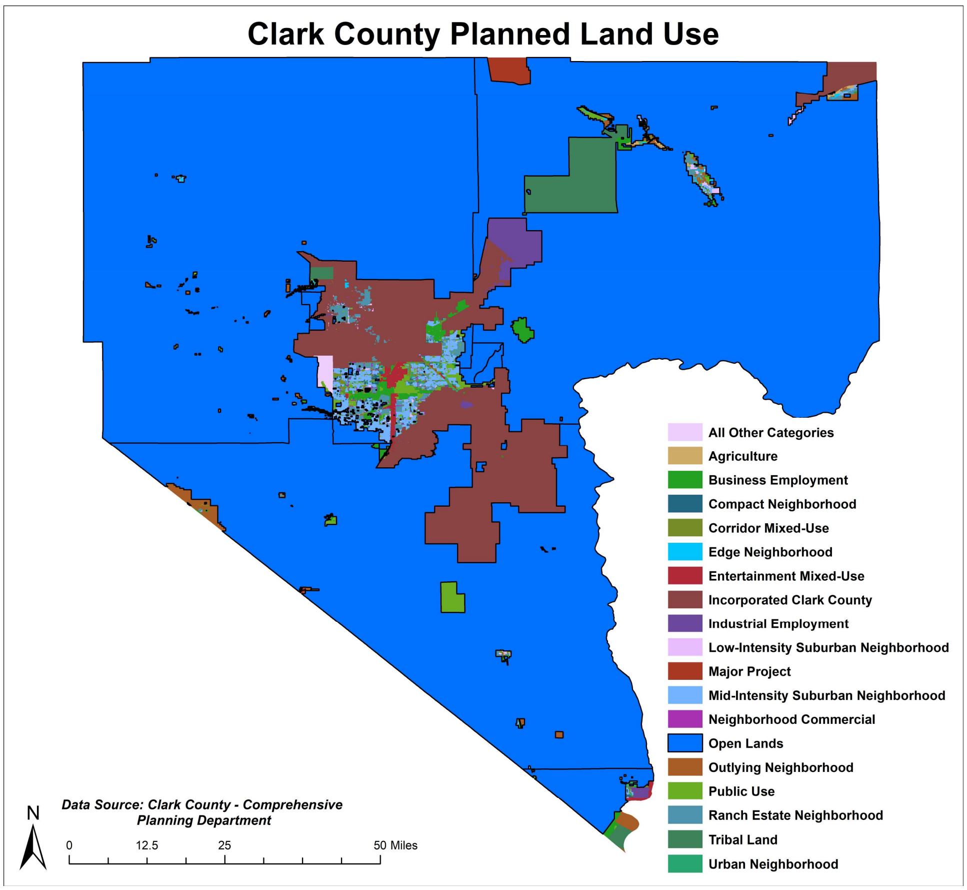


Figure 2.2-10. Planned land use boundaries in Clark County.

Planned land use around the Green Valley site is comprised entirely of incorporated land (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 buildings (baseball fields and single-family homes) and paved surfaces (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.

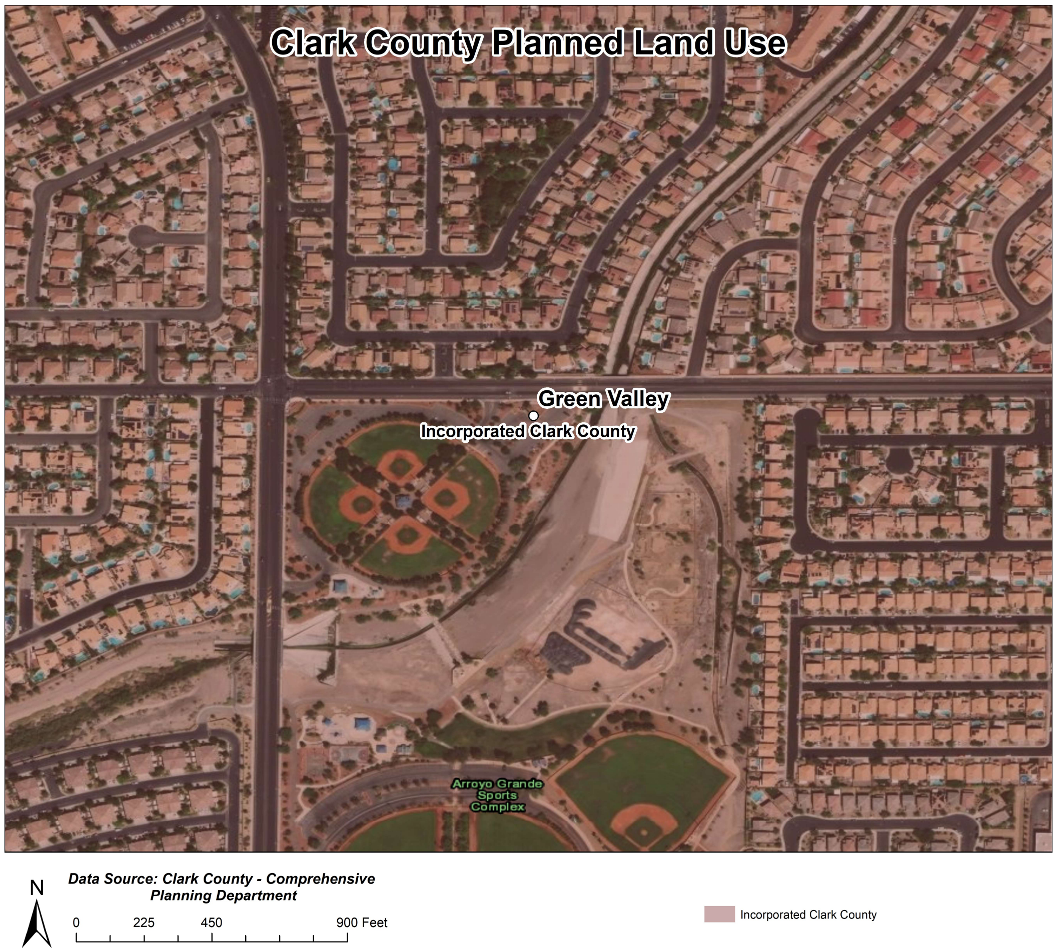


Figure 2.2-11. Planned land use boundaries in the area around the Green Valley station.

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

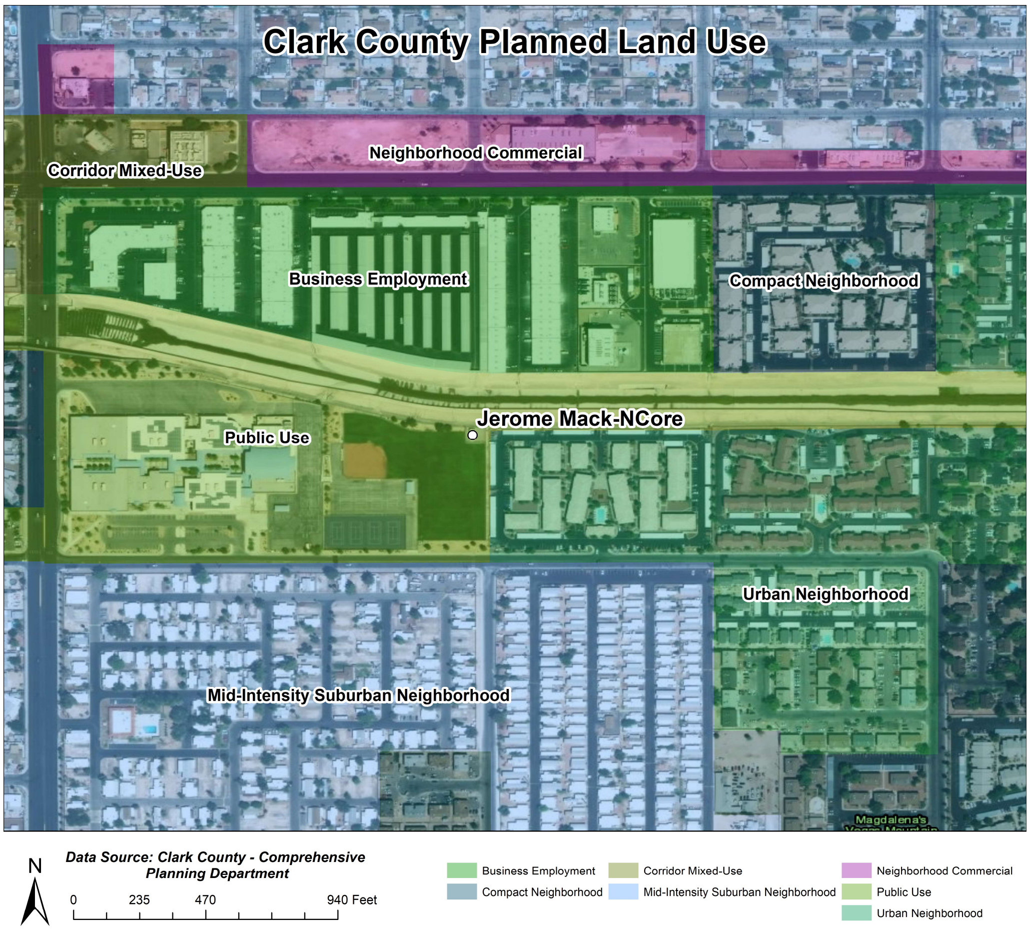


Figure 2.2-12. Planned land use boundaries in the area around the Jerome Mack station.

Planned land use around the 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 2.2-13**). 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.

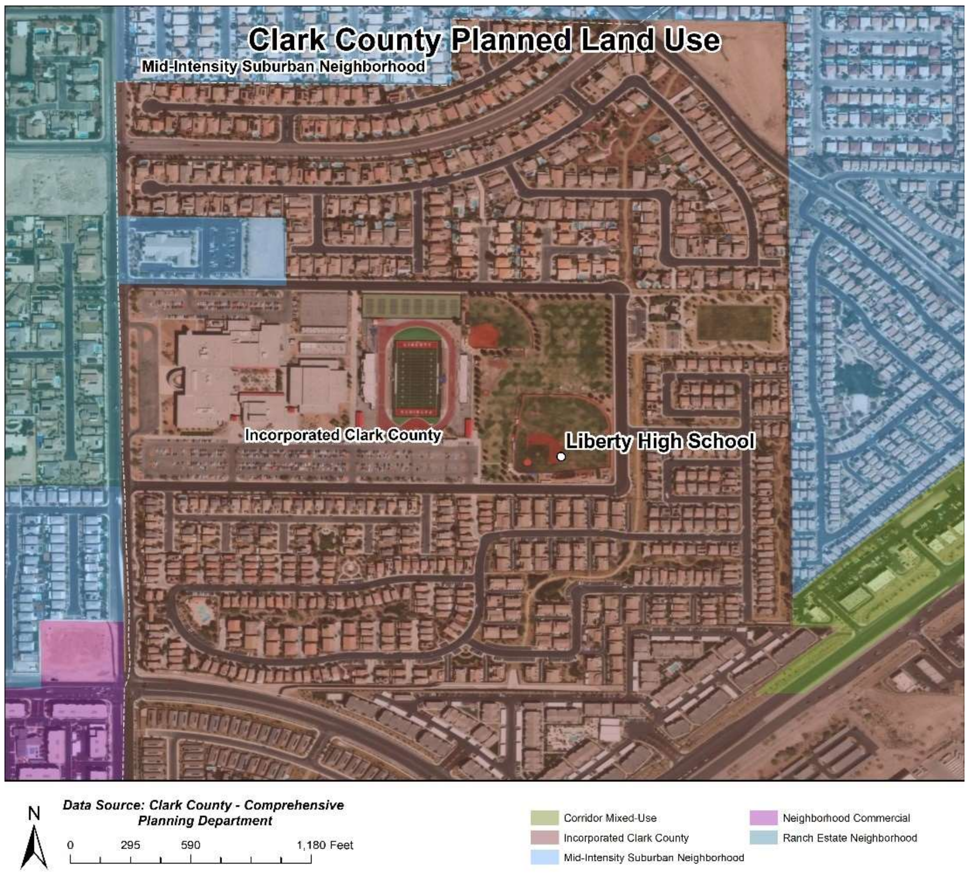


Figure 2.2-13. Planned land use boundaries around the Liberty High School station.

Planned land use around the Sunrise Acres site is comprised mostly of incorporated land (Figure 2.2-14). Residential areas are also present to the south, including compact neighborhood, mid-intensity suburban neighborhood, and commercial neighborhood. 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.

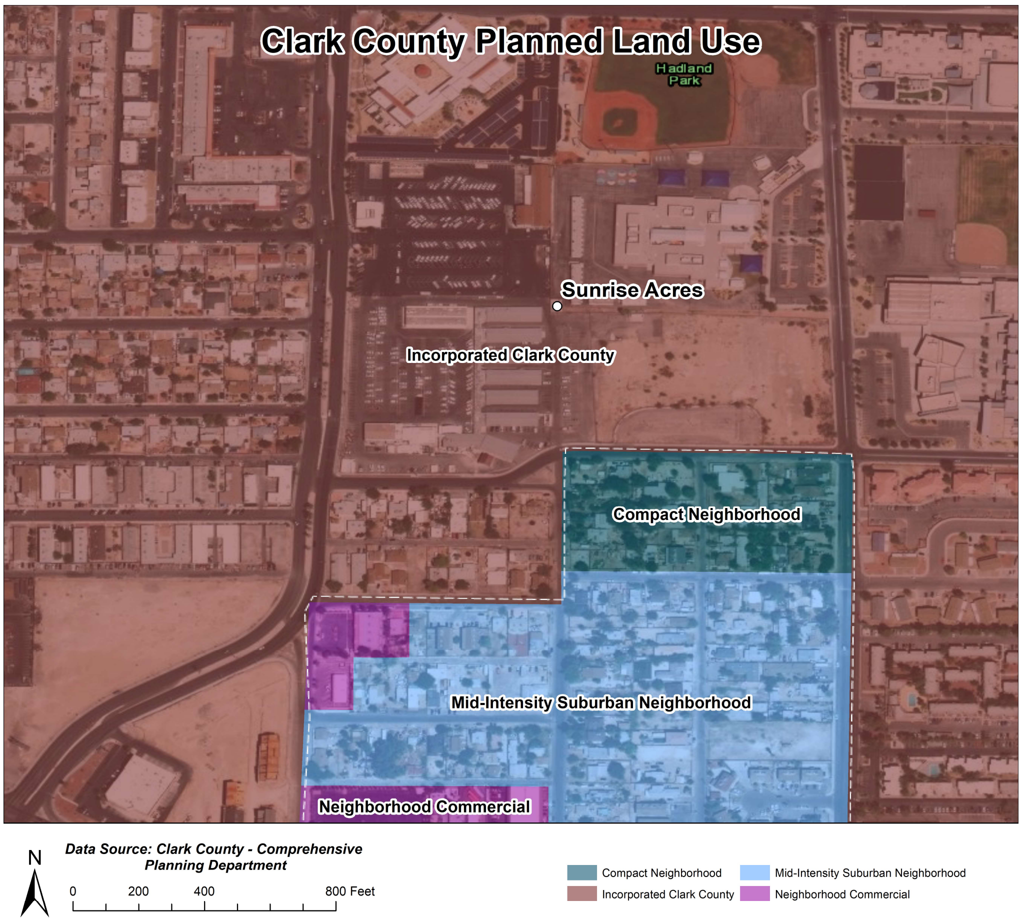


Figure 2.2-14. Planned land use boundaries in the area around the Sunrise Acres station.

Figure 2.2-15 shows the 2020 National Emissions Inventory (NEI) PM_{10} point sources in the Las Vegas metropolitan area, where the size of the point source marker is proportional to the total annual PM_{10} emissions. The map shows that there are no PM_{10} point sources within approximately 2 miles of the Jerome Mack, Sunrise Acres, or Green Valley sites, and the closest point sources emit less than 4-7 tons of PM_{10} annually.

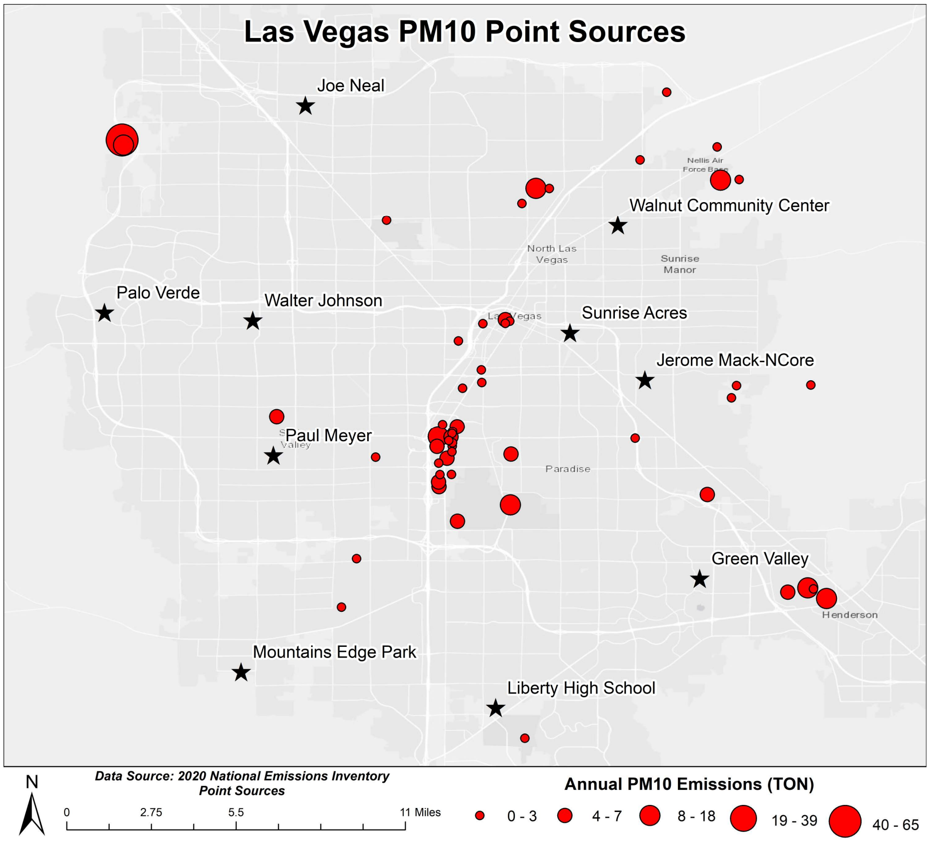


Figure 2.2-15. 2020 NEI point sources of PM_{10}.

Clark County, NV, provided information on all PM_{10} emissions as part of the 2012 "Redesignation Request and Maintenance Plan for Particular 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 Jerome Mack, Sunrise Acres, Liberty High School, and Green Valley sites, it is unlikely that point sources contributed to the February 21, 2022, exceedance. Nonpoint sources, however, contributed >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 2.2-16). Increasing contributions from construction-related emissions are due to increasing conversion of vacant lands to built area. Therefore, there has been an increasing contribution to total emissions from wind erosion from construction, paved roads, and other sources. The Jerome Mack site is ~0.25 mile away from a major paved road source (S Lamb Blvd), so paved roads and on-road emissions likely did not contribute to the exceedance on February 21, 2022.

A Construction Notice was issued for Monday, February 21, 2022, a Dust Alert was issued for Tuesday, February 22, 2022, due to blowing dust via southwesterly winds from the Mojave Desert. A Construction Notice requires construction sites to immediately inspect their construction sites, implement BACM, and avoid blasting activity at threshold wind speeds to mitigate wind-blown dust.

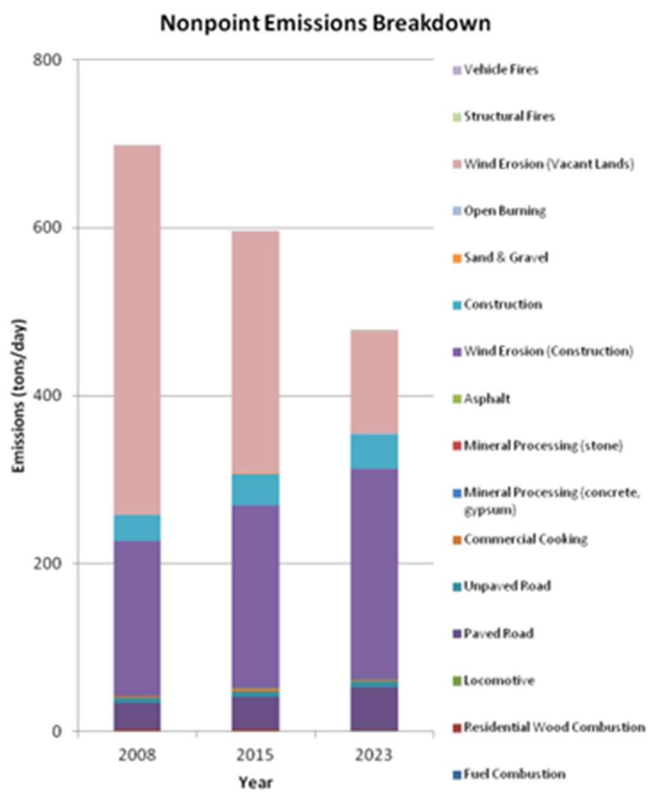


Figure 2.2-16. Nonpoint emissions inventory breakdown from the 2012 'Redesignation Request and Maintenance Plan for Particular Matter (PM_{10})' document.

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 the affected sites. Although not regulatorily significant (outside of the regulatory area), the table includes statistics for Garrett Jr. High and Jean monitoring sites because concentrations exceeded the NAAQS value on the event date. This helps to examine the regional effect of the high-wind dust event. Garrett Junior High and Liberty High School site data collection did not begin until spring 2021, thus summary statistics are shown for the data available through December 2022 for these sites. Mean concentrations range from 20-36 μg/m^3 and medians range from 16-31 μg/m^3.

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

Statistic (µg/m^3)	Jerome Mack	Sunrise Acres	Green Valley	Garrett Jr. High	Jean	Liberty High School
Mean	35	36	25	23	20	31
Median	31	32	21	17	16	26
Mode	31	25	20	11	17	18
St. Dev	25	25	24	27	18	32
Minimum	4	4	2	3	1	2
95th percentile	66	72	49	52	47	62
99th percentile	116	105	108	145	89	201
Maximum	445	468	586	350	236	365
Range	441	464	584	347	235	363
Count	1790	1796	1820	635	1795	610
Exceedances (>150 µg/m^3)	13	11	9	5	7	8

Seasonal and monthly trends in the 24-hour average PM_{10} data for the five years preceding the event (2018-2022) are shown in boxplots in Figure 2.2-17 and Figure 2.2-18. The interquartile range is represented by the lower (25th percentile) and upper (75th percentile) edges of the box, 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 outlying and have been removed for monthly and seasonal trend clarity (see Section 3.4.2 for trends including outliers). Interquartile ranges for 24-hour average PM_{10} values have high overlap across seasons, ranging from 11-40 µg/m^3 with median values ranging from 19 µg/m^3 in winter to 27 µg/m^3 in summer and autumn. For February, the interquartile range is 12-34 µg/m^3, with a median value of 34 µg/m^3.

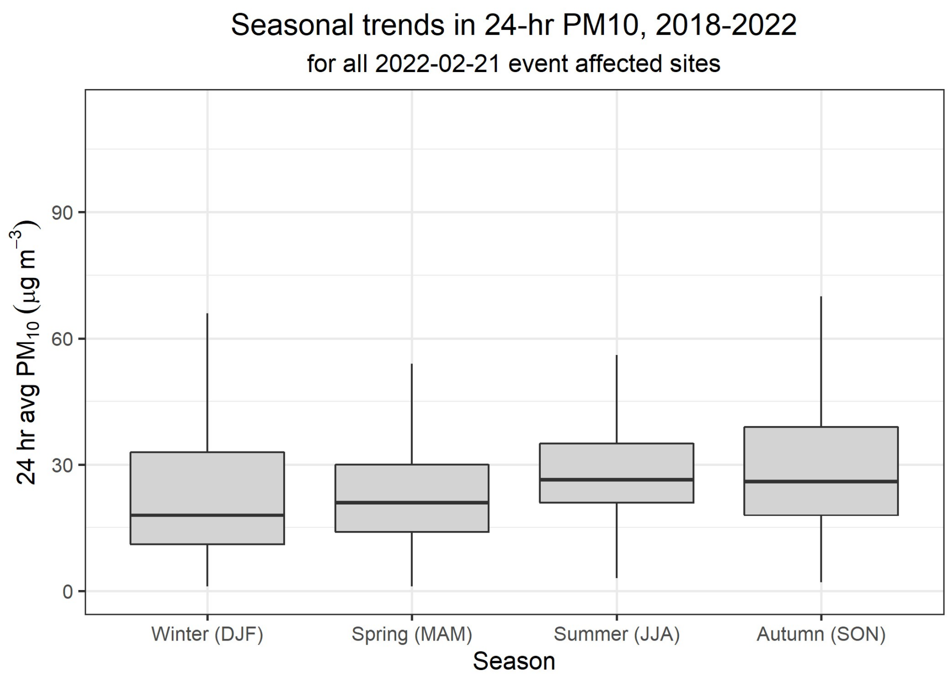


Figure 2.2-17. Seasonal trends in values of PM_{10} from 2018-2022 (outliers have been removed for trend clarity).

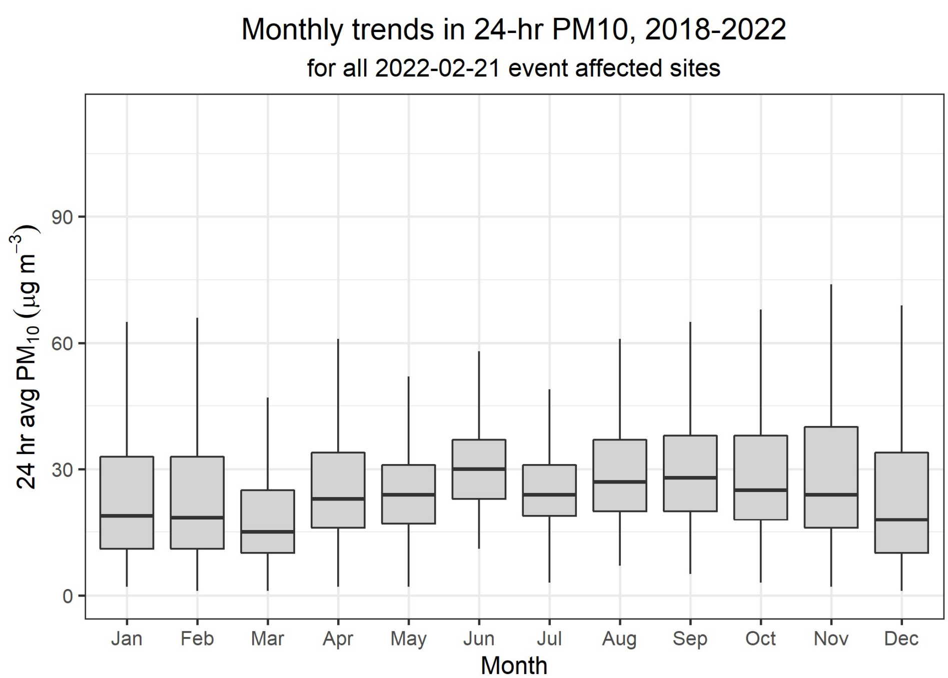


Figure 2.2-18. Monthly trends in values of PM_{10} from 2018-2022 (outliers have been removed for trend clarity).

3. Clear Causal Relationship

During February 2022, a frontal passage southward through central Nevada drove a windblown dust event that increased PM_{10} concentrations in Clark County, NV, on February 21, 2022. Strong winds in the Mojave Desert source region were well above the 25-mph threshold for hourly average measurements. The frontal passage lofted, entrained, and transported dust from the source region to Clark County starting at 11:00 PST on February 21, peaking from 13:00-15:00 PST, and lasting through the rest of the day. The severe drought conditions affecting the Mojave Desert in southeastern California, (**Section 2.2**) created an ample source of dust from friable soils. Enhanced hourly average wind speeds of ~20 mph in the Las Vegas Valley coincided with increased PM_{10} concentrations. Overall, we find 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 were exceptionally outside 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 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 February 21, 2022, dust from the Mojave Desert impacted the Las Vegas region, which led to 24-hour average PM_{10} concentrations of 225 µg/m^3 at Liberty High School, 199 µg/m^3 at Jerome Mack, 192 µg/m^3 at Green Valley, and 169 µg/m^3 at Sunrise Acres. Strong winds in the Mojave Desert region of southeastern California produced dense blowing dust that was transported to the Las Vegas metropolitan area, increasing PM_{10} concentrations starting at 11:00 PST on February 21, peaking between 13:00 and 15:00 PST, and lasting through the rest of the day. Though not regulatorily significant, two other sites (Jean and Garrett Jr. High) also experienced PM_{10} concentrations greater than the 24-hour PM_{10} NAAQS. All other sites within the Las Vegas Valley experienced enhanced PM_{10} concentrations concurrently with the exceeding sites. 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 which meteorological variables led to poor air quality, observational data were analyzed from the following sources:

- Upper-air winds and geopotential heights,
- Satellite and Doppler radar imagery, and
- 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- and lower-level and surface weather patterns. For completeness, this analysis examines the period from February 20-22, 2022.

250-mb analysis

During the early morning hours of February 20, a low-pressure trough aloft was present from eastern British Columbia to just west of the Pacific Northwest coast. A 75-125 kt jet streak was Northwest of the trough axis, stretching from southern Alaska to off the British Columbia coast. The location of the jet streak allowed the trough to move southward into the northwestern United States by late afternoon on February 20.

The jet streak remained on the western flank of the upper-level trough at 12:00 UTC (04:00 PST) on February 21, pushing the trough into western Nevada. Additionally, the left-exit region (LER) of this jet streak, associated with lift at mid-levels, was centered over Oregon (see **Figure 3.1-1**). However, the jet streak weakened slightly throughout the day, which slowed the progression of the upper-level trough. By the late afternoon of February 21, the trough axis reached the Nevada-Utah border, where it remained stationary through the early morning hours of February 22.

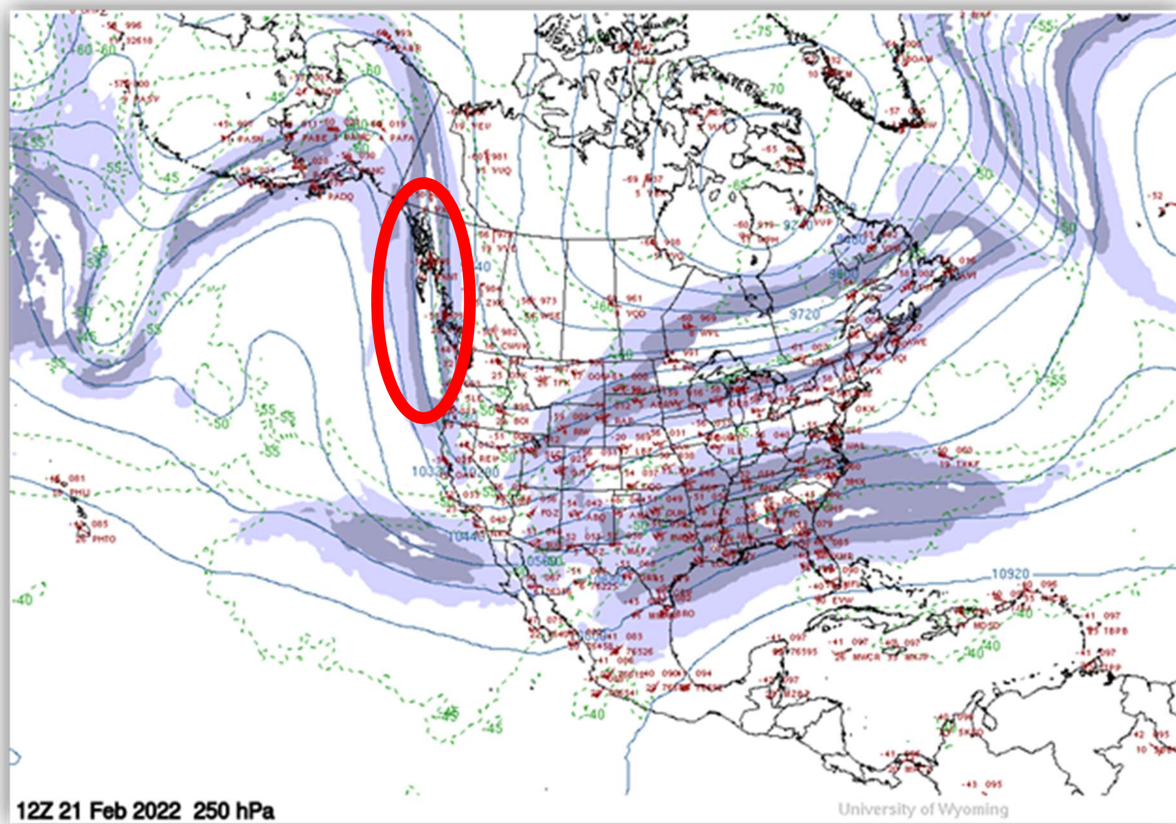


Figure 3.1-1. 250-mb map the morning of February 21, 2022. An upper-level jet streak (circled) off the Pacific Northwest coast helped guide a trough into the Las Vegas region. Source: University of Wyoming.

500-mb analysis

The 250-mb trough and jet streak supported the development of a shortwave trough of low pressure at 500 mb. On the morning of February 20, a trough at 500 mb resided from central British Columbia to off the Pacific Northwest coast. At this time, the recorded 500-mb geopotential height at the National Weather Service Las Vegas upper-air meteorological station (code: KVEF) was 568 dm. Twelve hours later, the mid-level trough reached eastern Oregon and northwestern Nevada, which caused the 500-mb geopotential heights to decrease to 563 dm at KVEF.

By the morning of February 21, the mid-level trough axis was positioned from southwestern Idaho to southern California, positioned under the 250-mb trough and near the LER of the 250-mb jet streak. The upper-level sounding from KVEF at 12:00 UTC (04:00 PST) recorded another geopotential heigh fall at 500 mb, dropping to 555 dm. The mid-level trough moved across the Las Vegas region on February 21, departing by the early evening. As the trough exited the region, height falls at 500 mb continued. The KVEF upper-air sounding in the late afternoon of February 21 recorded a 500-mb height of 550 dm. This marked an 18 dm drop in 500-mb heights over the 36-hour period between 12:00 UTC (04:00 PST) on February 20 and 00:00 UTC (16:00 PST) on February 22 (see **Figure 3.1-2**).

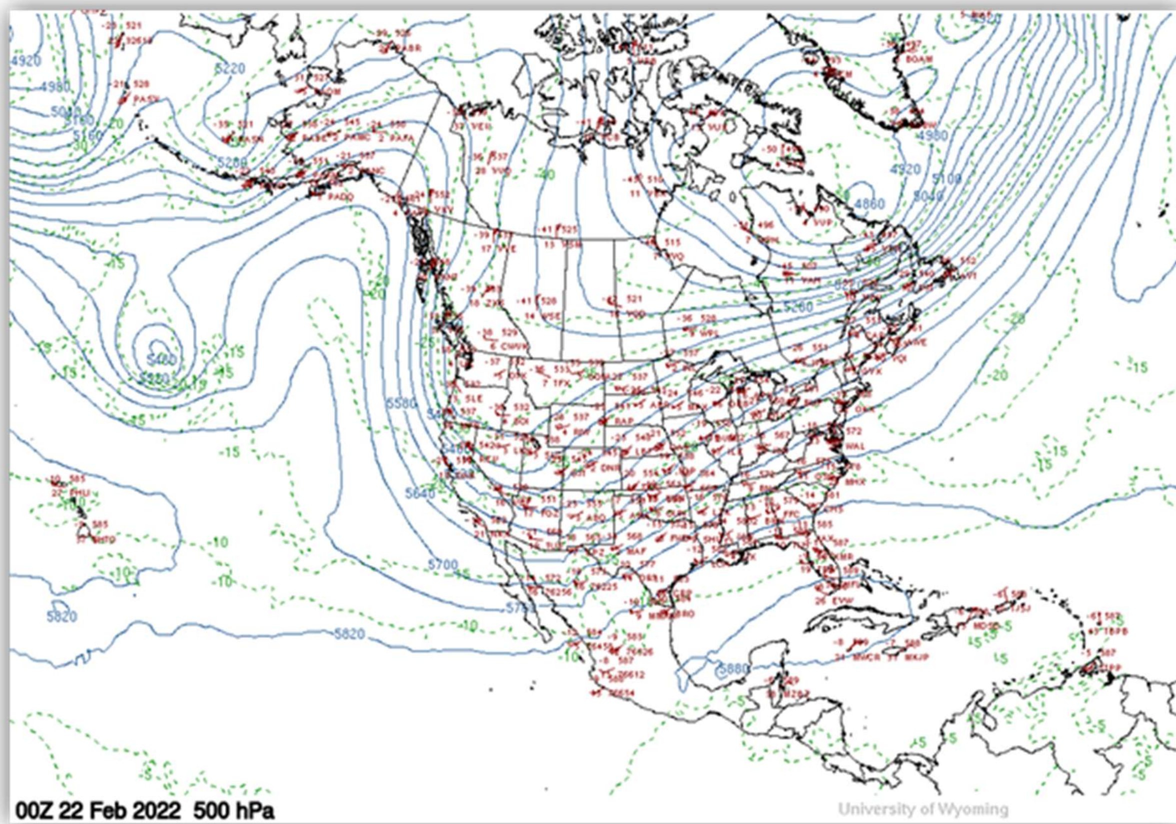


Figure 3.1-2. 500-mb weather map the late afternoon of February 22, 2022. A shortwave mid-level trough resides along the Nevada/Utah border. Source: University of Wyoming.

Due to the weakening of the 250-mb jet streak, the trough at 500-mb became stationary over southern Nevada and the Colorado River Valley at 12 UTC (4:00 PST) on February 22. With upper-level support diminishing, 500-mb geopotential heights at KVEF remained at 550 dm at this time.

Surface analysis

Mid- and upper-level dynamics supported the development of a surface cold front, which played a critical role in the February 21 dust event. The previous day, a weak surface low pressure system was analyzed over northern Montana, with an associated mid-level trough across western Montana to central Idaho. By the evening hours, as the low-pressure system progressed southward into western Wyoming, the surface trough transitioned into a cold front over northern Utah and central Nevada.

The transition from surface trough to cold front on the evening of February 20 was driven by mid-level lift provided by the 500-mb trough, along with the upper-level 250-mb trough and jet streak.

During the day on February 20, wind speeds increased ahead of the 250-mb trough as it moved into the northwestern United States. This region of increasing wind speeds at upper levels led to an area of divergence aloft, located above the surface low and surface trough. The divergence aloft allowed for the surface low to modestly deepen, from 1,002 mb in the morning to 997 mb in the late evening. Furthermore, divergence aloft aided the transition from surface trough to surface cold front in central Nevada and northern Utah.

On the morning of February 21, the cold front entered southern Nevada. Additionally, as the front moved southward, the pressure gradient across eastern California and southern Nevada increased between 15:00 and 18:00 UTC (7:00 and 10:00 PST). This led to strengthening southwesterly winds across the region, which lofted dust and led to a sharp rise in hourly observed PM_{10} concentrations over the Mojave Desert and southern Nevada. The tight pressure gradient remained intact through the early evening, producing gusty southwesterly winds ahead of the cold front (**Figure 3.1-3**).

Figure 3.1-3. Surface weather map at 16:00 PST on February 21, 2022. Numerous isobars (brown lines) were analyzed between Los Angeles and Las Vegas, indicating a strong pressure gradient. Source: NOAA Weather Prediction Center.

As the cold front began to exit southern Nevada on the evening of February 21, it started to encounter less-favorable upper-level dynamics. At 250 mb, the trough axis pushed east of Las Vegas, with decreasing westerly to southwesterly wind speeds aloft in southern Nevada to northern Arizona. The impacts of this upper-level convergence caused the surface front and pressure gradient to weaken. While the weakened pressure gradient led to lighter winds and less blowing dust, carryover of dust from earlier in the day kept observed PM_{10} hourly concentrations enhanced across Clark County through the early morning hours of February 22.

Radar imagery taken during the event period at 0.5° tilt is shown in **Figure 3.1-6 through Figure 3.1-6**. The location of a radar shadow to the west-southwest of the station, a result of mountainous terrain, is noted in the top-left image in each figure. A buildup of airborne dust to the west of Clark County intensified shown by the radar signatures starting at 11:00 PST and reaching a peak at 15:00 PST. The dust signature was pushed eastward across Clark County by westerly surface winds, and was still visible through 20:00 PST.

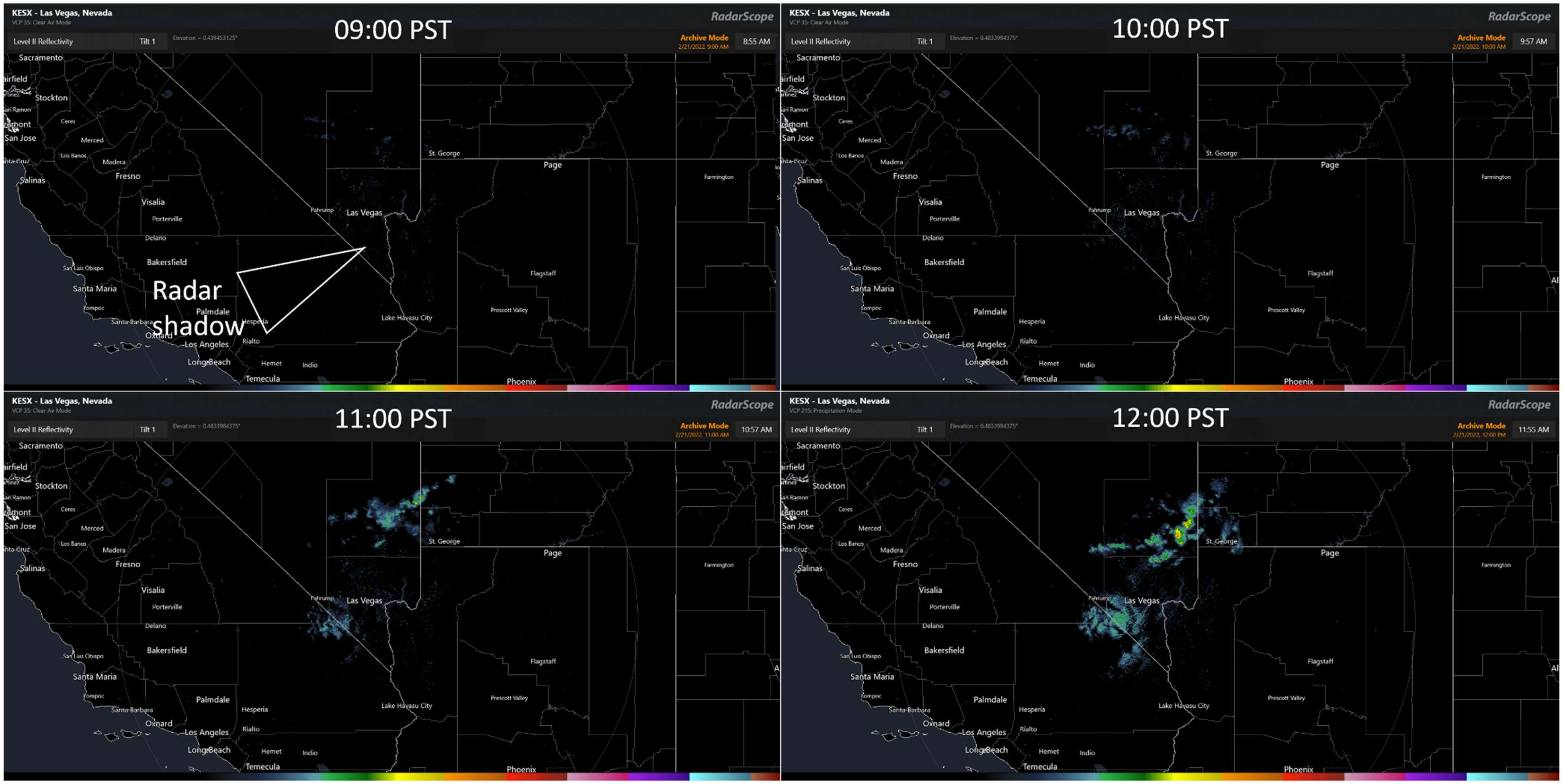


Figure 3.1-4. Doppler radar image, valid 09:00 to 12:00 PST on February 21, 2022. Source: RadarScope.

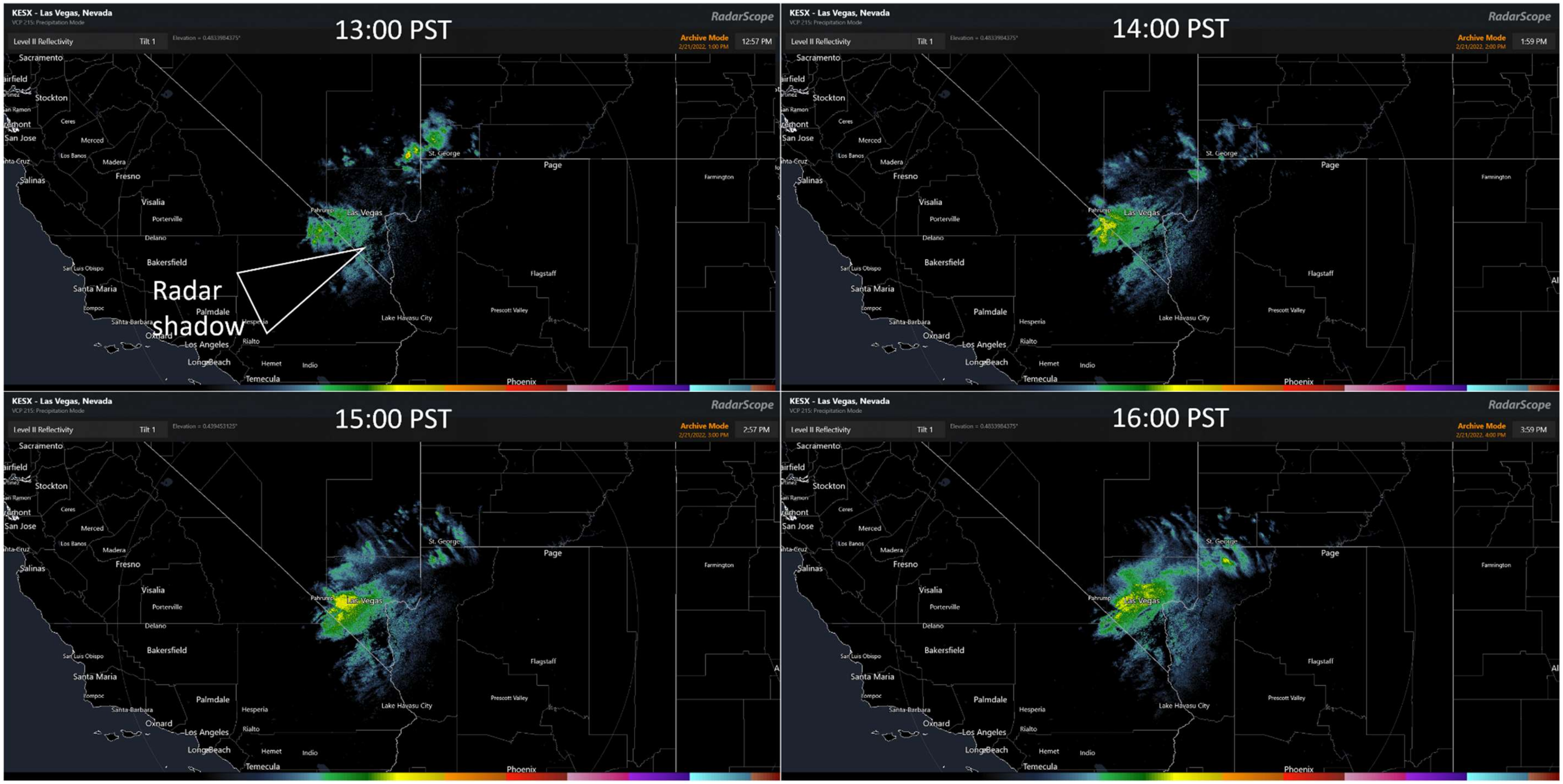


Figure 3.1-5. Doppler radar image, valid 13:00 to 16:00 PST on February 21, 2022. Source: RadarScope.

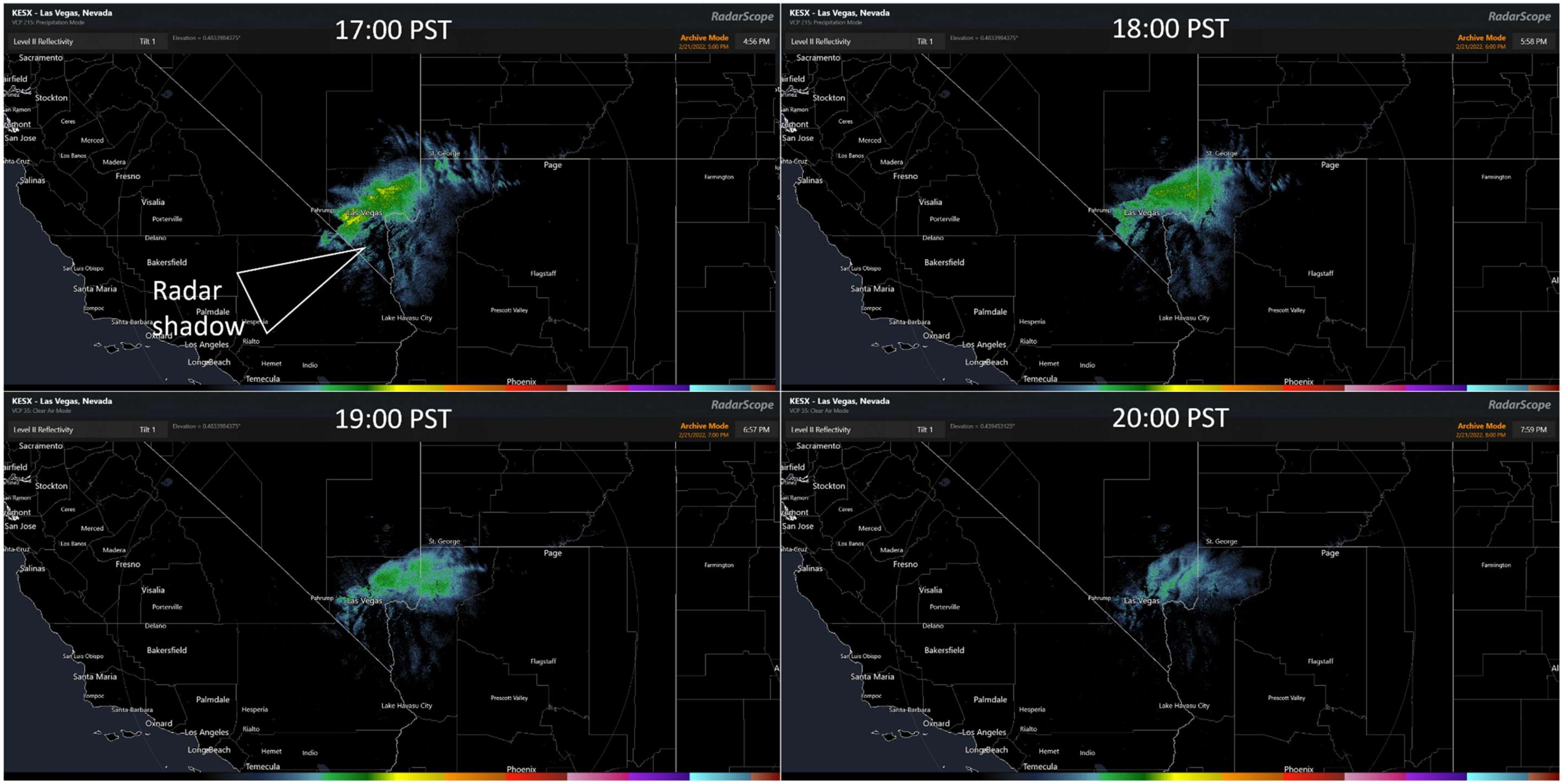


Figure 3.1-6. Doppler radar image, valid 17:00 to 20:00 PST on February 21, 2022. Source: RadarScope.

3.1.2 Satellite Images and Analysis

Satellite imagery and reanalysis products provide evidence of dust corresponding with a frontal passage. Multi-Angle Implementation of Atmospheric Correction (MAIAC) Aerosol Optical Depth (AOD) imagery from MODIS on February 21 shows a streak of high AOD over southeastern California and southern Nevada (Figure 3.1-7). The highest AOD values are shown on the border of Clark County and southeastern California.

The Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) reanalysis data show enhanced wind speeds in the source region and the Las Vegas Valley on February 21, 2022 (Figure 3.1-8 and Figure 3.1-9). A surface cold front generated southwesterly winds that produced dense blowing dust in the Las Vegas region. The winds averaged ~10 m/s (22 mph) with maximum sustained winds of ~16 m/s (36 mph) occurred on the event date as shown in the MERRA-2 reanalysis figures.

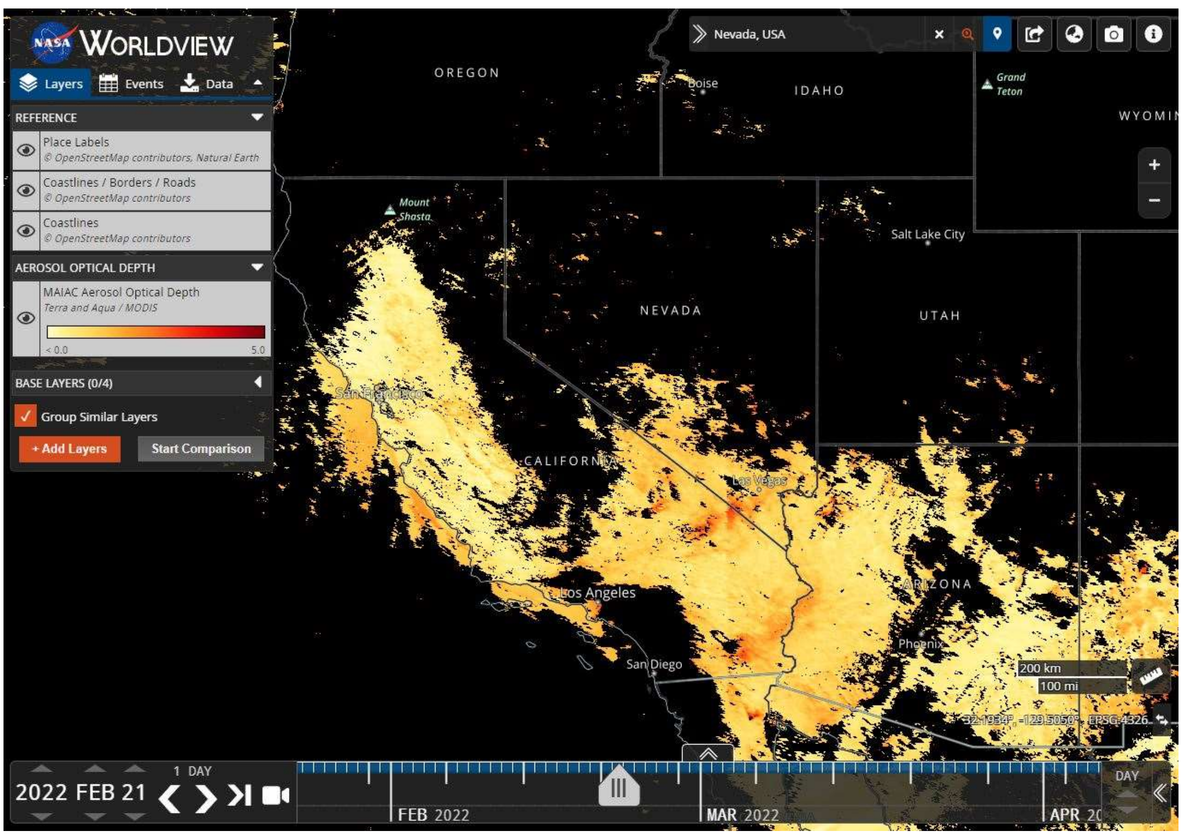


Figure 3.1-7. Satellite aerosol optical depth from MAIAC Aqua and Terra combined. Terra imagery at 10:30 local time and Aqua imagery at 13:30 local time on February 21, 2022.

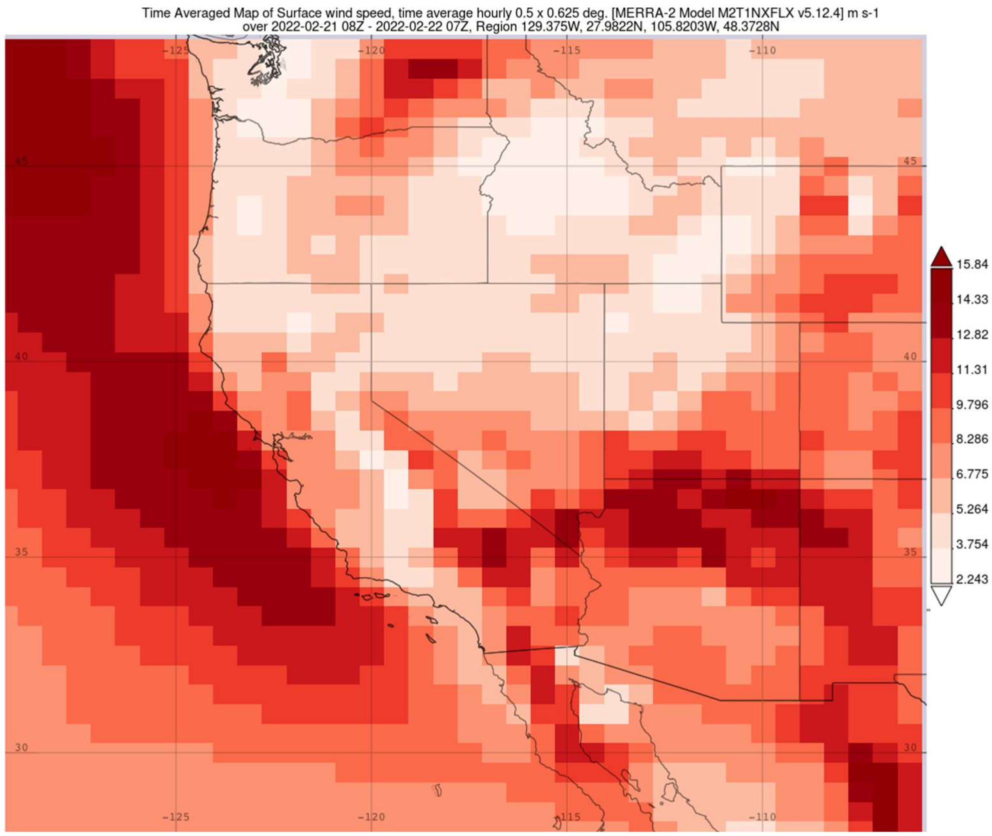


Figure 3.1-8. MERRA-2 reanalysis data hourly averaged surface wind speed (m/s) over February 21, 2022, at 08:00 UTC (February 21, 2022 at 00:00 PST) through February 22, 2022, at 07:00 UTC (February 21, 2022 at 23:00 PST).

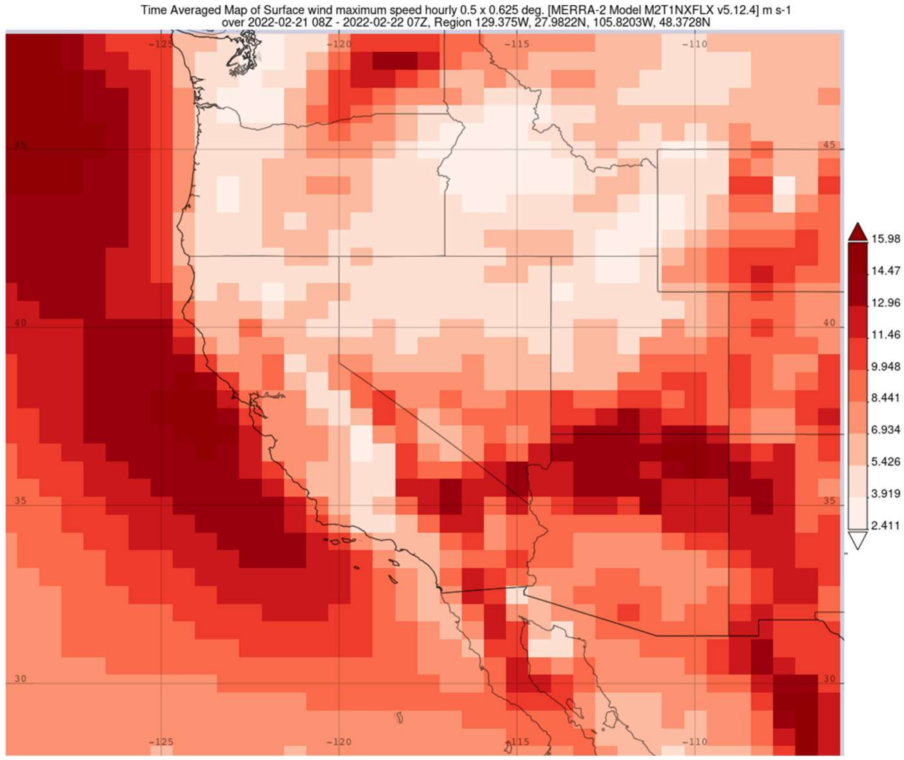


Figure 3.1-9. MERRA-2 reanalysis data hourly maximum surface wind speed (m/s) over February 21, 2022, at 08:00 UTC (00:00 PST) through February 22, 2022, at 07:00 UTC (February 21, 2022 23:00 PST).

3.1.3 Supporting Ground-Based Data

We were unable to find ground-based images in the source region due to the 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 3.1-10 shows that the peak sustained wind speeds in southeastern California and the Mojave Desert were 44 mph on February 21, 2022. Figure 3.1-11 shows that the peak sustained wind speeds in Clark County, NV, were ~33 mph on February 21, 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.

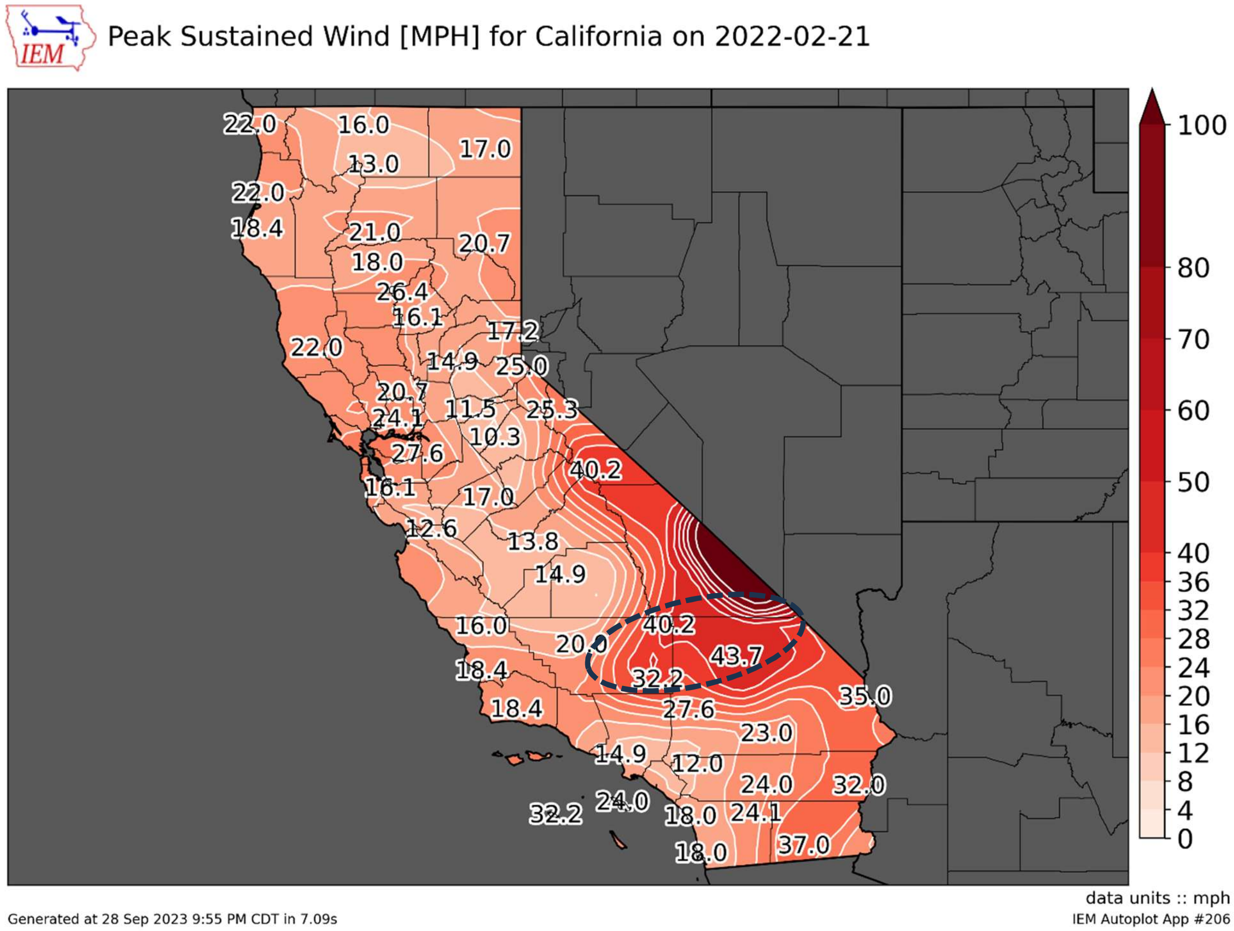


Figure 3.1-10. Peak sustained winds for California on February 21, 2022. The source region is located in southeastern California (the Mojave Desert region). The black dashed line shows the approximate source region. Data source **https://mesonet.agron.iastate.edu/plotting/auto/**.

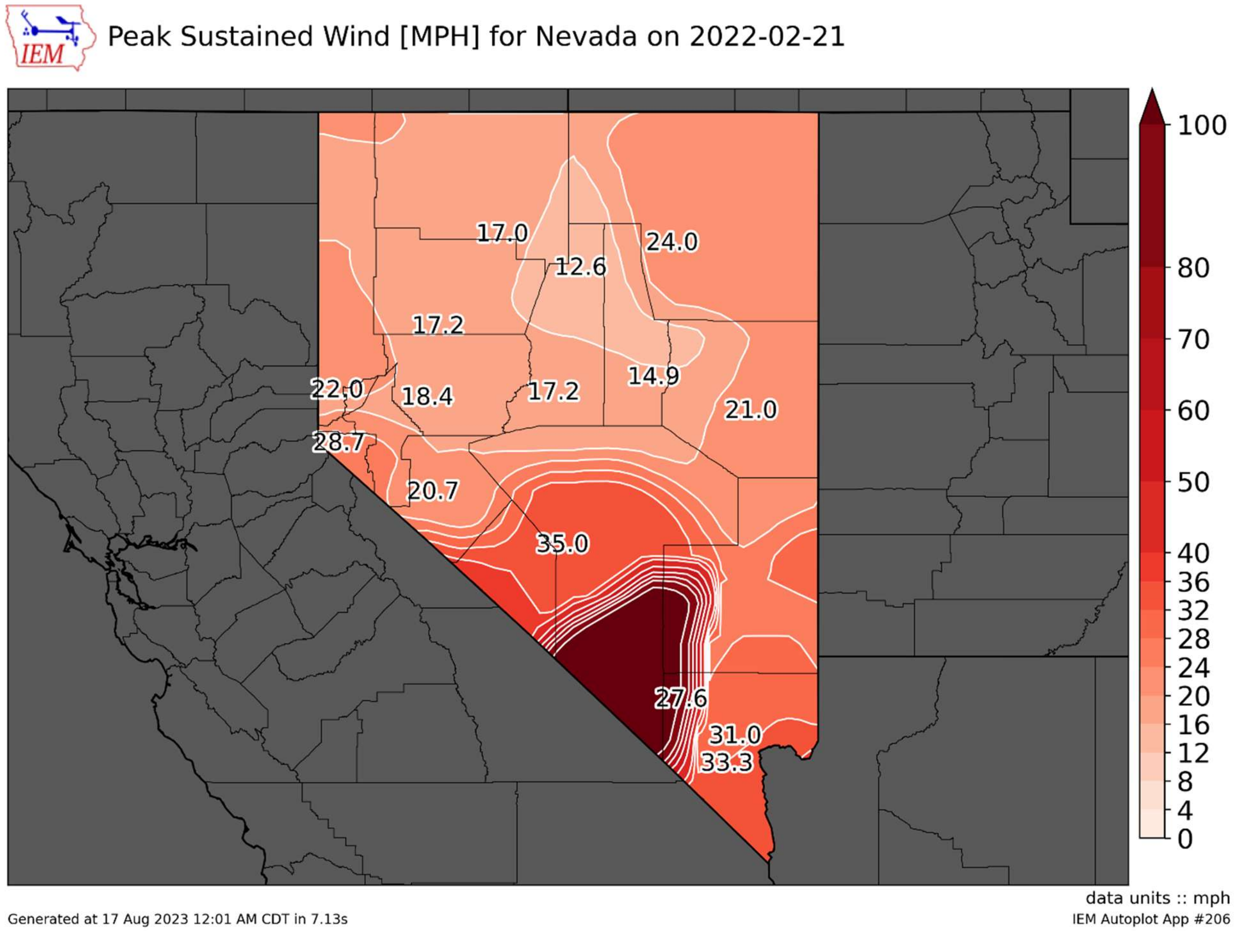


Figure 3.1-11. Peak sustained winds for Nevada on February 21, 2022. Data source https://mesonet.agron.iastate.edu/plotting/auto/.

Figure 3.1-12 shows the distribution of maximum daily temperature recorded at several sites in the wind-blown dust source region on February 20 and 21 (1991-2021), and the maximum daily temperature recorded on February 20 and 21, 2022. The site locations are shown in Figure 2.2-8. Maximum daily temperatures recorded at all sites on February 20, 2022, were above the 75th percentile in the dust origin region and along the transport path compared to maximum daily temperatures from 1991 to 2021. Maximum daily temperatures recorded at all sites on February 21, 2022, the day of the PM_{10} exceedance, were above the median compared to 1991-2021. The maximum temperatures recorded on February 20 and 21 provide evidence that the wind-blown dust source region was unusually hot the day before and the day of the PM_{10} exceedance.

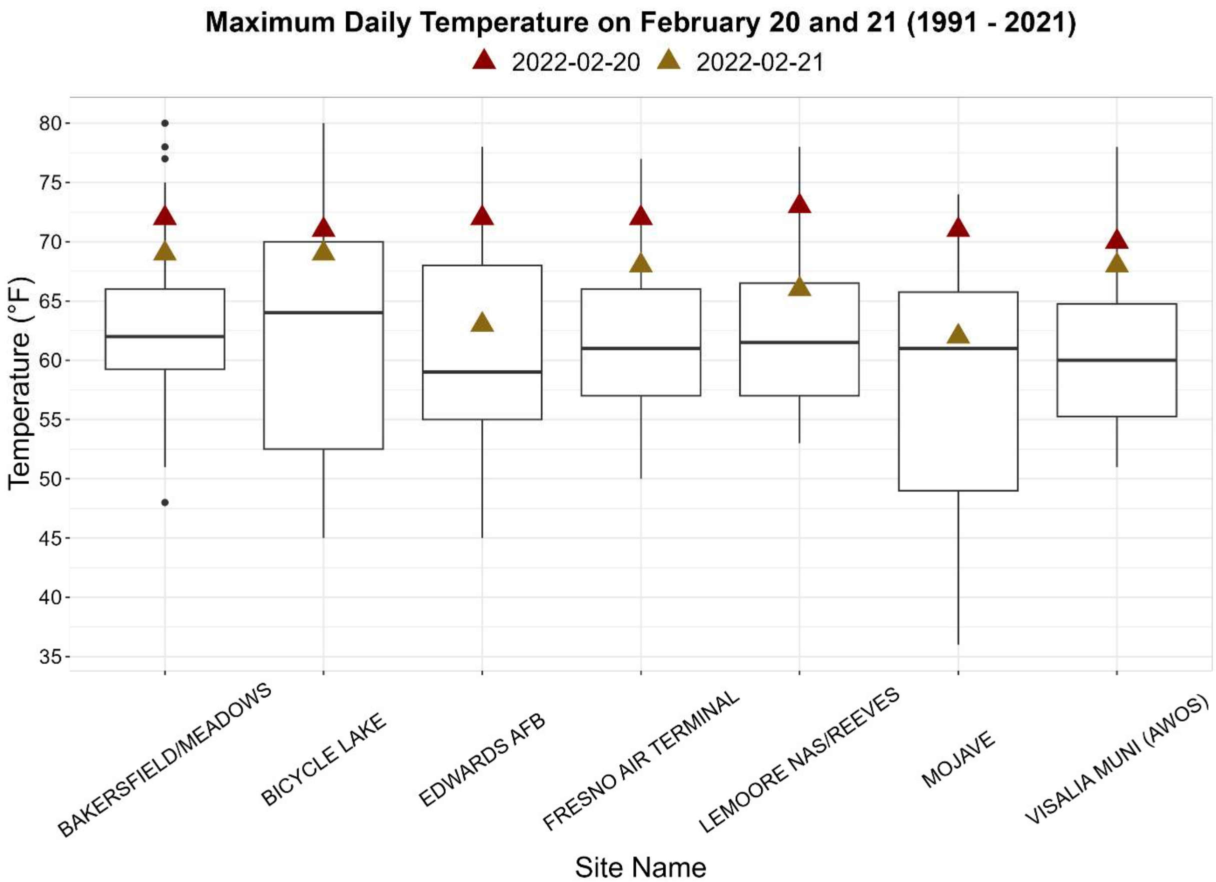


Figure 3.1-12. Maximum daily temperature on February 20 and February 21, 2022, compared to the 1991-2021 distribution at each site.

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 morning and early afternoon on February 21, 2022, associated with a frontal passage. The evidence corroborating this 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 in southeastern California into Clark County; (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 before the event on February 20-21, 2022; and (5) aggregated measurements of high winds in the Mojave Desert source region and Clark County on February 21, 2022.

3.2 Transport to Clark County

3.2.1 HYSPLIT Analysis

Backwards trajectories were modeled from Jerome Mack, Jean, and Garret Jr. High School at the start of the high PM_{10} concentrations (hourly concentration greater than 150 µg/m^3), on February 21, 2022, at 13:00 PST 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 NCEP.

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

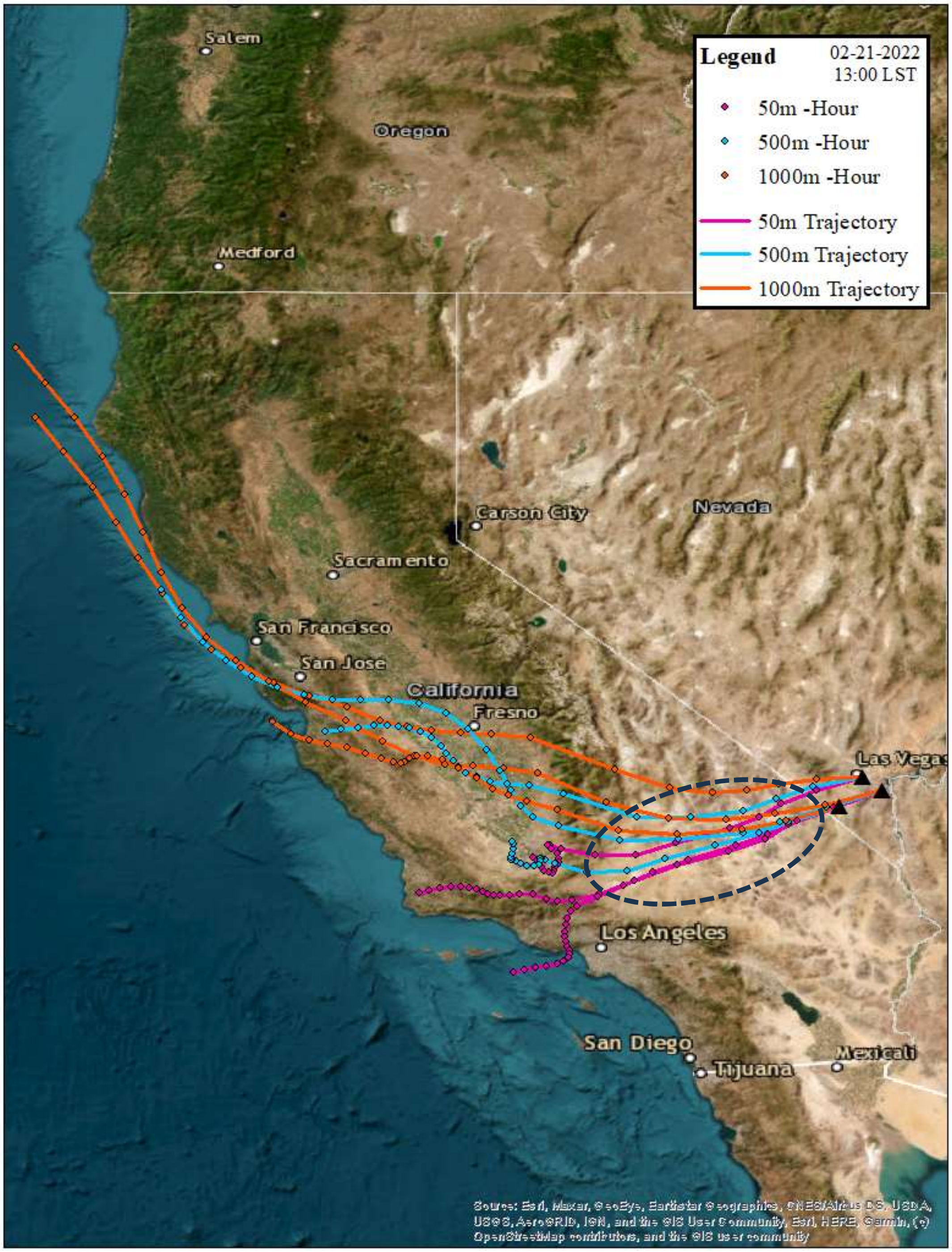


Figure 3.2-1. HYSPLIT 24-hour back trajectories from Jerome Mack, Jean, and Garret Jr. High School on February 21, 2022, at 13:00 PST, originating at (maroon) 50-m, (green) 500-m, and (blue) 1,000-m with hourly points. The approximate location of the Mojave Desert source region is shown by a black, dashed oval.

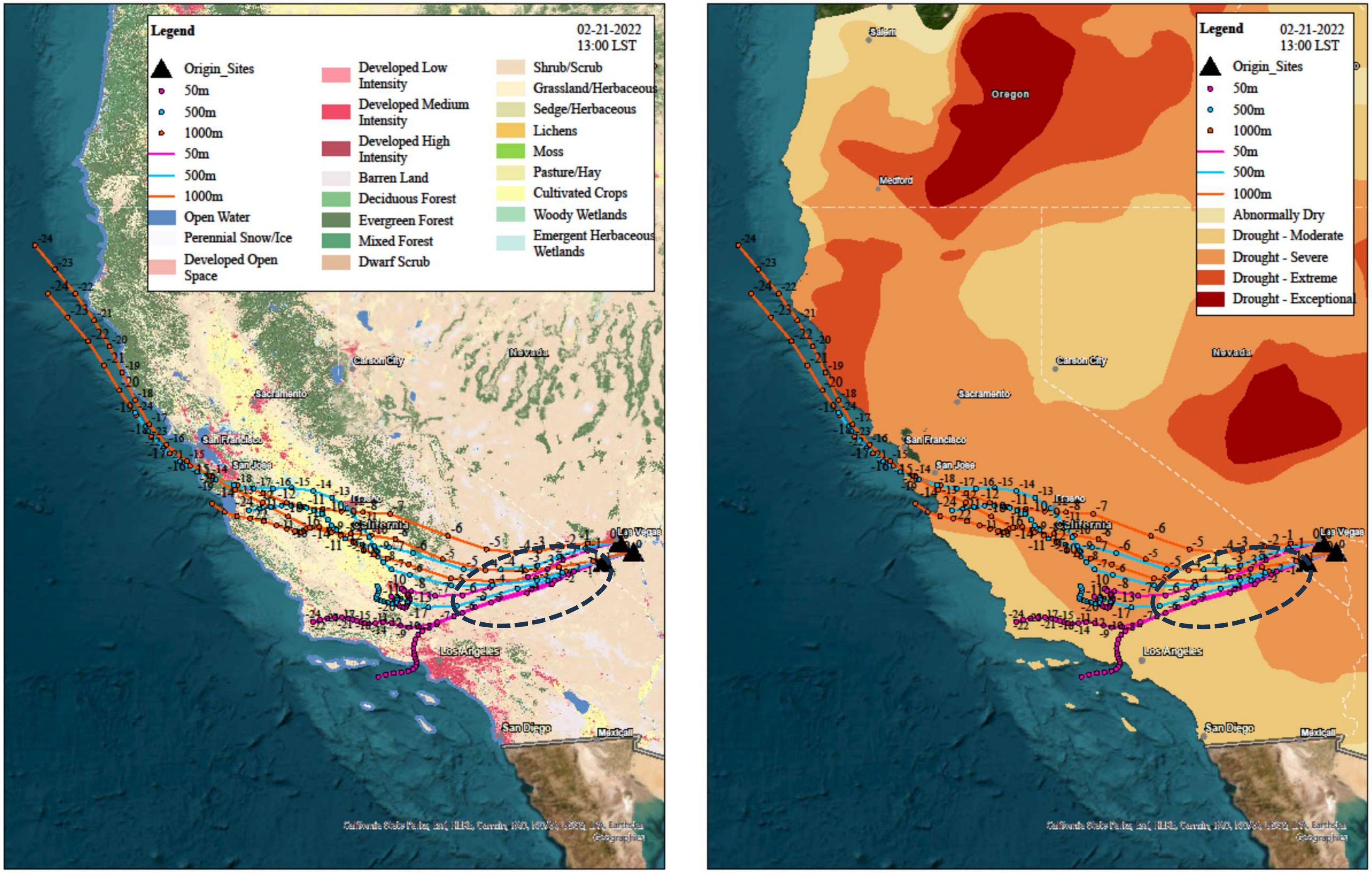


Figure 3.2-2. HYSPLIT 24-hour back trajectories from Jerome Mack, Jean, and Garret Jr. High School on February 21, 2022, at 13:00 PST, overlayed on (left) national land type database and (right) drought monitor class. The approximate location of the Mojave Desert source region is shown by a black, dashed oval.

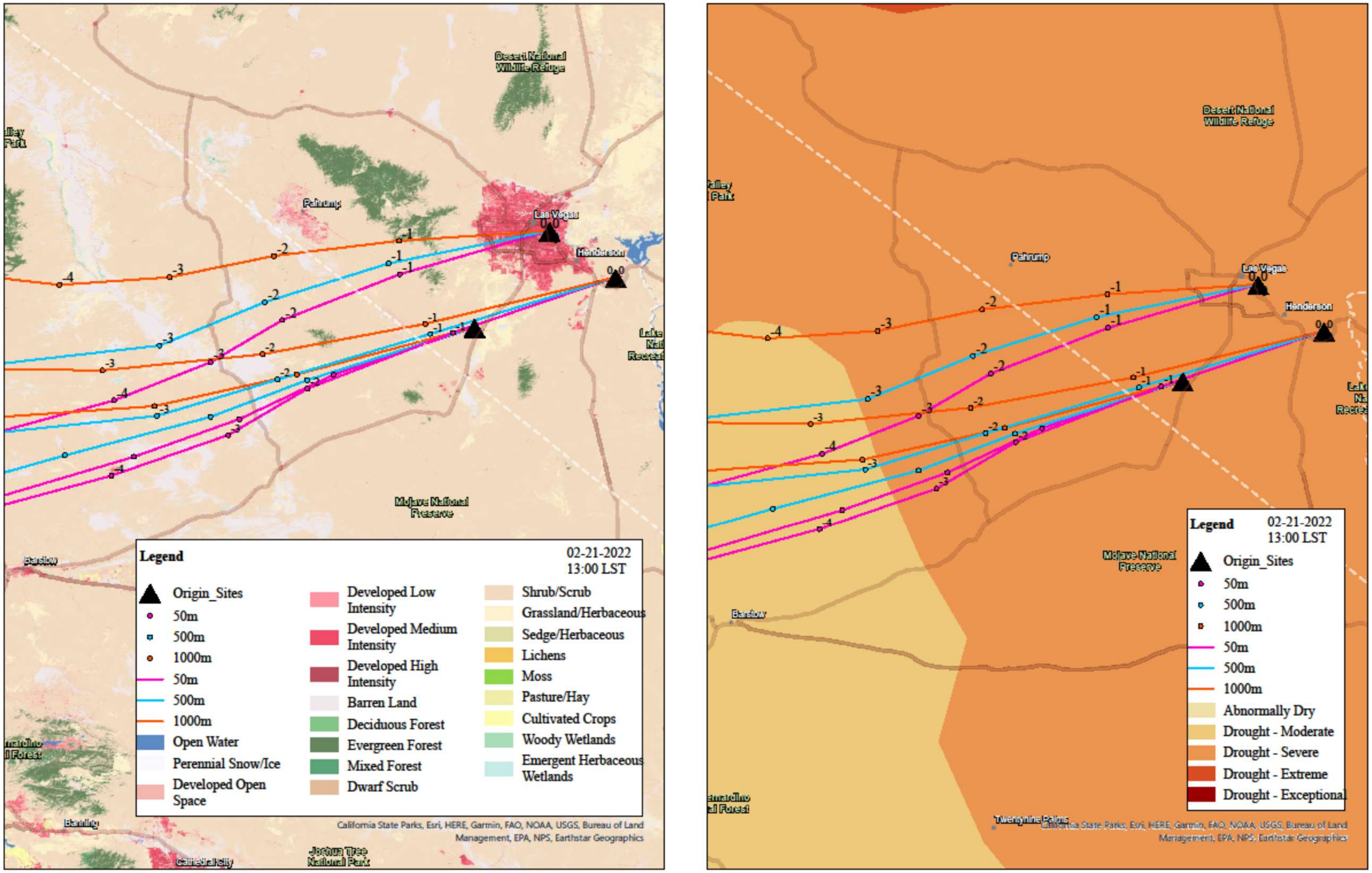


Figure 3.2-3. Zoomed in HYSPLIT 24-hour back trajectories from Jerome Mack, Jean, and Garret Jr. High School on February 21, 2022, at 13:00 PST overlayed on (left) national land type database and (right) drought monitor class.

3.2.2 High Wind Event Timeline

The PM_{10} exceedance concentration on February 21, 2022, affected six monitoring sites, four with regulatory significance, in Clark County, reaching a maximum of 225 µg/m^3 at Liberty High School. PM_{10} concentrations started to increase at 11:00 PST and peaked between 13:00 and 15:00 PST with a secondary peak between 20:00 and 21:00 PST. PM_{10} concentrations remained high through 23:00 PST at most sites.

In addition to the meteorological evidence of the frontal passage, hourly average wind speed and PM_{10} concentrations along the trajectory are also provided in **Figure 3.2-4 and Figure 3.2-5**. As stated in the meteorological analysis in Section 3.1.1, the pressure gradient in eastern California and southern Nevada strengthened between 07:00 and 10:00 PST with the southward movement of a cold front on February 21, 2022. As shown in Figure 3.2-4, Kern, Inyo, and San Bernardino counties in California, labeled one through three, were first impacted as PM_{10} concentrations rose to a peak between 07:00 and 10:00 PST. Hourly average wind speeds in Kern, Inyo, and San Bernardino counties are displayed in Figure 3.2-5. There is close temporal alignment between the rise in PM_{10} concentrations and an increase in hourly average wind speeds above 25 mph in the source region. Hourly average wind speeds rose above 25 mph between 07:00 and 10:00 PST at Ridgecrest-Ward, Canebrake, Coso Junction, Olancha-Well 404 and Trona, fulfilling a key factor for a Tier 2 high-wind dust event as defined by EPA guidance. As the cold front continued to move through the area and the pressure gradient increased, the Pahrump and Las Vegas, NV, regions (labeled as four and five) then show peaks in PM_{10} concentrations starting around 11:00 and peaking between 13:00 and 16:00. The Jean site, on the far western side of Clark County, experienced the enhancement in PM_{10} first, compared with the central Las Vegas Valley sites. This confirms the source direction and timeline of dust movement from the Mojave source region to Clark County. Wind speeds at most Clark County sites were not as intense as in the source region at their peak. **Figure 3.2-6** shows the distribution of wind speed and direction at five-minute increments measured at Harry Reid International Airport (LAS) on February 21, 2022, providing an overview of more instantaneous wind conditions in Clark County on the event date. Winds came predominantly from the southwest, consistent with the approach of a cold front, with a peak five-minute speed of 28 mph. This provides significant evidence of windblown dust lofting and transport due to high winds along the steep pressure gradient created by the frontal system moving through the area.

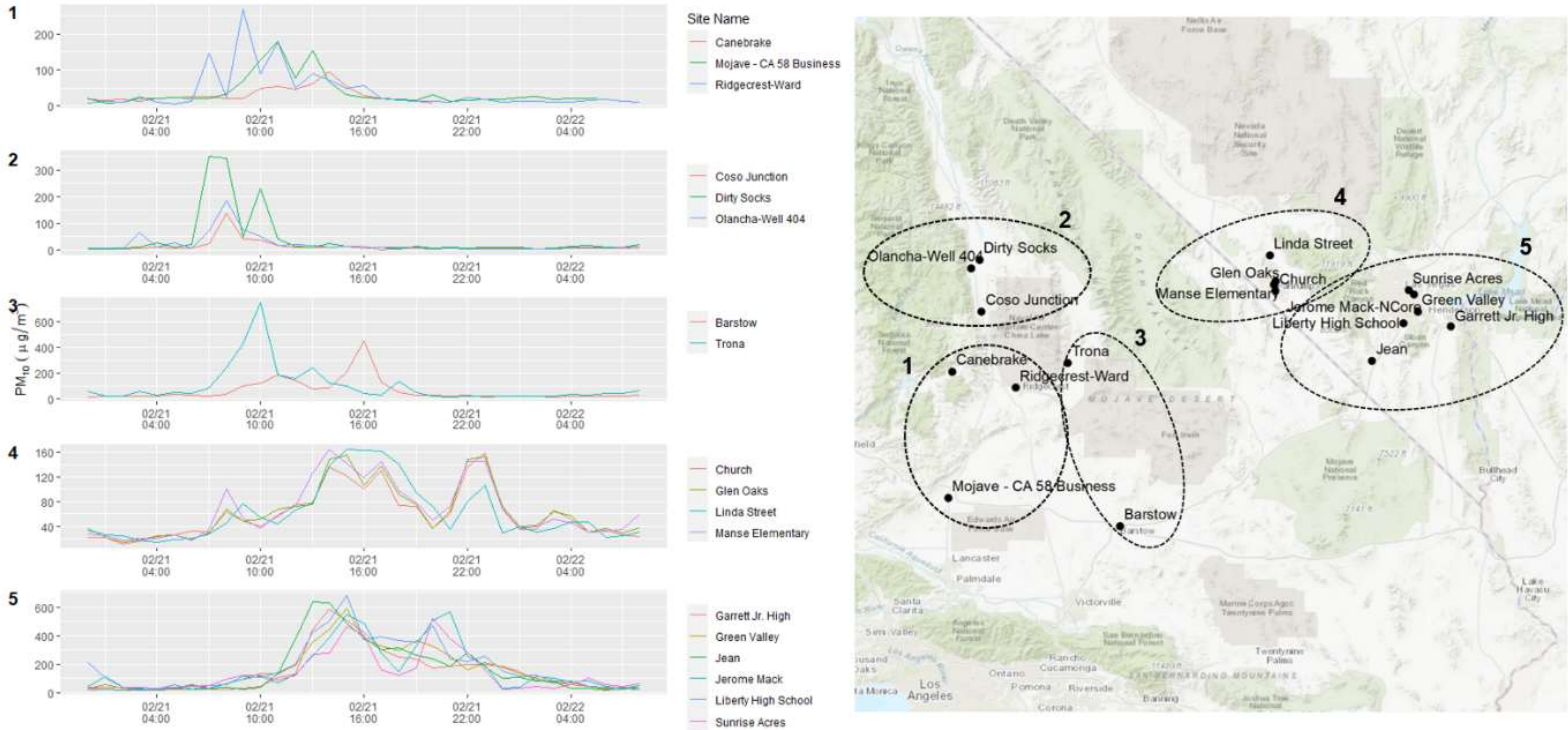


Figure 3.2-4. Timeseries of PM_{10} (left) along the pressure gradient resulting from an approaching cold front. Panel 1 includes data from Kern County, panel 2 includes data form Inyo County, panel 3 includes data from San Bernadino County, panel 4 includes data from the Pahrump area, and panel 5 includes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

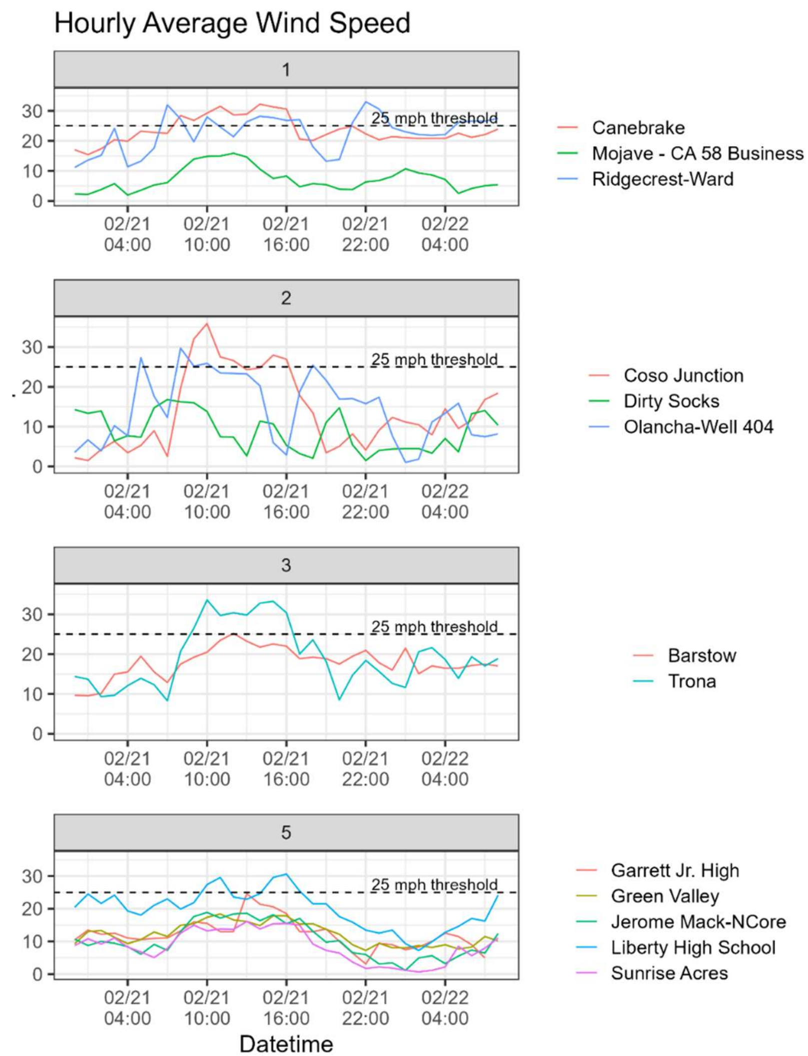


Figure 3.2-5. Hourly average wind speed at sites shown in Figure 3.2-4 sourced from the AQS database. Sites that do not report meteorological data are omitted. The number above each plot panel matches the numbered panels and circled regions in Figure 3.2-4.

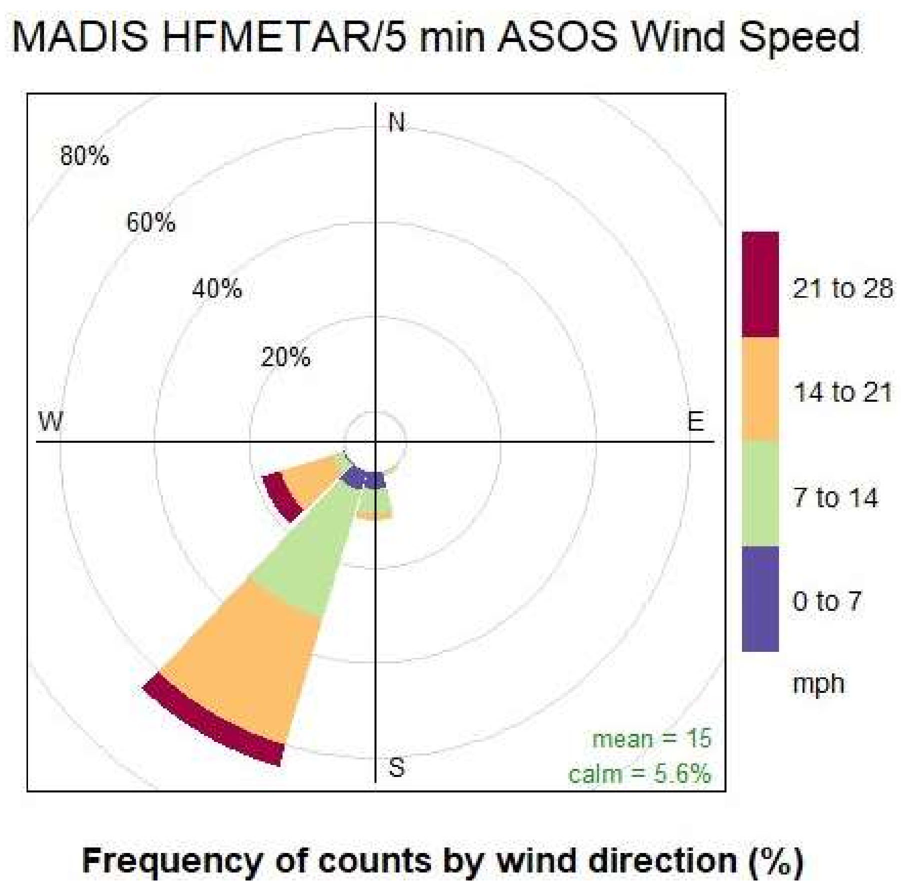


Figure 3.2-6. Wind rose including both wind speed and direction for February 21, 2022, at Harry Reid Int'l Airport (LAS). Wind data was sourced from the Iowa Environmental Mesonet (https://mesonet.agron.iastate.edu/).

Wind speed, direction, and concentrations across Clark County, NV, are consistent with the approach of a frontal system (**Figure 3.2-7 to Figure 3.2-13**). Between 08:00 and 10:00 PST, winds shifted west-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. The shift in winds occurred as the pressure gradient from the low-pressure system and frontal movement started to intensify throughout the region. By 11:00 PST, winds in the valley have increased with the highest concentrations of PM_{10} are reported directly in line with the mountain pass. PM_{10} concentrations also accumulated in the lower elevation areas of the Valley (in the east) through 15:00 PST including the exceedance sites: Jerome Mack, Sunrise Acres, Green Valley, and Liberty High School. Between 16:00 and 21:00 PST, concentrations of PM_{10} start to decrease due to declining winds speeds across Clark County. Concentrations remained higher at the low elevation sites due to accumulation, which ultimately caused a 24-hour average PM_{10} concentration above the NAAQS. 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. Wind speeds in the Las Vegas Valley fell to around 10 mph by 21:00 PST, coinciding with the fall in PM_{10} concentrations.

Enhanced PM_{10} concentrations at the Green Valley, Jerome Mack, Liberty High School, and Sunrise Acres 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, enhanced PM_{10} concentrations at all sites in the Las Vegas Valley is indicative of a regional high-wind dust event. While it is possible that some portions of planned land use, such as the undeveloped lot to the southeast of the Sunrise Acres site, may have contributed to local dust during the high wind event, evidence of high winds over a natural, undisturbed 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 frontal passage 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 PM10 concentrations experienced on February 21, 2022.

Peak sustained winds for Clark County and the surrounding regions are shown in **Figure 3.2-14** using the Iowa State University Mesonet Automated Data aggregation tool. This plot shows sustained winds greater than the 25-mph high wind threshold on February 21, 2022, providing further proof that this was a high-wind event affecting Clark County.

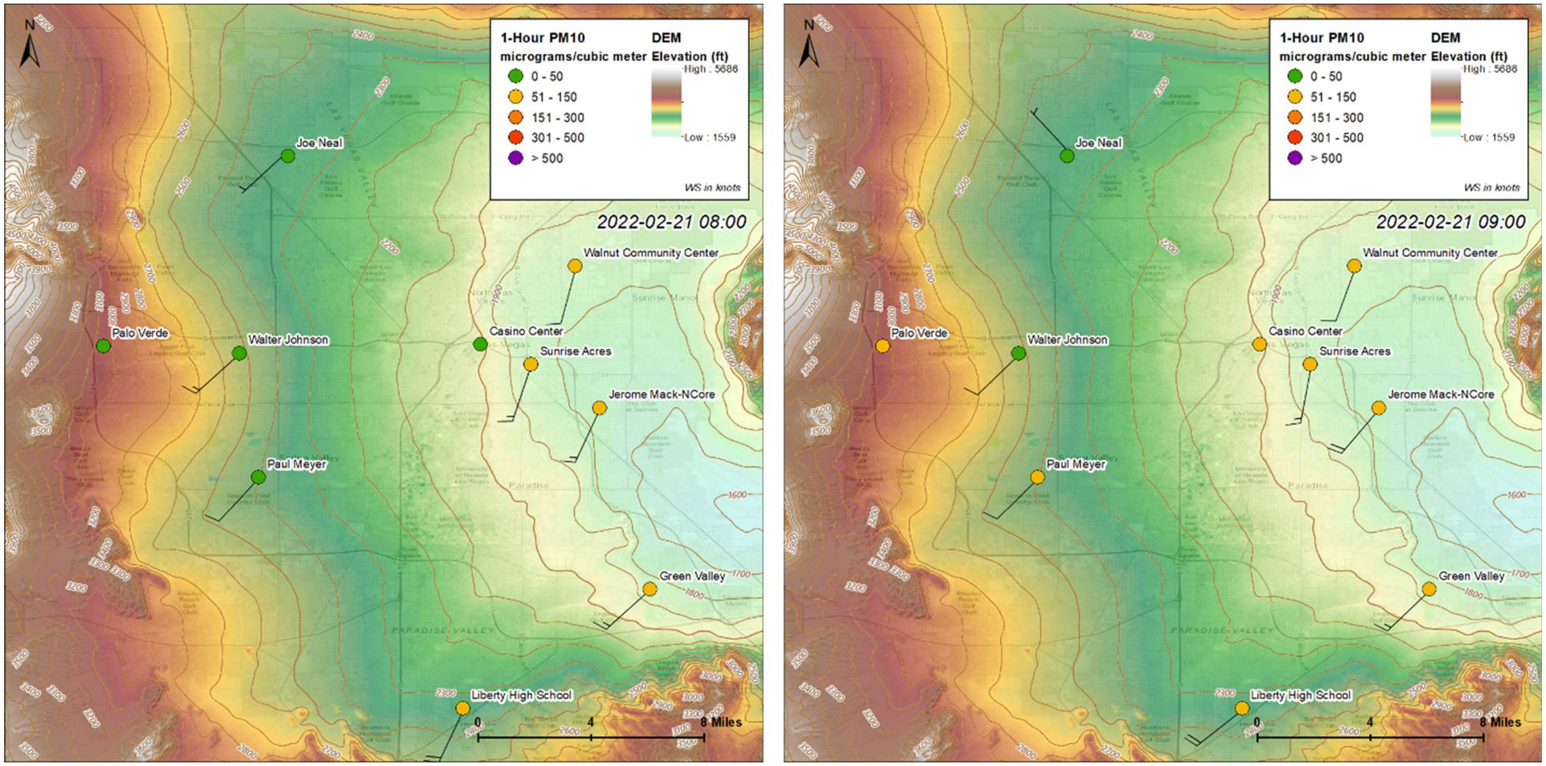


Figure 3.2-7. Topographical map showing surface observations of wind speed, wind direction, hourly PM_{10} from each measurement site in Clark County, NV, for February 21, 2022, from 08:00 PST to 09:00 PST.

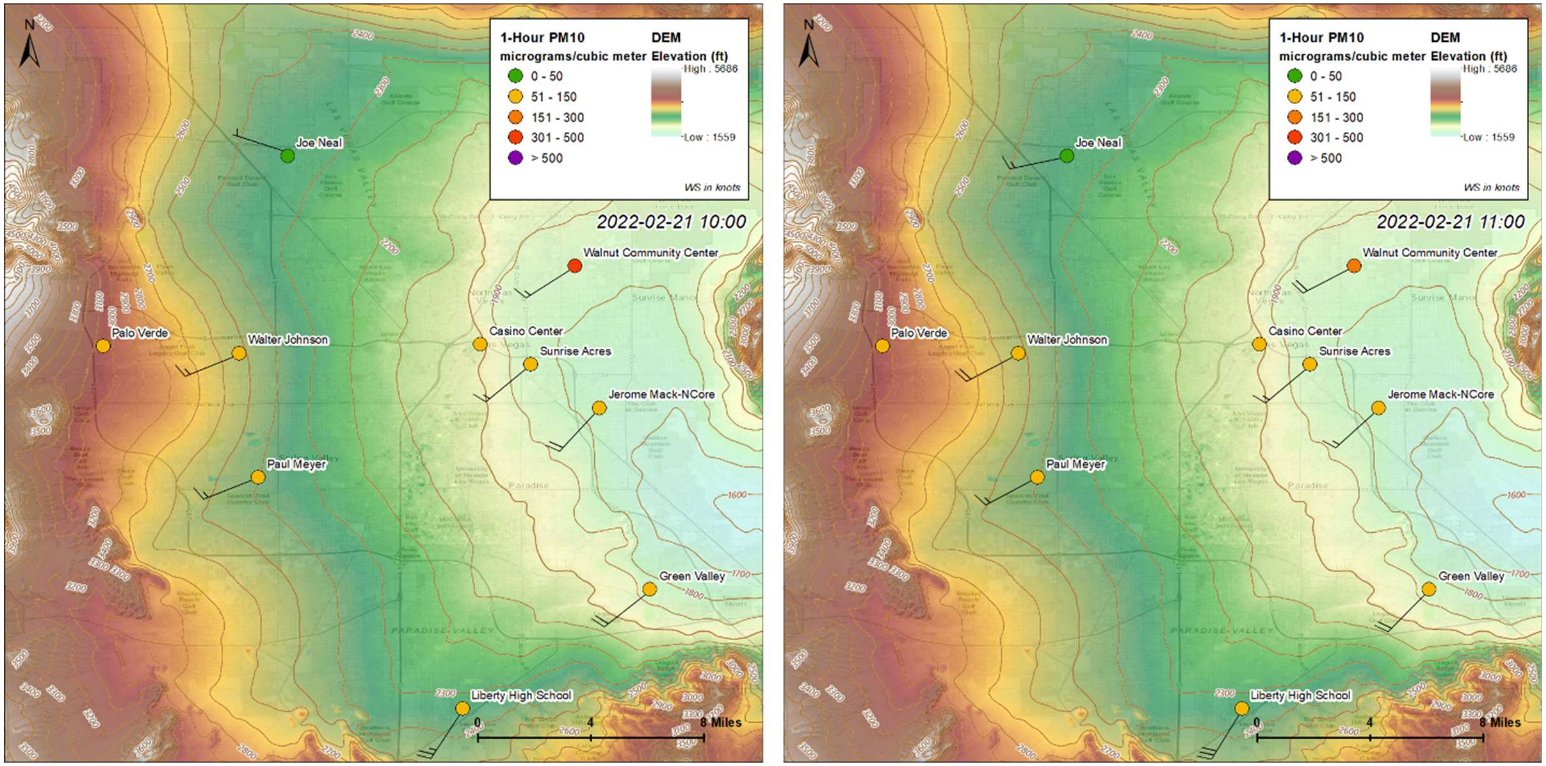


Figure 3.2-8. Topographical map showing surface observations of wind speed, wind direction, hourly PM_{10} from each measurement site in Clark County, NV, for February 21, 2022, from 10:00 PST to 11:00 PST.

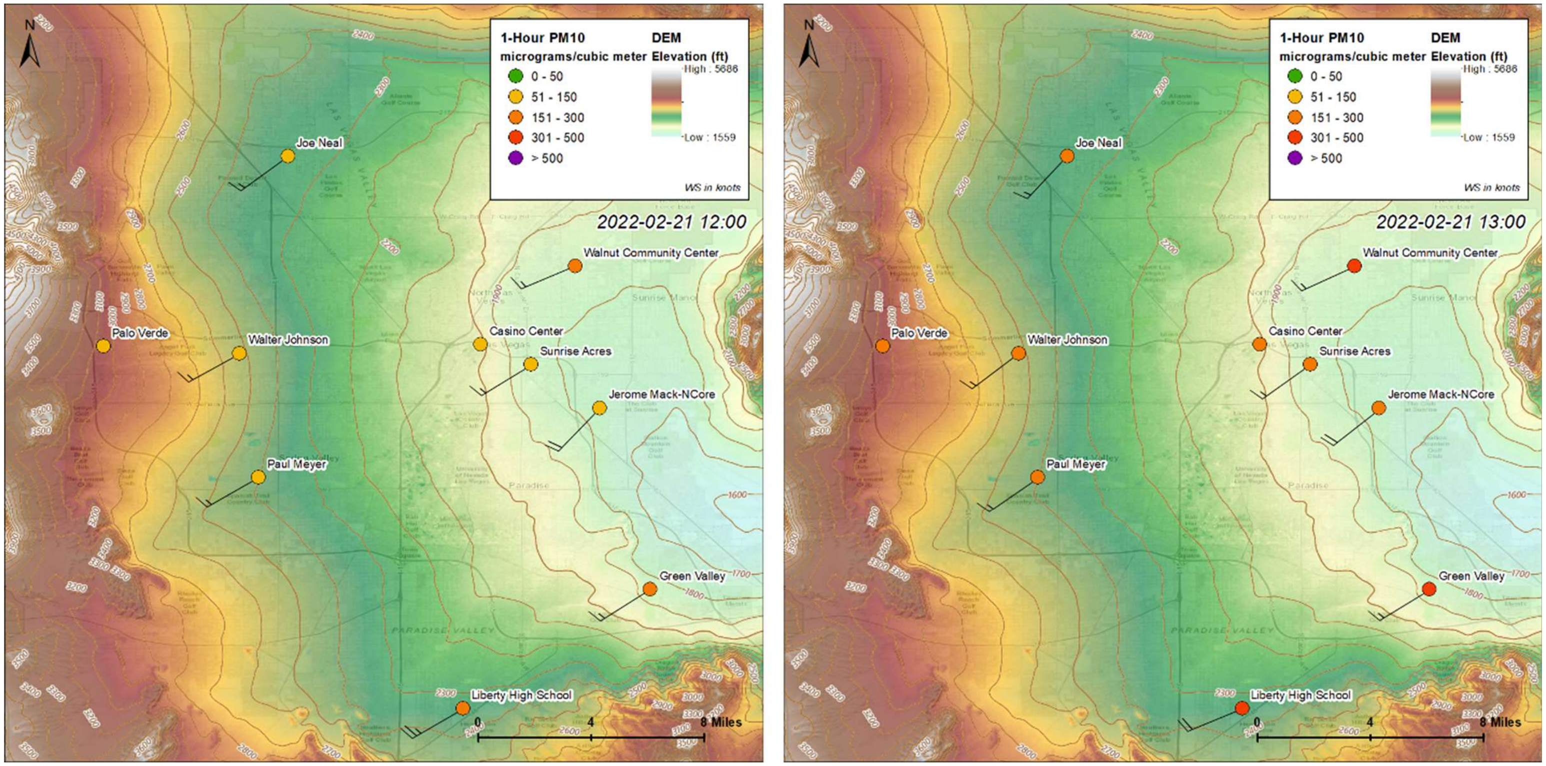


Figure 3.2-9. Topographical map showing surface observations of wind speed, wind direction, hourly PM_{10} from each measurement site in Clark County, NV, for February 21, 2022, from 12:00 PST to 13:00 PST.

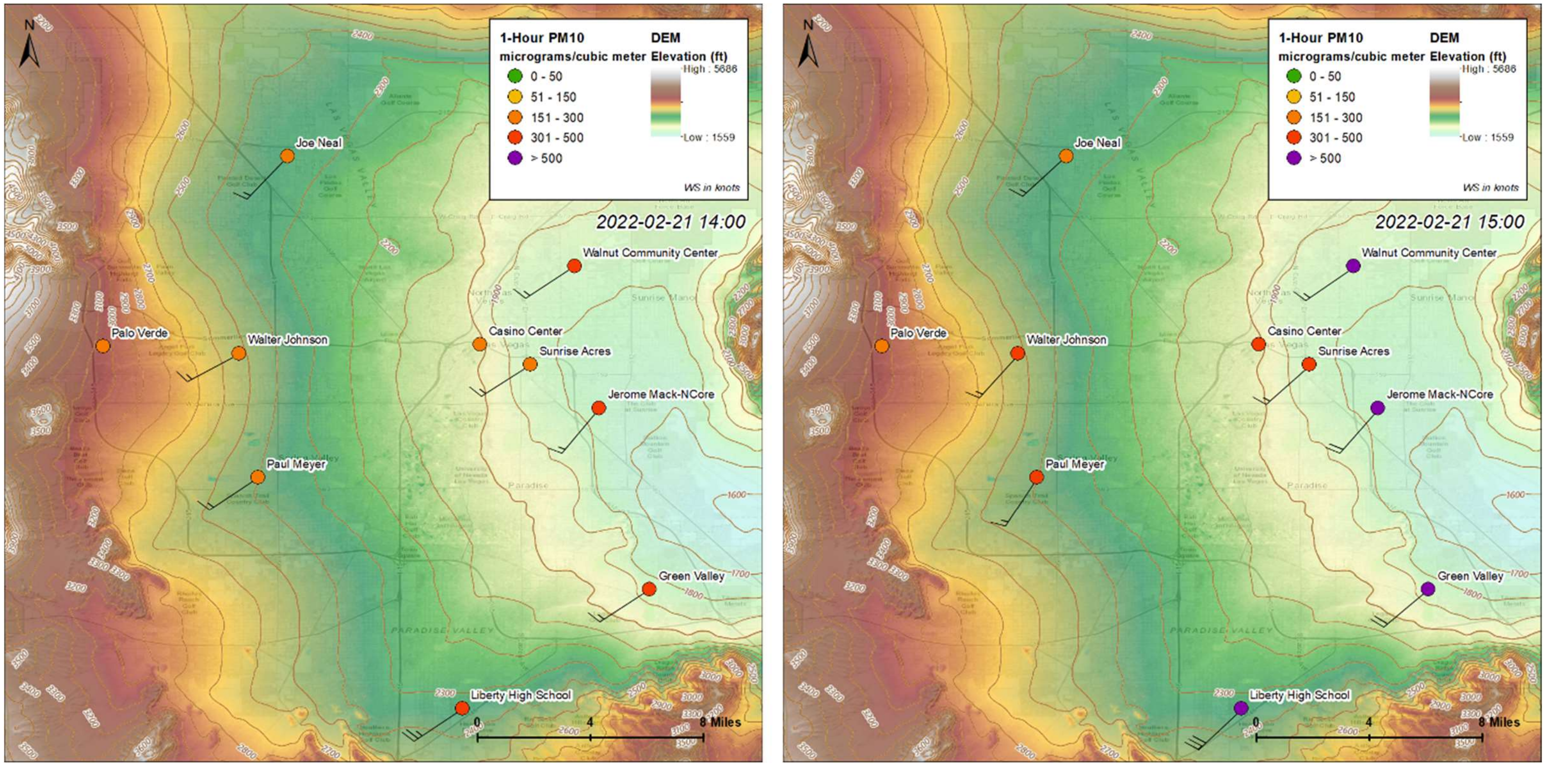


Figure 3.2-10. Topographical map showing surface observations of wind speed, wind direction, hourly PM_{10} from each measurement site in Clark County, NV, and for February 21, 2022, from 14:00 PST to 15:00 PST.

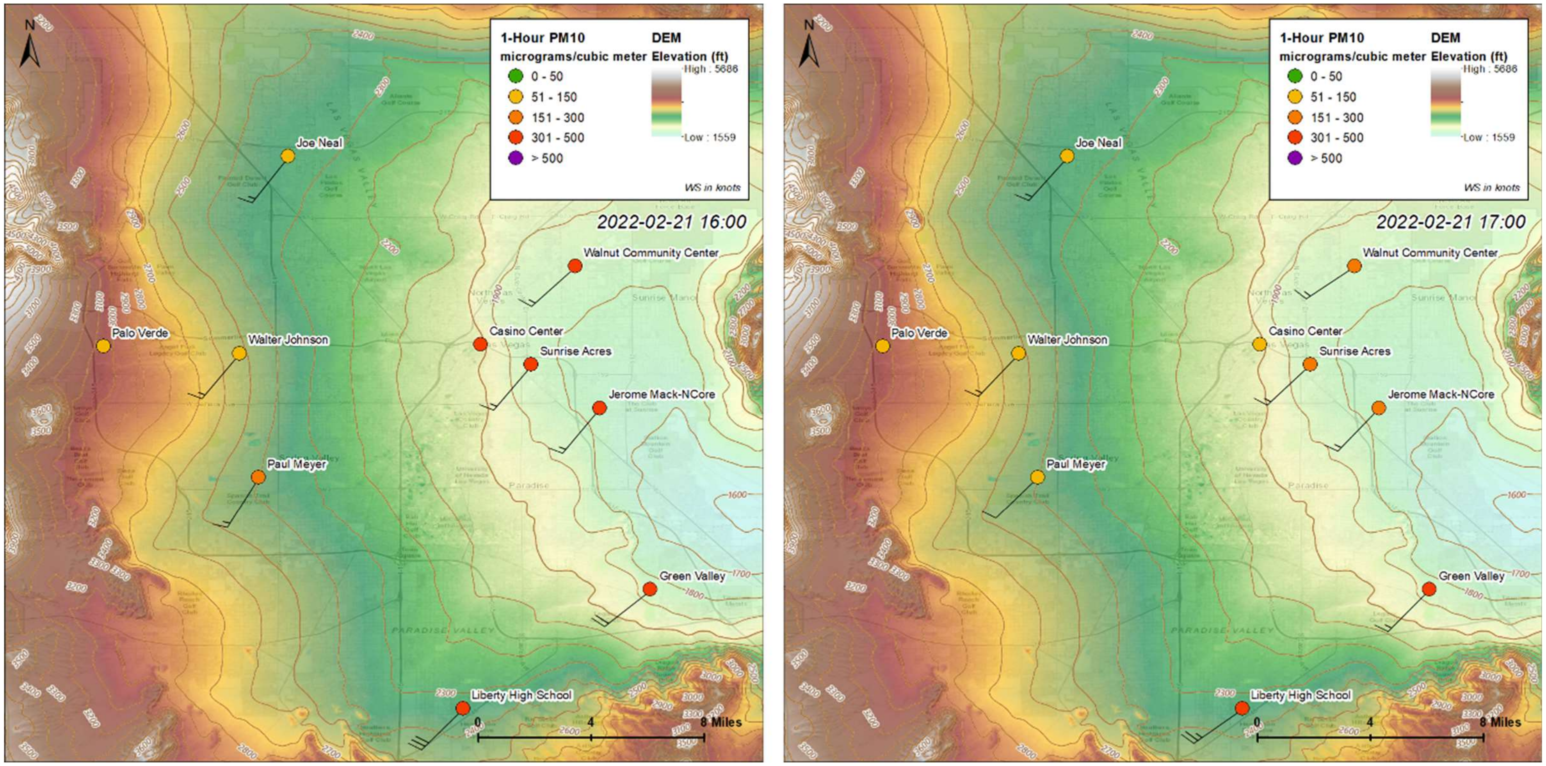


Figure 3.2-11. Topographical map showing surface observations of wind speed, wind direction, hourly PM_{10} from each measurement site in Clark County, NV, for February 21, 2022, from 16:00 PST to 17:00 PST.

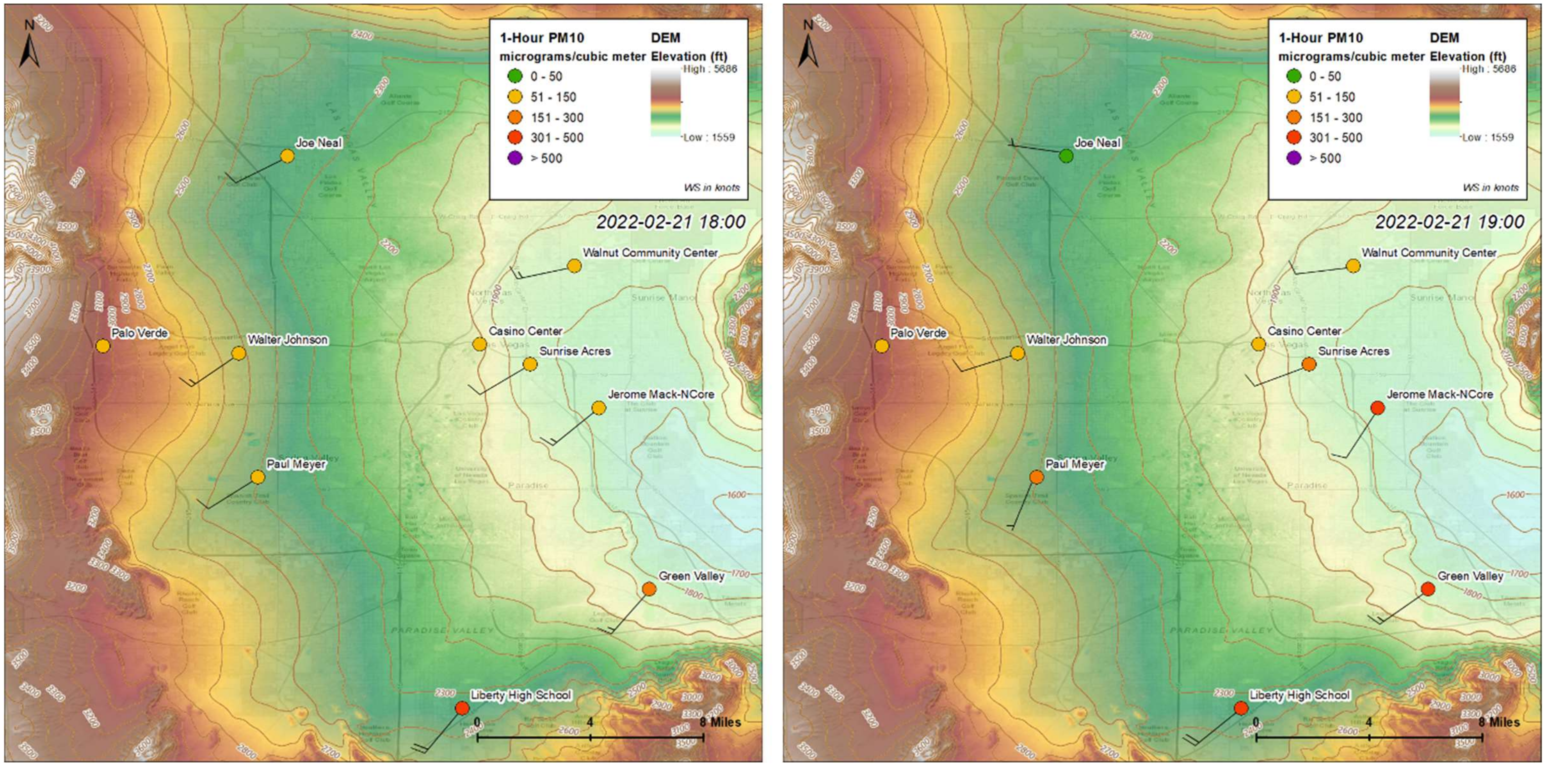


Figure 3.2-12. Topographical map showing surface observations of wind speed, wind direction, hourly PM_{10} from each measurement site in Clark County, NV, for February 21, 2022, from 18:00 PST to 19:00 PST.

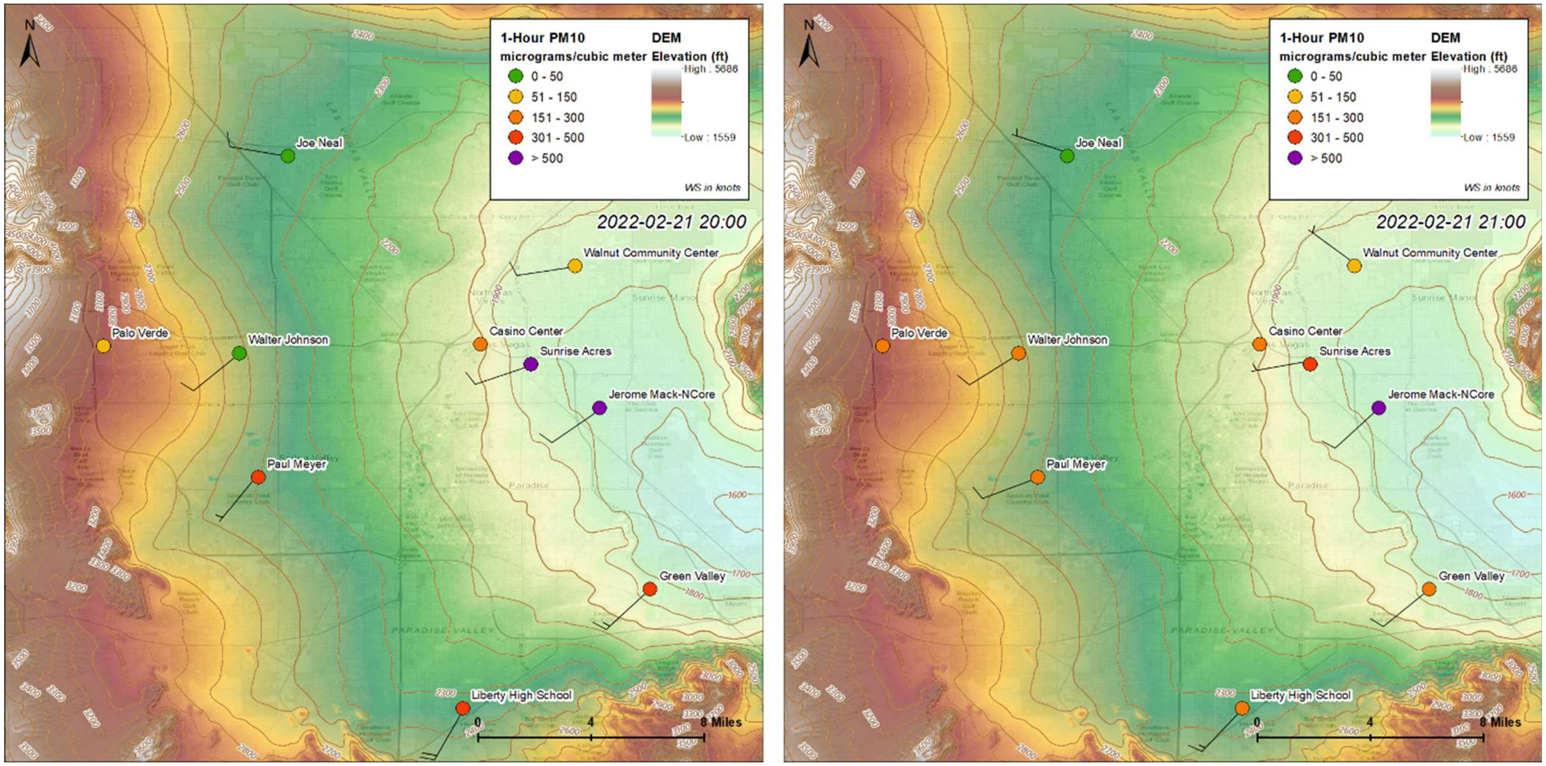


Figure 3.2-13. Topographical map showing surface observations of wind speed, wind direction, hourly PM_{10} from each measurement site in Clark County, NV, for February 21, 2022, from 20:00 PST to 21:00 PST.

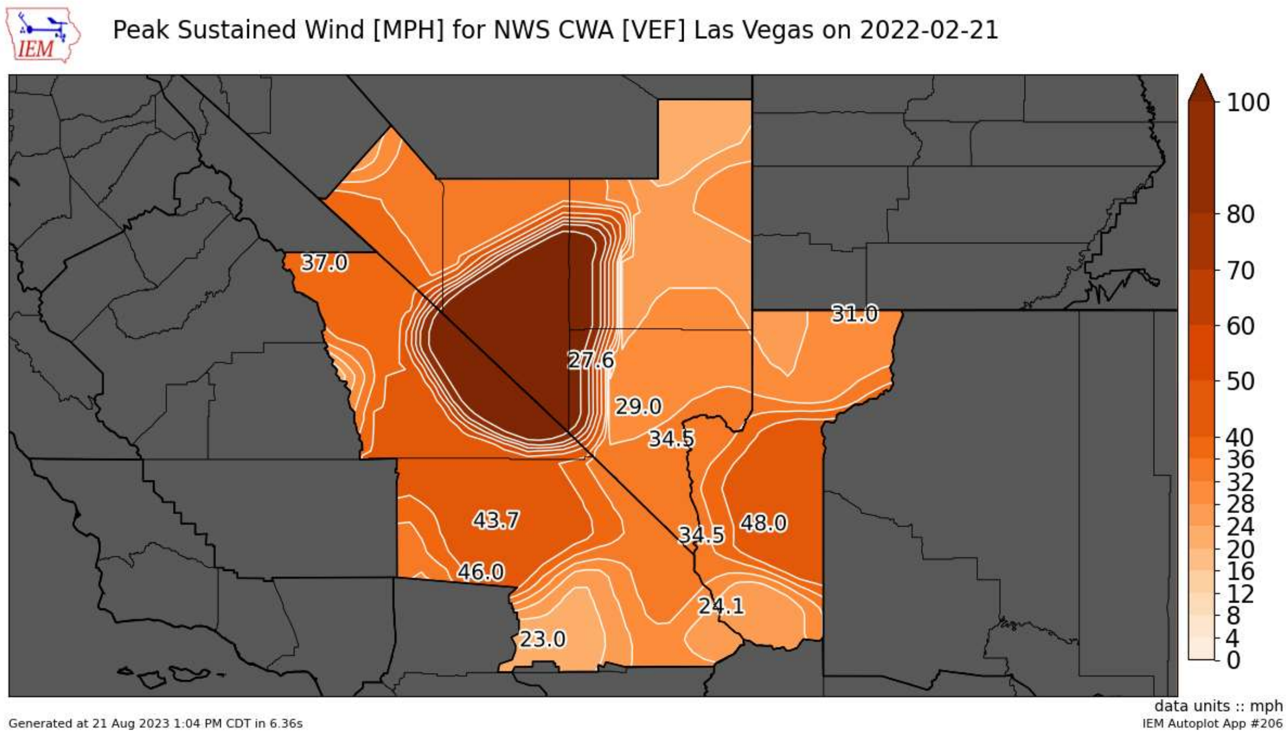


Figure 3.2-14. Peak sustained winds in Clark County and surrounding counties on February 21, 2022. Data source: **https://mesonet.agron.iastate.edu/plotting/auto/**.

Overall, we find overwhelming evidence that PM_{10} was transported from the Mojave Desert in the morning and early afternoon on February 21, 2022, with a strong frontal passage. Wind speeds in the source region and along the transport path show sustained speeds >25 mph. 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 four hours; (2) changes in wind speed along the transport path; (3) PM_{10} evidence from monitoring sites along the transport path; (4) ground-based observation of PM_{10} and wind speed/direction in Clark County; and (5) interpolated wind data for Clark County and the surrounding areas showing winds well above the 25-mph threshold. All of these pieces of evidence corroborate the PM_{10} event time of arrival and intensity of the event.

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

3.3.1 Clark County Alerts

On Monday, February 21, 2022, Clark County issued a Construction Notice 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 the same day. The construction notice was upgraded to a Dust Advisory the following day, which was again disseminated to all dust control permit holders, contractors, and stationary sources. Figure 3.3-1 and Figure 3.3-2 provide the emails sent by Clark County.

Clark County Nevada created a news release for February 22, 2022 (Figure 3.3-3), with an air quality advisory for dust to warn people to limit outdoor exertion on windy days with dust in the air. They advised residents and local construction sites of possible enhanced dust levels from the high winds in the area. The news article alerted the public that there was blowing dust in the area from the windy conditions. The health effects of dust were described to include worsening respiratory diseases with recommendations to stay indoors as much as possible.

DES
DEPARTMENT OF ENVIRONMENT AND SUSTAINABILITY

Clark County Department of Environment and Sustainability

Division of Air Quality

CONSTRUCTION NOTICE

for Monday, February 21, 2022

Attention Dust Control Permit Holders, Contractors, and Stationary Sources

National Weather Service and the weather models used by the Division of Air Quality (DAQ) show the potential for high winds begging Monday morning and lasting throughout the evening. The forecast is for **sustained winds 20-25 mph,** with gusts **to 35 mph.**

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

BLASTING: This forecast is for wind gusts to 35 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.

DAQ will continue to monitor these forecasts for any further wind developments. If the weather forecast is upgraded and conditions warrant, you will be notified of a Dust Advisory.

Figure 3.3-1. Email from AQDCP@ClarkCountyNV.gov to all Dust Control Permit holders on February 21, 2022.

DES
DEPARTMENT OF ENVIRONMENT AND SUSTAINABILITY

Clark County Department of Environment and Sustainability

Division of Air Quality

DUST ADVISORY

for Tuesday, February 22, 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 25-35 mph**, with **gusts of 40 mph**, beginning Tuesday afternoon and lasting throughout the evening.

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 40 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 3.3-2. Email from AQDCP@ClarkCountyNV.gov to all Dust Control Permit holders on February 22, 2022.

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 **Tuesday, Feb. 22, 2022**

Air Quality Dust Advisory Issued for Tuesday

The Clark County Department of Environment and Sustainability has issued a dust advisory for Tuesday, Feb. 22, 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 3.3-3. News release by Clark County Nevada on February 22, 2022, indicating dust was present and issuing an Air Quality Advisory.

3.3.2 Media Coverage

Many news sources including KTNV Las Vegas, 8 News Now, News 3, Las Vegas Locally, and NWS Las Vegas, reported on the windy conditions and dust present on February 21, 2022. Several sources, including Las Vegas Locally and NWS Las Vegas, posted on Twitter about dust and visibility on February 20-21, 2022. Screenshots of the news articles referenced throughout this section are available in Appendix A.

KTNV Las Vegas reported on the dust advisory issued by the Clark County DES for Tuesday, February 22, 2022. Tips for reducing exposure to dust were included in the article. (https://www.ktnv.com/news/clark-county-issues-dust-advisory-due-to-high-winds-on-tuesday)

KTNV Las Vegas reported on the weather forecast for February 21, 2022. There was a wind advisory across southern Nevada until 20:00 PST Monday night, with 40-50 mph gusts, which had the potential to make travelling dangerous across the region. (https://www.ktnv.com/weather/13-first-alert-weather-forecast-monday-evening-feb-21-2022)

8 News Now reported on the wind advisories issued for February 21, 2022 with winds up to 50 mph in some neighborhoods. There was dust from the dry lake beds in the area that led to decreased air quality. (https://www.8newsnow.com/weather/gusty-winds-kick-up-dust-all-over-the-region-today-heres-tedds-forecast-for-monday-february-21st/)

News 3 reported on a multiple vehicle crash on the highway south of Boulder City on February 21, 2022. There were 11 vehicles involved in the crash on US 95 near mile marker 50 that was possibly due to brown out conditions, according to the Boulder City and Nevada State Police Highway patrol. (https://news3lv.com/news/local/several-injured-multi-vehicle-crash-us-95-south-boulder-city-searchlight-nevada-state-police-highway-patrol-traffic-alert-dust-wind-brownout)

Las Vegas Locally posted on Twitter to watch out for haboobs if you are driving from California as shown in Figure 3.3-4. (https://twitter.com/LasVegasLocally/status/1495885478373257216)

NWS Las Vegas posted on Twitter about a multi-vehicle crash on Highway 95 that led to traffic diversions for both north and south lanes as shown in Figure 3.3-5. They expected strong westerly winds to continue through the evening on February 21, 2022, which could have led to sudden cross winds and heavy blowing dust. (https://twitter.com/NWSVegas/status/1495866338937430019/)

NWS Las Vegas posted on Twitter on February 21, 2022, about the reduced visibility conditions due to blowing dust in the area. A camera view that typically shows the Spring Mountains and Mount Charleston showed they were obscured by dust from California as shown in Figure 3.3-6. The reduced visibility conditions from blowing dust on Pierce Ferry Road near Archibald Wash was shown in their Twitter post (Figure 3.3-7) (https://twitter.com/NWSVegas/status/1495897906242482180?s=20 and https://twitter.com/NWSVegas/status/1495843332525678595?s=20)

NWS Las Vegas posted on Twitter on February 20, 2022, about windy weather conditions expected for February 21-22, 2022. Blowing dust and debris, hazardous crosswinds, choppy lakes, and cooler weather with a chance of rain or snow was included. They advised people to be alert for sudden reduced visibility and use caution with high profile vehicles. It also noted wind advisories were in effect for some areas. (https://twitter.com/NWSVegas/status/1495424504776040453?s=20)

KTNV Las Vegas reported that winds from 40-50 mph were possible for southern Nevada on February 21, 2022. The winds would be picking up dust and throwing debris, which could make travel difficult and dangerous. After sunset, they reported the winds should drop below 30 mph. There were cold and windy conditions on February 22, 2022, with gusts from 40-50 mph. (https://darik.news/nevada/13-first-alert-weather-monday-evening-february-21-2022/506988.html)

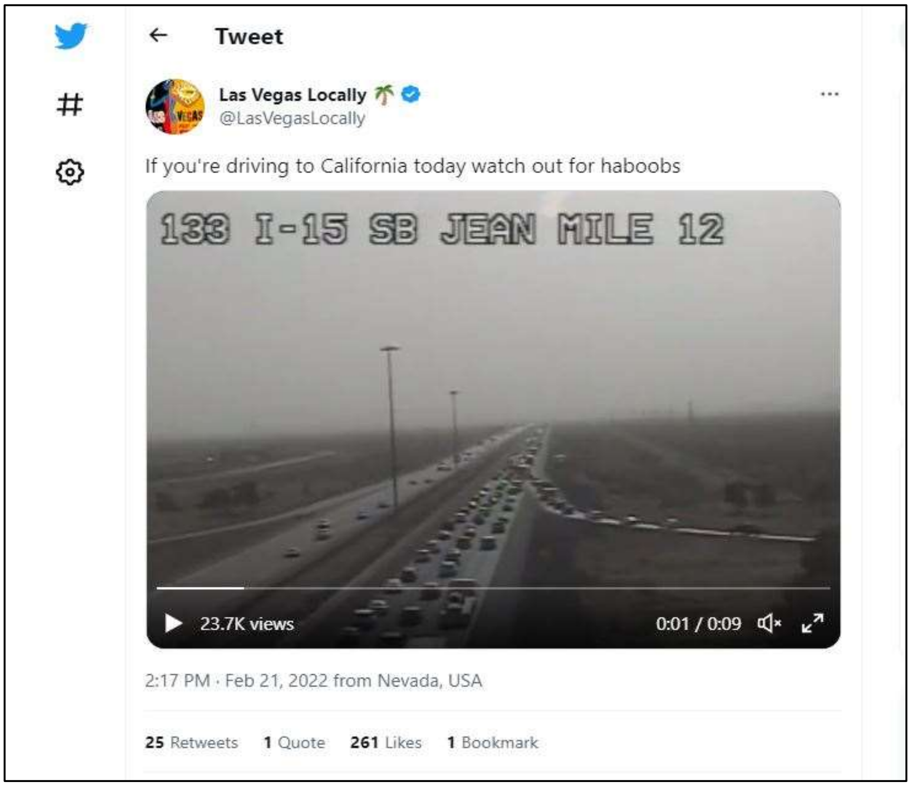


Figure 3.3-4. Twitter post from a local media page on February 21, 2022, showing the traffic camera in Jean with poor visibility and warning of dust storms.

Figure 3.3-5. Twitter post from National Weather Service Last Vegas on February 21, 2022, indicating strong winds and blowing dust were expected.

Figure 3.3-6. Twitter post from National Weather Service Last Vegas on February 21, 2022, identifying the dust transport into Clark County as externally sourced.

Figure 3.3-7. Twitter post from the National Weather Service Las Vegas on February 21, 2022

Table 3.3-1 includes all urgent weather messages (including wind advisories) and dust storm warnings for Clark County, the Mojave source region, and surrounding counties also affected by the dust event. Details for all weather messages and advisories are included in Appendix A.

Table 3.3-1. National Weather Service Las Vegas, Nevada, warnings issues on February 21, 2022.

Warning	Time (PST)	Location
Urgent Weather Message	09:55	Eastern Sierra Slopes, Cadiz Basin-Northeast Clark County-Western Clark and Southern Nye County-Las Vegas Valley, Northwest Plateau-Northwest Deserts-Owens Valley-Eastern Mojave Desert-Morongo Basin-Southern Clark County, Western Mojave Desert
Urgent Weather Message	15:29	Eastern Sierra Slopes, Northwest Plateau-Northwest Deserts-Owens Valley- Eastern Mojave Desert-Morongo Basin-Cadiz Basin- Northeast Clark County-Western Clark and Southern Nye County- Las Vegas Valley-Southern Clark County, Western Mojave Desert, Lake Mead National Recreation Area
Dust Storm Warning	11:09	Central Mohave County in northwestern Arizona
Dust Storm Warning	12:41	Central Mohave County in northwestern Arizona
Dust Storm Warning	13:00	Central Mohave County in northwestern Arizona
Dust Storm Warning	14:05	Central Mohave County in northwestern Arizona
Dust Storm Warning	15:01	Central Mohave County in northwestern Arizona
Urgent Weather Message	19:40	Northwest Plateau-Northwest Deserts-Owens Valley-Eastern Mojave Desert-Morongo Basin-Cadiz Basin-Northeast Clark County-Western Clark and Southern Nye County- Las Vegas Valley-Southern Clark County, Lake Mead National Recreation Area, Eastern Sierra Slopes, Western Mojave Desert
Urgent Weather Message	20:17	Eastern Sierra Slopes, Lake Mead National Recreation Area-Eastern Mojave Desert- Morongo Basin-Northeast Clark County- Western Clark and Southern Nye County-Spring Mountains- Red Rock Canyon-Las Vegas Valley-Southern Clark County, Western Mojave Desert

3.3.3 Pollutant and Diurnal Analysis

As discussed in Section 3.2, PM_{10} concentrations in the Las Vegas Valley showed a rapid increase at most sites by 11:00 PST on February 21, 2022, which coincided with the approach of a frontal system. Figure 3.3-8 shows hourly PM_{10} concentrations at monitoring sites throughout Clark County. Multiple sites exceeded an hourly concentration of 500 µg/m^3 at 15:00 PST, when the regional peak hourly concentration of 680 µg/m^3 is measured at Liberty High School. Enhanced PM_{10} concentrations persisted through midnight at many sites. The concurrent rise in PM_{10} at a majority of monitoring sites in the Las Vegas Valley is indicative of a regional dust event.

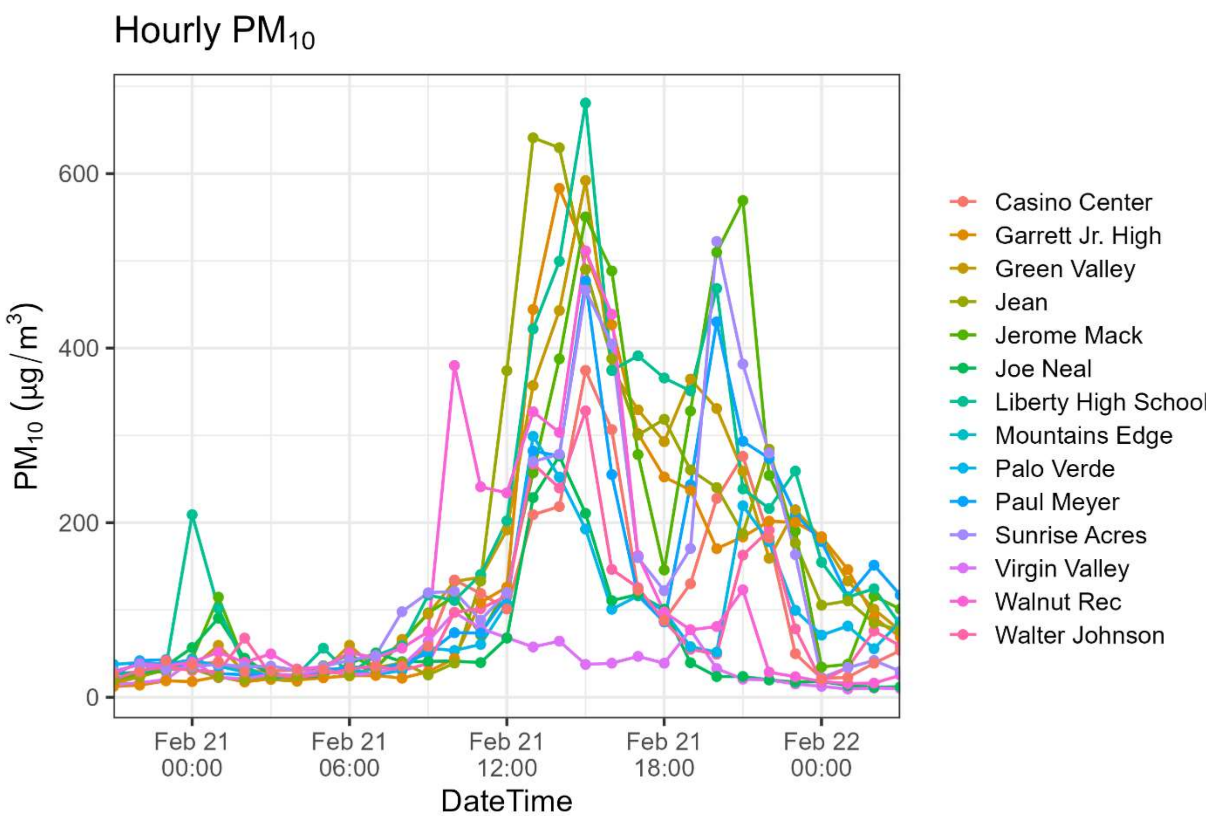


Figure 3.3-8. Hourly PM_{10} concentrations from all Clark County measurement sites on the event date, including regulatorily significant sites Green Valley, Jerome Mack, Liberty High School, and Sunrise Acres.

Figure 3.3-9 shows the measured hourly PM_{10} concentrations on February 21, 2022, together with the diurnal profile of the historical hourly data from 2018-2022 at sites with regulatory significance. On February 21, 2022, starting from 08:00 PST, the hourly PM_{10} began surpassing the 5-year 95th percentile. Peak values near 600 µg/m^3 were observed between 13:00 and 21:00 PST.

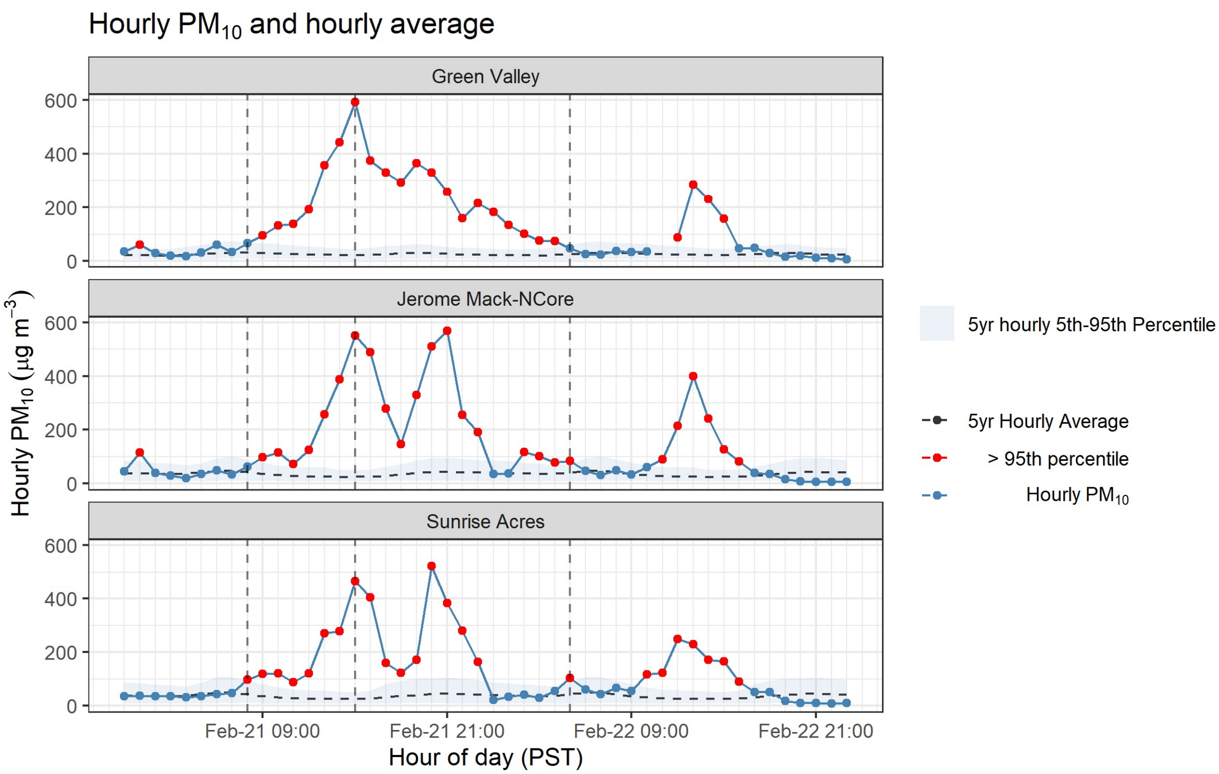


Figure 3.3-9. Measured hourly PM_{10} values compared to 5-year diurnal pattern. The dotted solid line represents the hourly PM_{10} values measured on the event day. The dashed line represents the mean hourly PM_{10} for each hour of the day from 2018-2022 at each site and the blue shaded area indicates the 5th - 95th percentile.

The 24-hour average PM_{10} values at all sites in Clark County before and after the exceedance event on February 21, 2022, remained mostly below the 99th percentile of the 5-year (2018-2022) historical values (Figure 3.3-10). On February 20, 2022, the 24-hour average PM_{10} values at all sites are below 50 µg/m^3. On February 21, 2022, the day of the exceedance, the 24-hour average PM_{10} values at 10 out of 12 sites met or exceeded the 99th percentile. PM_{10} concentrations at the Garrett Jr. High, Green Valley, Jean, Jerome Mack, Liberty High School, and Sunrise Acres sites exceeded the 24-hour PM_{10} NAAQS value of 150 µg/m^3. The simultaneous increase in PM_{10} concentrations at all sites, with most exceeding the 99th percentile threshold, indicates a regional source of PM_{10} such as a wind-blown dust event.

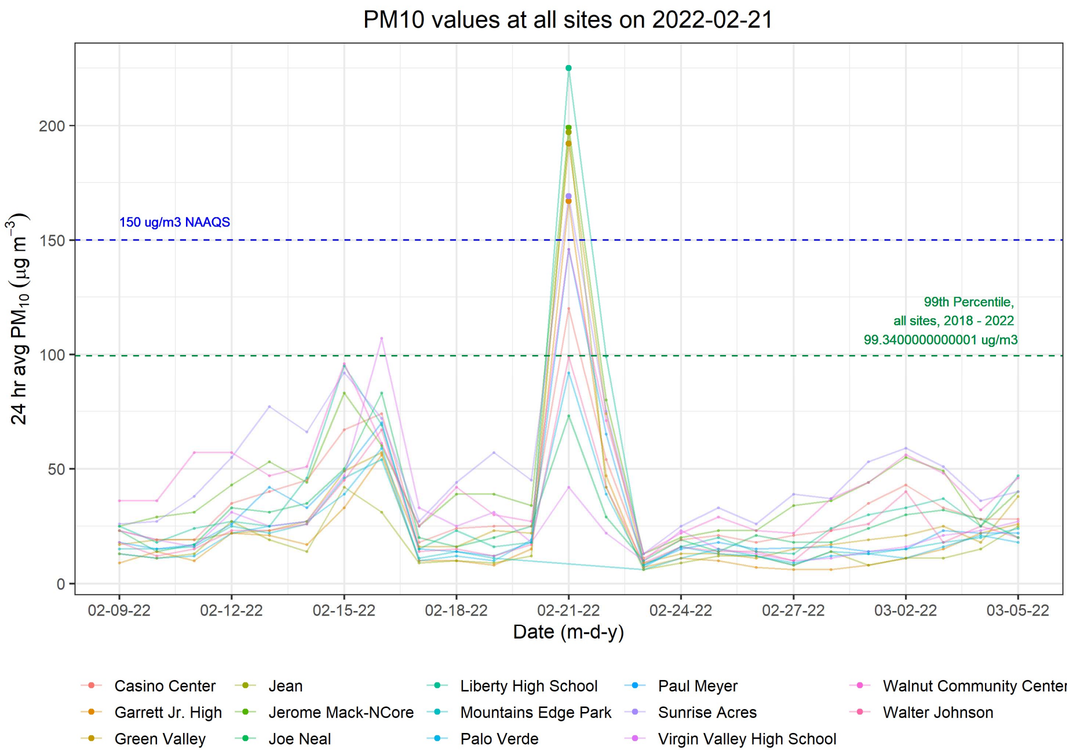


Figure 3.3-10. PM_{10} values at all Clark County, NV, measurement sites from February 9, 2022, to March 5, 2022, with NAAQS (blue dash) indicated. The green dashed line indicates the 99th percentile of 99.34 µg/m^3 of the 5-year historical values at these sites.

3.3.4 Particulate Matter Analysis

Before the suspected high-wind dust event on February 21, 2022, the hourly $PM_{2.5}/PM_{10}$ ratio was approximately average but mostly variable at all sites except for Jean based on 2018 – 2022 data (Figure 3.3-11). On February 21, 2022, the hourly $PM_{2.5}/PM_{10}$ ratio at all sites dropped to approximately 0.1 during late morning/midday and remained low for the remainder of the day. The low value of 0.1, which was at or below the 5th percentile of the 2018 – 2022 $PM_{2.5}/PM_{10}$ ratios at all sites, is consistent with values from dust events reported in studies (Jian et al., 2018). The decrease in the $PM_{2.5}/PM_{10}$ ratio observed during the late morning/midday is consistent with the increase in hourly PM_{10} concentrations as described in Section 3.2.2. This drop in $PM_{2.5}/PM_{10}$ ratios is indicative of a windblown dust event because manually entrained and transported dust particles are most likely to be in the PM_{10} (coarse + fine) mode rather than the $PM_{2.5}$ (fine) mode, causing the ratio of the two to drop.

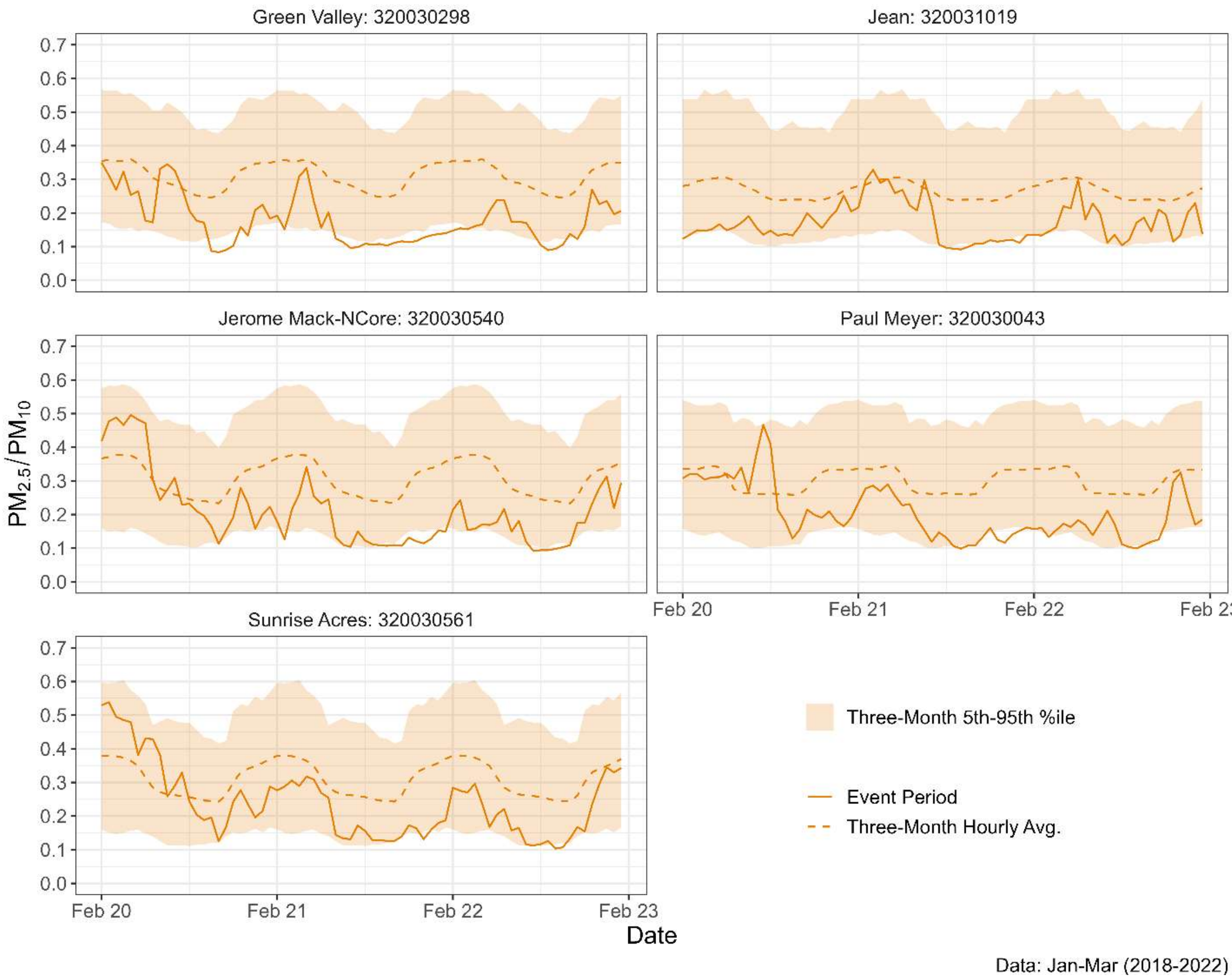


Figure 3.3-11. Ratio of $PM_{2.5}/PM_{10}$ concentrations before, during, and after the February 21, 2022, PM_{10} exceedance. The 5-year average $PM_{2.5}/PM_{10}$ diurnal ratio is displayed as a dotted line, and the 5th-95th percentile range is shown as a shaded ribbon. The 3-month hourly average and the 5th-95th percentile ratio is calculated across January – March (2018 – 2022).

3.3.5 Visibility/Ground-Based Images

Concurrent with the increasing wind speeds and the estimated time of frontal passage, visibility at LAS decreased at 12:00 PST and remained low until 18:00 PST, after which a subsequent drop occurred and lasted through midnight (Figure 3.3-12). This is confirmed by camera images in the Las Vegas Valley (Figure 3.3-13 through Figure 3.3-18), which show a drastic reduction in visibility between 11:00 and 13:00 PST. Additionally, the dust plume can be observed in the distance PM_{10} concentrations started to rise at 11:00 PST and reached an initial peak in Clark County at 13:00 PST. Dusty conditions and low visibility persisted through 16:00 PST. Images shown in this section end at 16:00 due to the limitations of photography in low-light conditions near and after sunset.

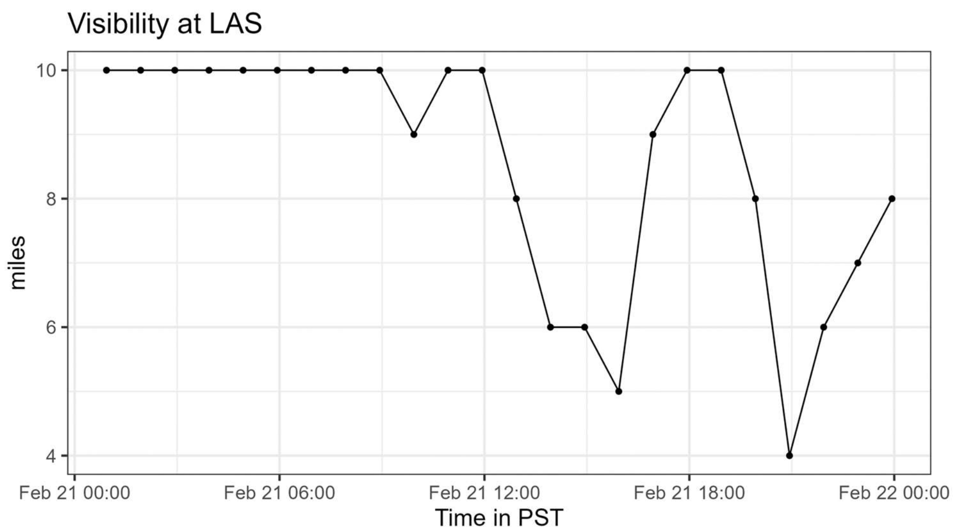


Figure 3.3-12. Visibility in miles on February 21, 2022, recorded at Harry Reid International Airport. Visibility data was sourced from the Iowa Environmental Mesonet (https://mesonet.agron.iastate.edu/).

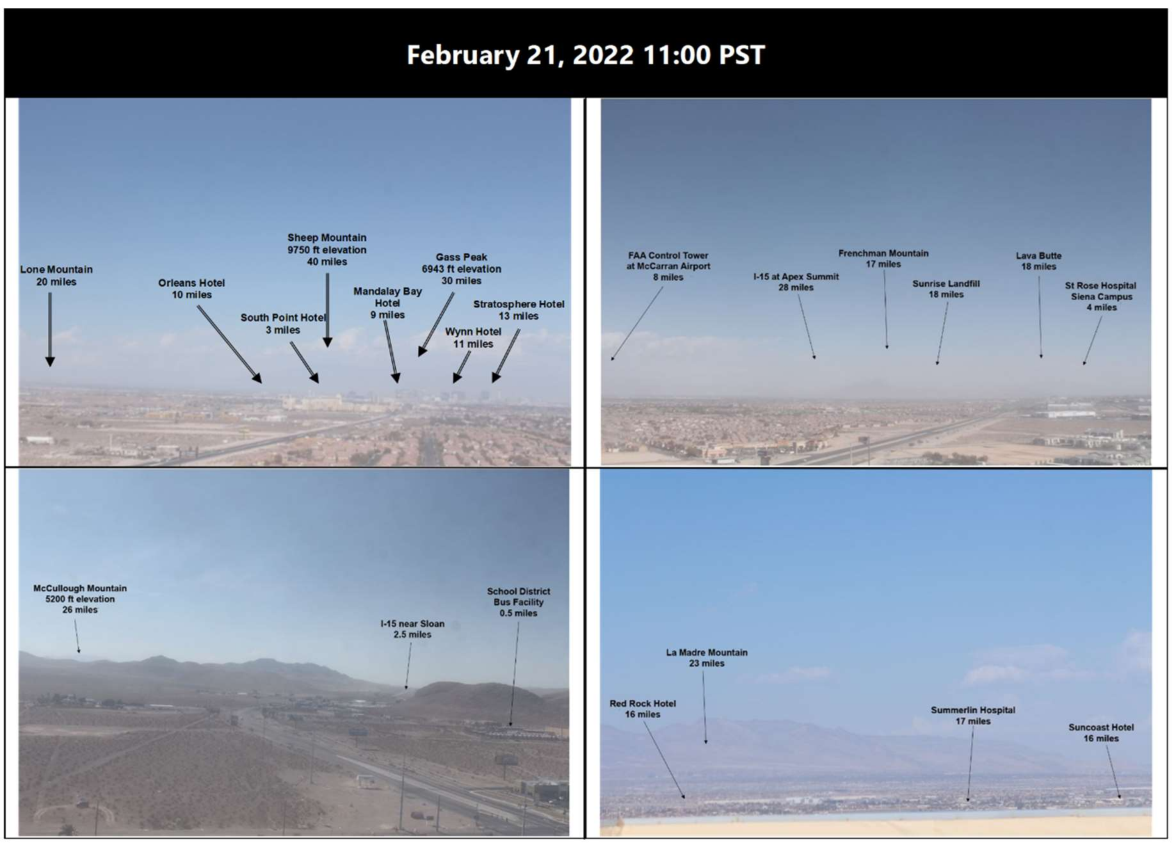


Figure 3.3-13. Camera images for N, NE, S, and NW (top left, top right, bottom left, and bottom right) directions from Clark County, NV, on February 21, 2022, at 11:00 PST.

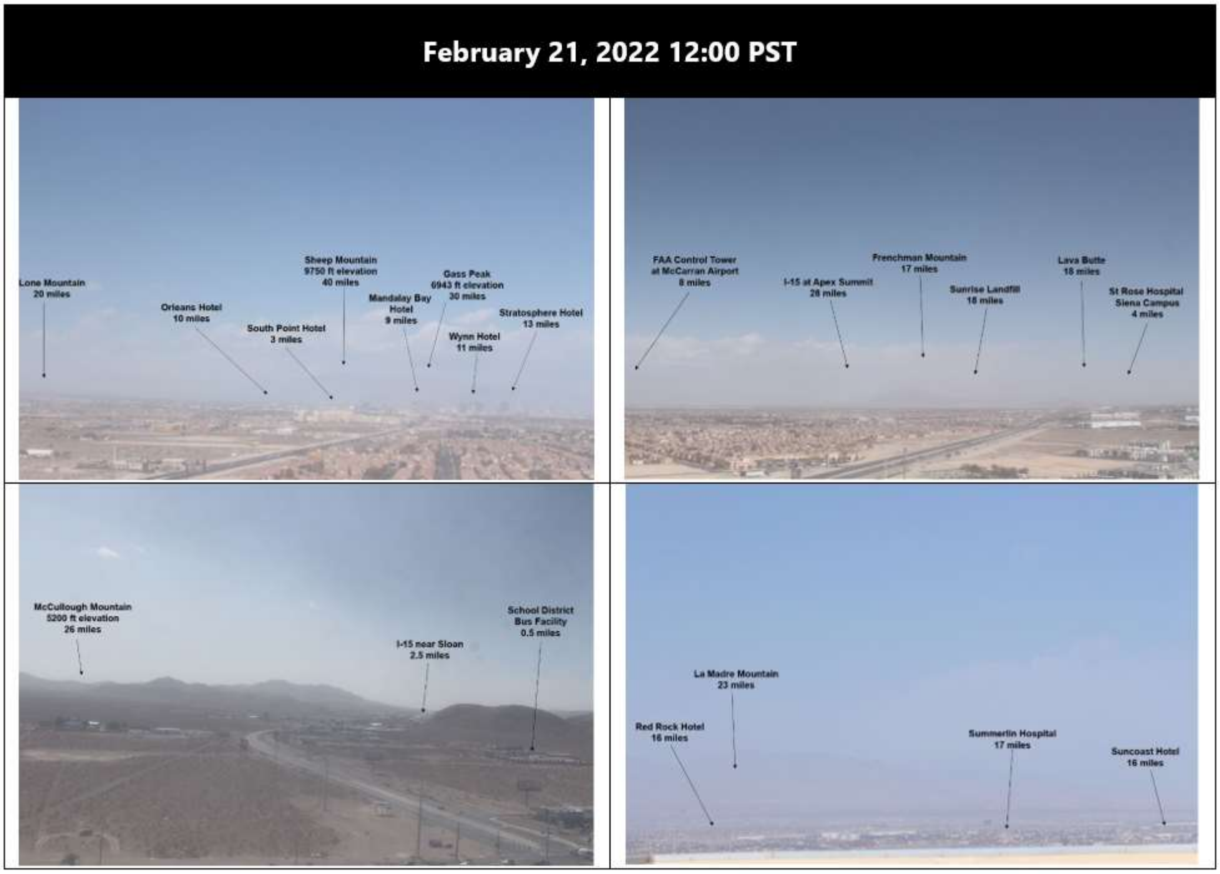


Figure 3.3-14. Camera images for N, NE, S, and NW (top left, top right, bottom left, and bottom right) directions from Clark County, NV, on February 21, 2022, at 12:00 PST.

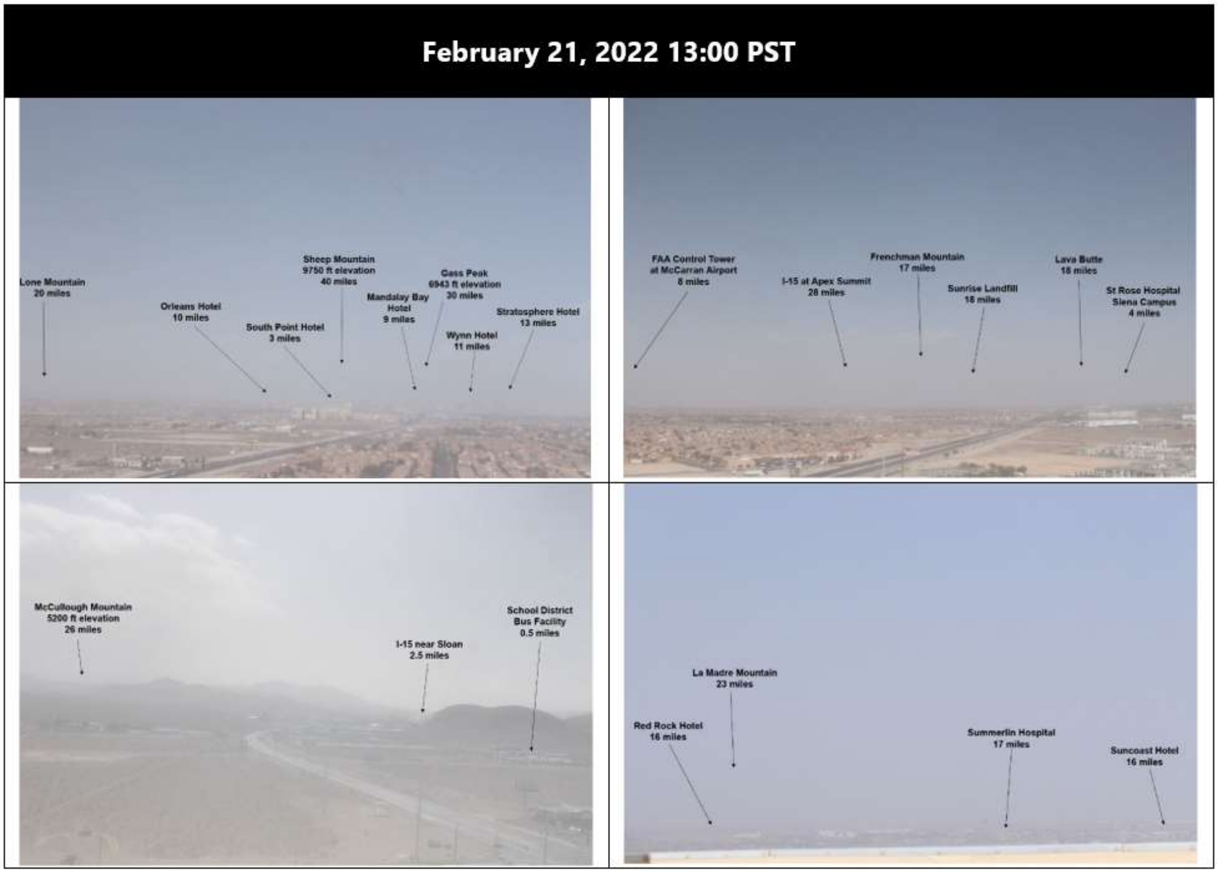


Figure 3.3-15. Camera images for N, NE, S, and NW (top left, top right, bottom left, and bottom right) directions from Clark County, NV, on February 21, 2022, at 13:00 PST.

Figure 3.3-16. Camera images for N, NE, S, and NW (top left, top right, bottom left, and bottom right) directions from Clark County, NV, on February 21, 2022, at 14:00 PST.

Figure 3.3-17. Camera images for N, NE, S, and NW (top left, top right, bottom left, and bottom right) directions from Clark County, NV, on February 21, 2022, at 15:00 PST.

Figure 3.3-18. Camera images for N, NE, S, and NW (top left, top right, bottom left, and bottom right) directions from Clark County, NV, on February 21, 2022, at 16:00 PST.

Overall, we find overwhelming evidence that PM_{10} was transported from the Mojave Desert in southeastern California to Clark County by approximately 11:00-13:00 PST on February 21, 2022. PM_{10} concentrations increased along with the frontal passage that entered the Clark County area at approximately 11:00 PST, and peaked around 13:00-15:00 PST on February 21. 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 at all PM_{10} monitoring sites in Clark County; (3) a drop in $PM_{2.5}/PM_{10}$ values indicating windblown dust sources; (4) decreased visibility at the Las Vegas 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 February 21, 2022. 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 February 21, 2022 ranked above the 99th percentile of all the concentrations observed in the 5-year period from 2018-2022 at all sites that exceeded the NAAQS (Table 3.4-1).

Table 3.4-1. Five-year (2018-2022) rank and percentile of PM_{10} values on February 21, 2022, at affected sites. Garrett Jr. High and Liberty High School data collection began spring 2021, and data represented starts from that point.

Date	Site	Rank	Percentile	24-hour PM_{10} (µg/m^3)
2/21/2022	Garrett Jr. High	4	99.53	167
2/21/2022	Green Valley	7	99.67	192
2/21/2022	Jean	4	99.83	197
2/21/2022	Jerome Mack	7	99.66	199
2/21/2022	Liberty High School	5	99.34	225
2/21/2022	Sunrise Acres	7	99.67	169

An annual time series of 24-hour average PM_{10} concentrations for each affected site is provided in Figure 3.4-1 through Figure 3.4-6. February 21, 2022, is marked by a red point for comparison to the 150 µg/m^3 NAAQS threshold (blue line) and the 5-year (2018-2022) 99th percentile (green line) described in Table 2.2-1 (note that data only dates back to spring 2021 for the Garrett Jr. High and Liberty High School sites). At all sites, observations on February 21 were above the 5-year 99th percentile.

A 5-year time series of 24-hour average PM_{10} concentrations for each affected site is provided in Figure 3.4-7 through Figure 3.4-12 to 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 February 21, 2022. Days which 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 5-year time series figures at all sites.

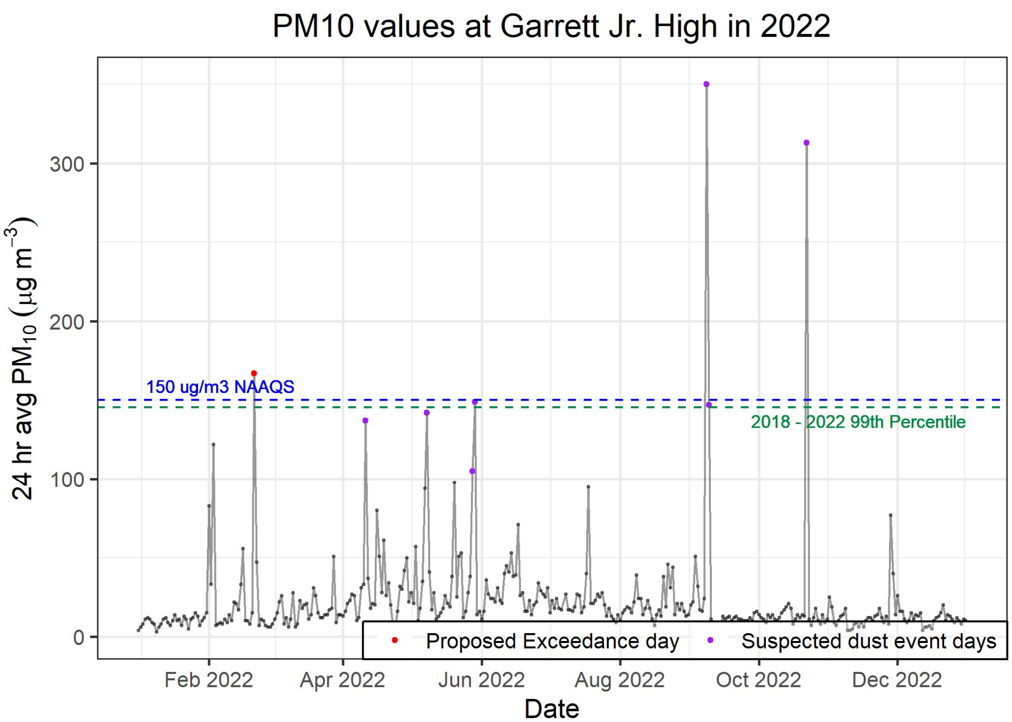


Figure 3.4-1. Garrett Jr. High 24-hour PM_{10} measurement in μg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

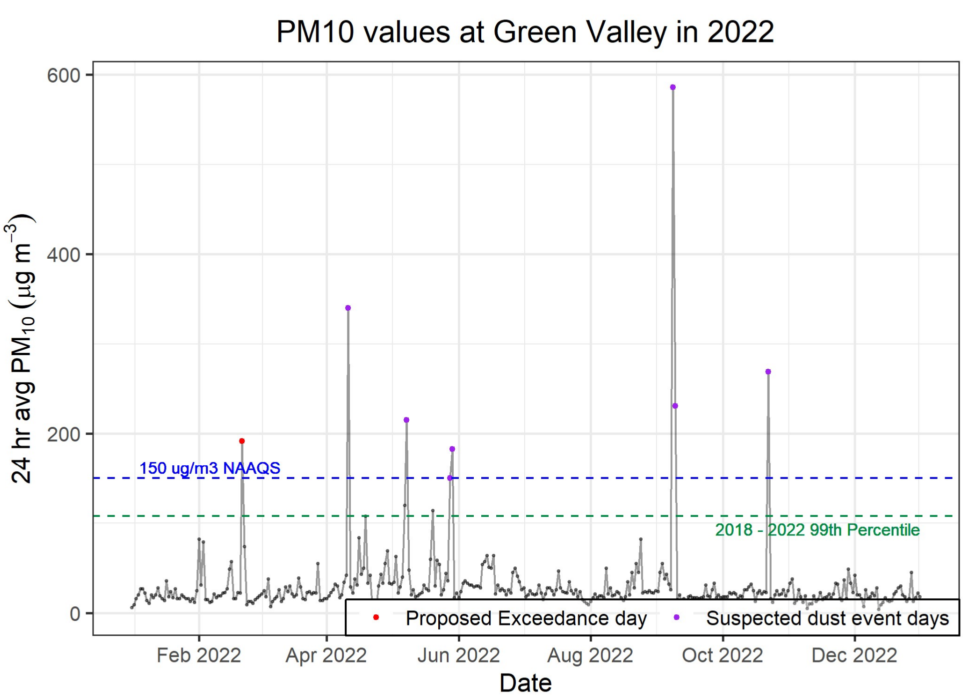


Figure 3.4-2. Green Valley 24-hour PM_{10} measurement in μg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

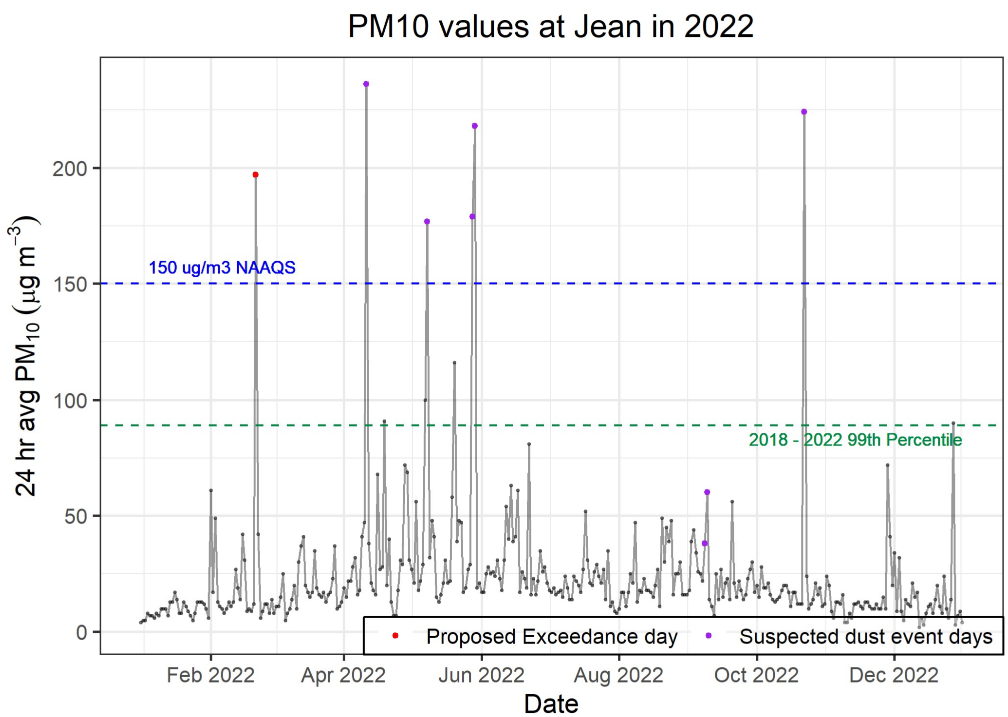


Figure 3.4-3. Jean 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

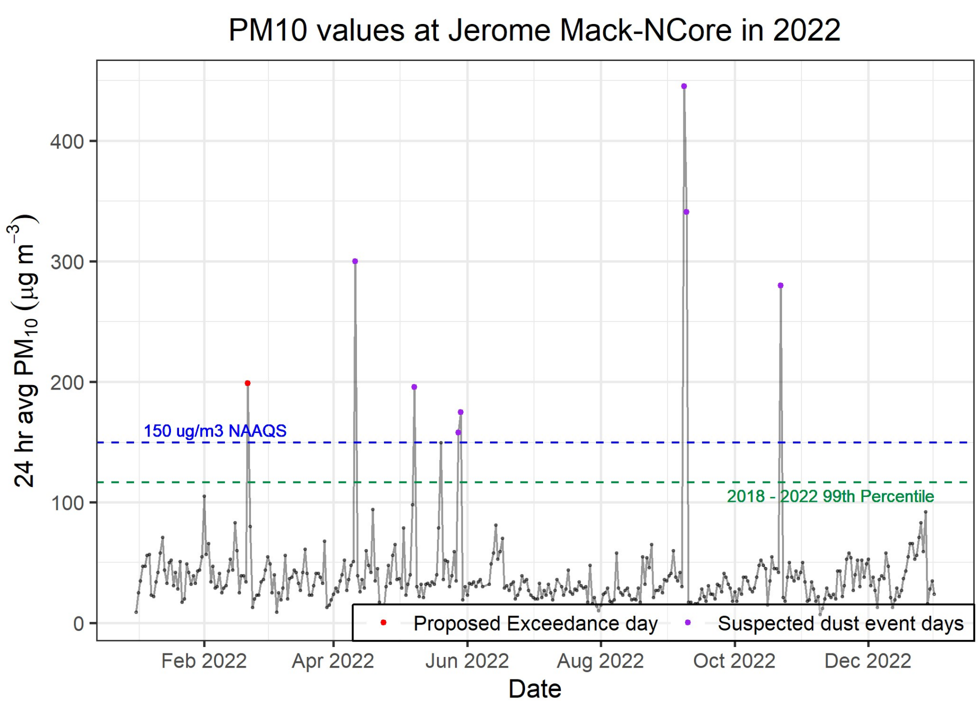


Figure 3.4-4. Jerome Mack 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

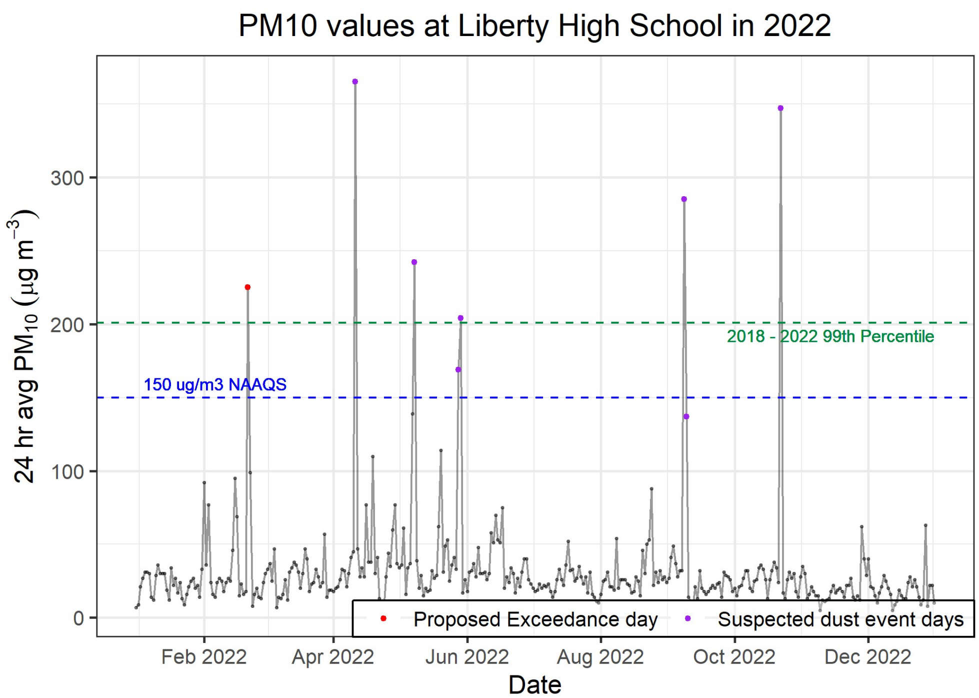


Figure 3.4-5. Liberty High School 24-hour PM_{10} measurement in $\mu g/m^3$ for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

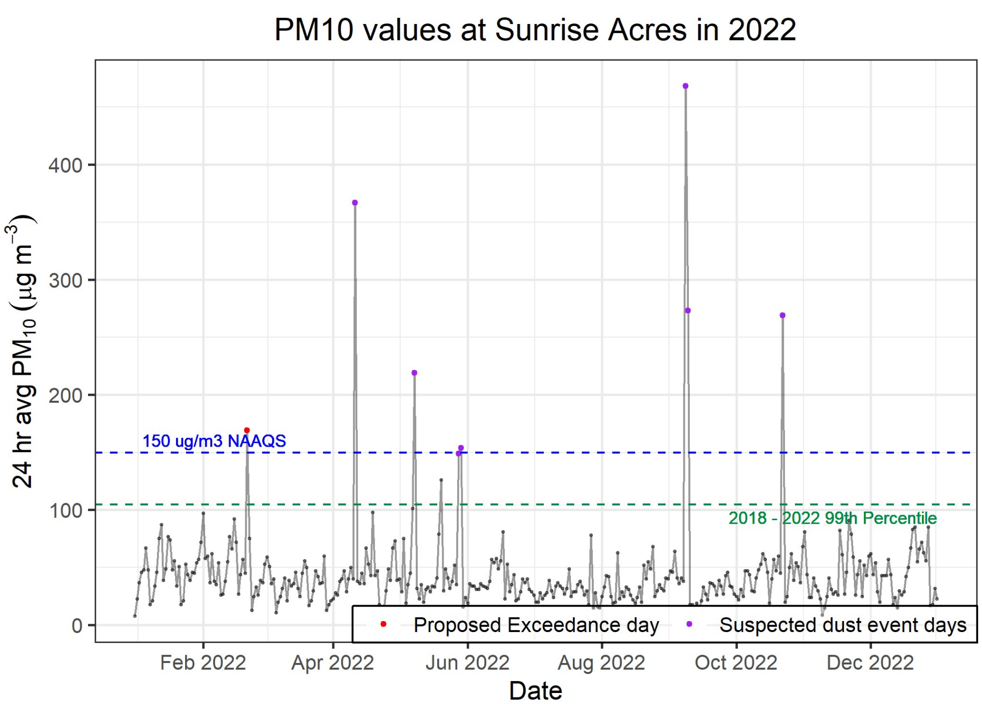


Figure 3.4-6. Sunrise Acres 24-hour PM_{10} measurement in $\mu g/m^3$ for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

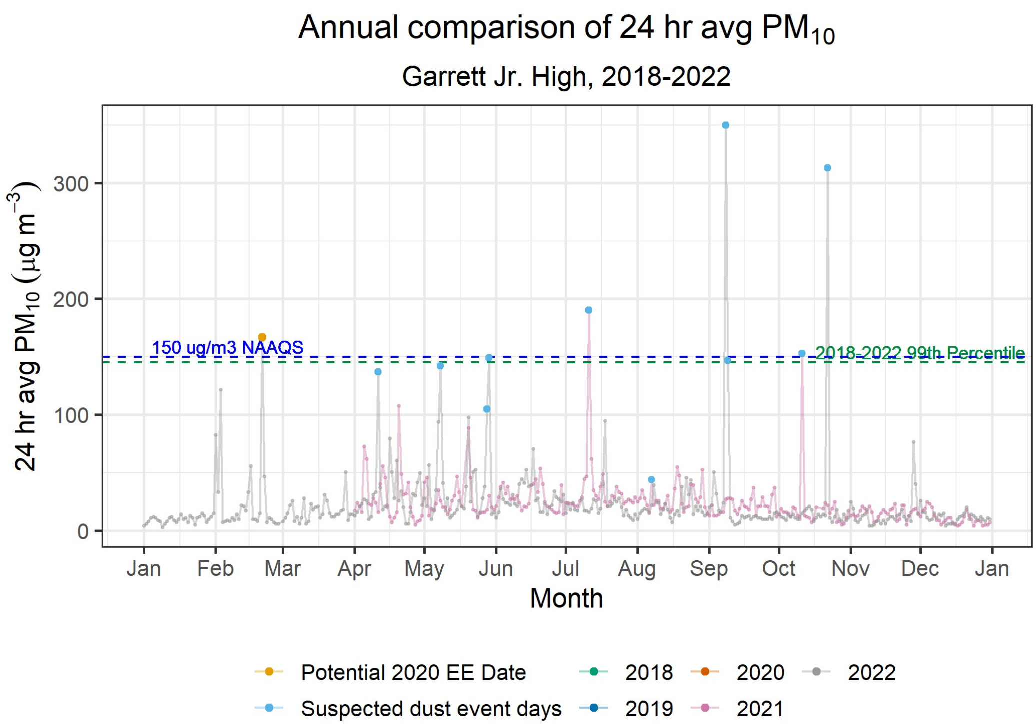


Figure 3.4-7. Garrett Jr. High 24-hour PM_{10} measurements in µg/m³ from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

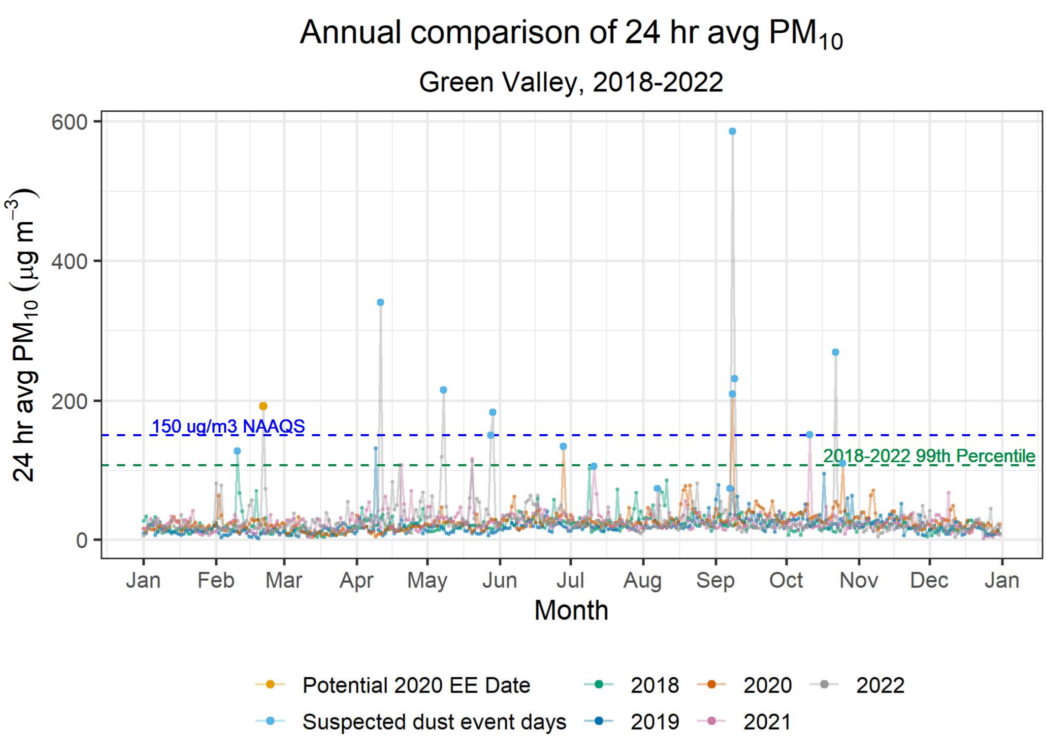


Figure 3.4-8. Green Valley 24-hour PM_{10} measurements in µg/m³ from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

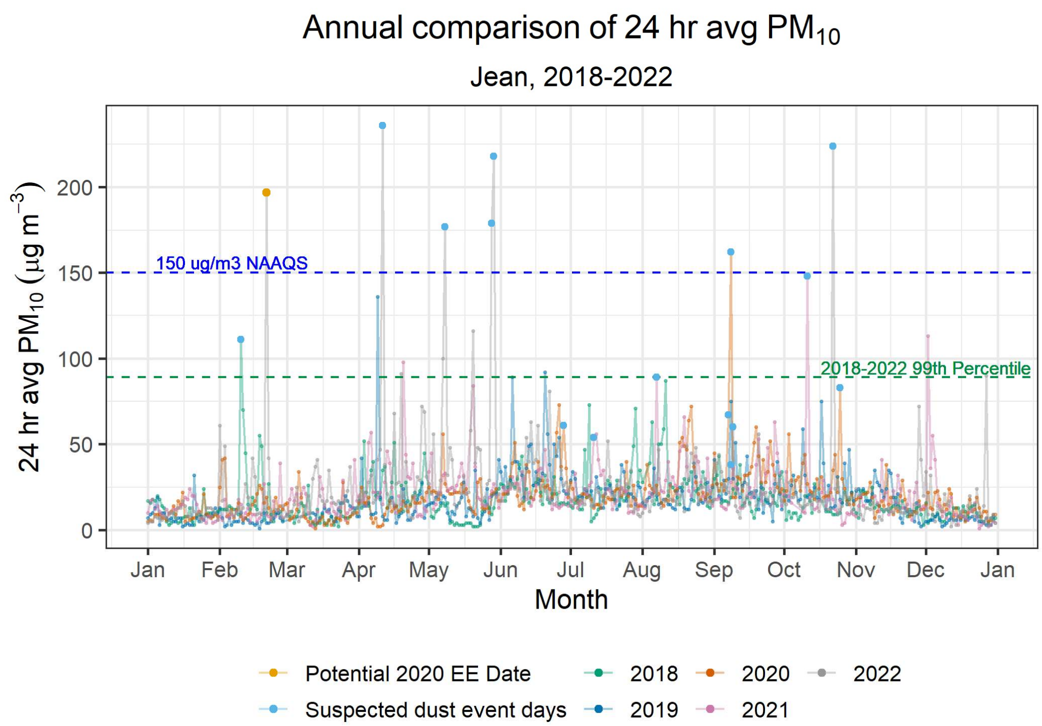


Figure 3.4-9. Jean 24-hour PM_{10} measurements in μg/m^3 from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

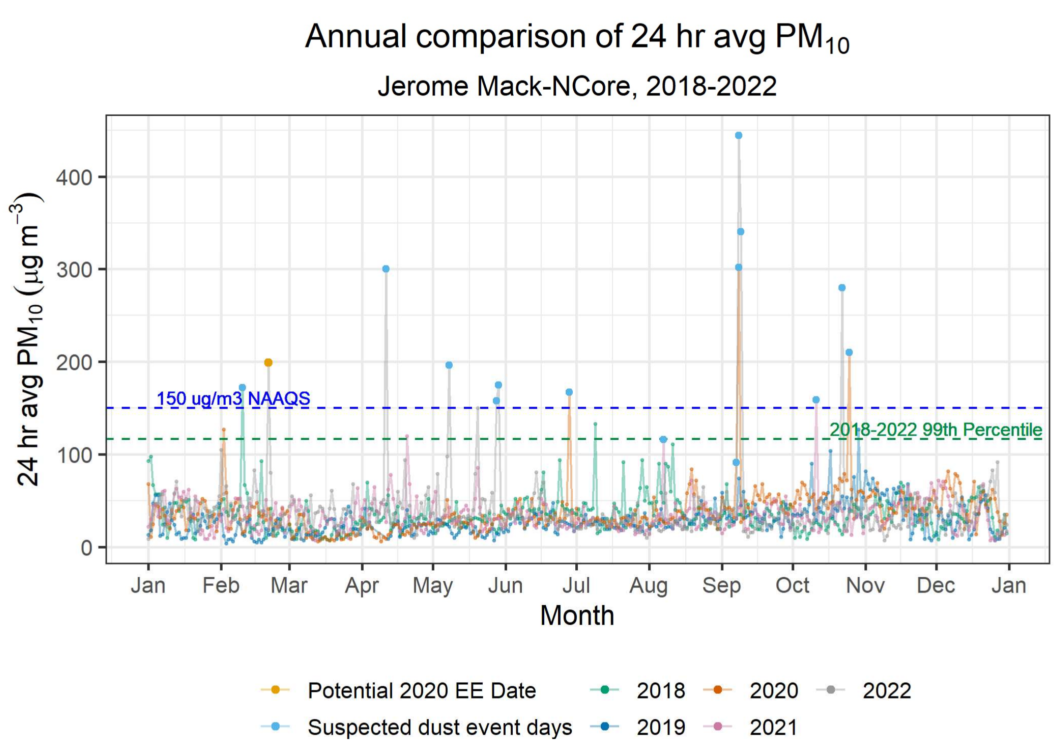


Figure 3.4-10. Jerome Mack 24-hour PM_{10} measurements in μg/m^3 from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

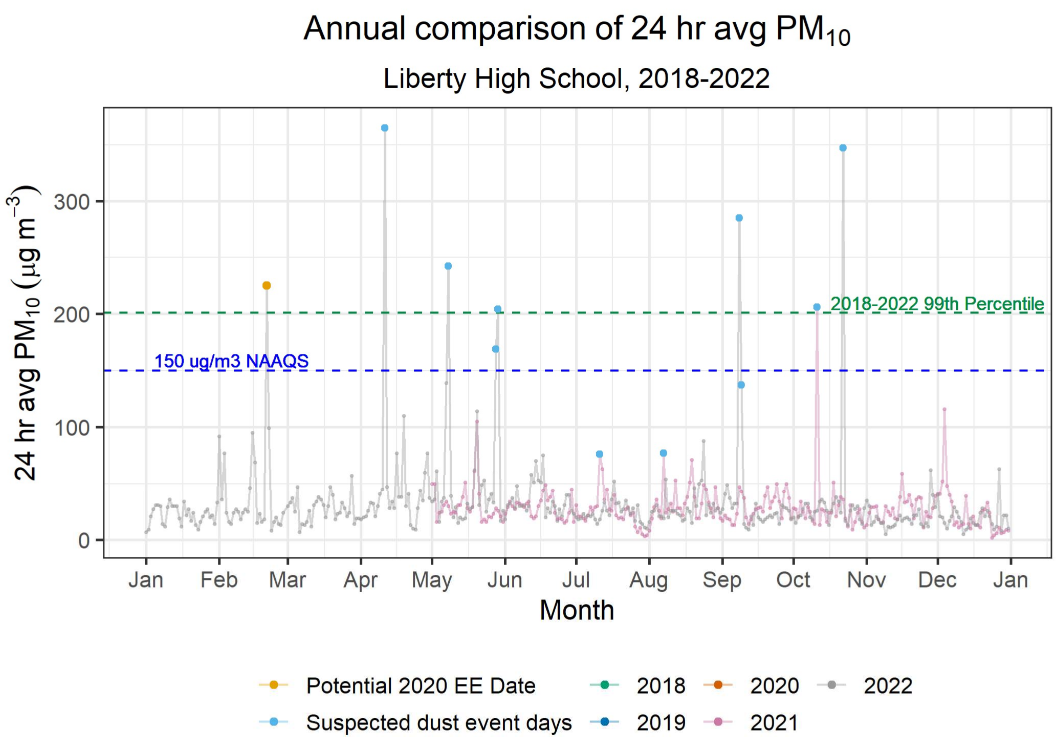


Figure 3.4-11. Liberty High School 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

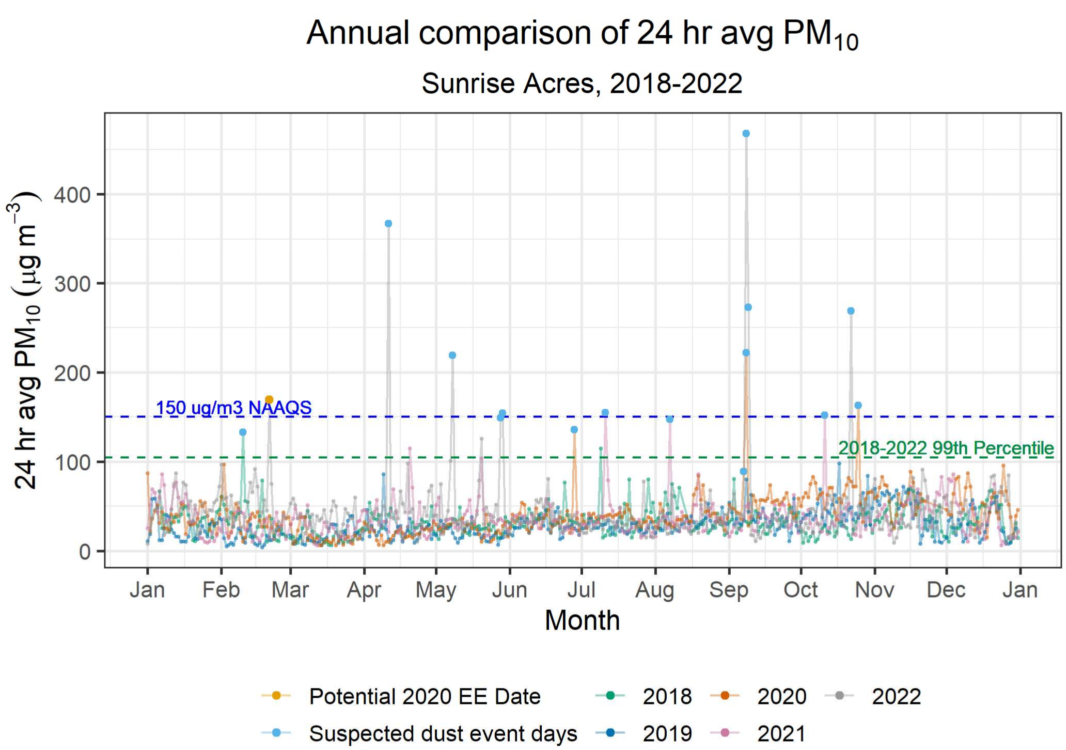


Figure 3.4-12. Sunrise Acres 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

3.4.2 Event Comparison with Diurnal/Seasonal Patterns

The 24-hour average PM_{10} concentrations were compared to 5-year (2018-2022) monthly and seasonal averages are shown in boxplots in **Figure 3.4-13 and Figure 3.4-14.** The lower (25th percentile) and upper (75th percentile) edges of the boxes correspond to the interquartile range, 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 February 21, 2022, are shown to be the highest recorded outliers for February and winter during the entire 5-year period.

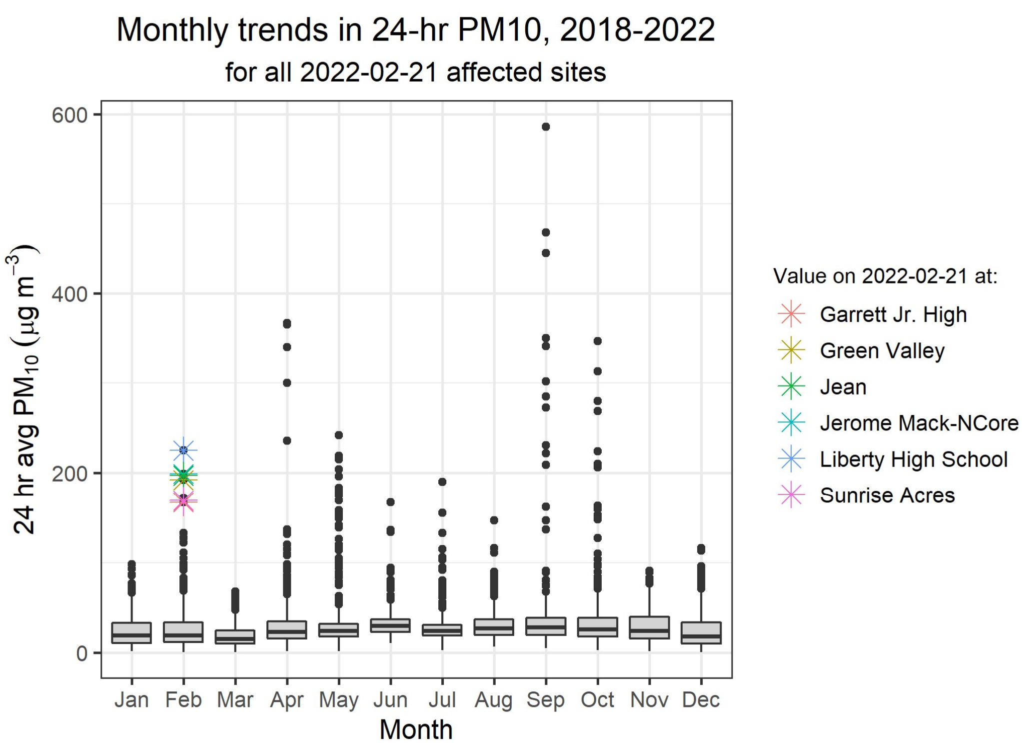


Figure 3.4-13. Monthly trend in 24-hour PM_{10} for 2018-2022, including outliers and highlighting the potential exceedance event day.

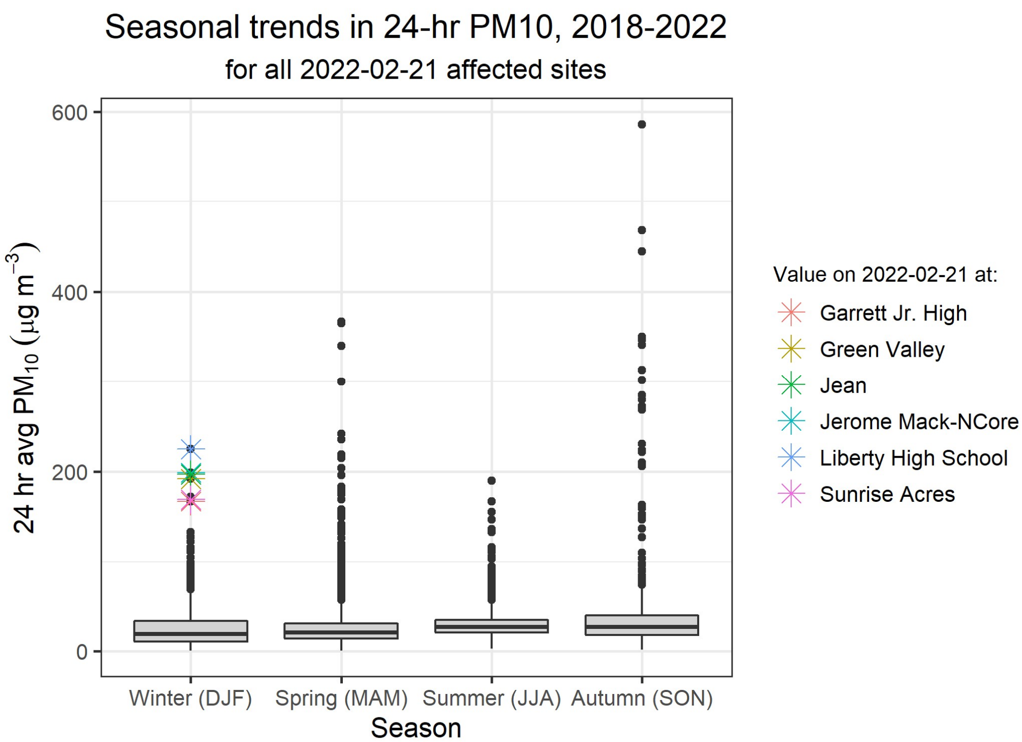


Figure 3.4-14. Seasonal trend in 24-hour PM_{10} for 2018-2022, including outliers and highlighting the potential exceedance event day.

The hourly PM_{10} concentrations were also compared to 5-year (2018-2022) hourly averages. A summary of the maximum value observed compared to the 5-year (2018-2022) 95th percentile is shown in Table 3.4-2, and time series are shown in Figure 3.4-15 through Figure 3.4-19. At the Green Valley site, for example, the hourly PM_{10} concentration reached a maximum of 592 μg/m^3 at 15:00 PST, which is 13 times the 5-year 95th percentile of 46 μg/m^3. Similar trends were seen across the other sites.

Table 3.4-2. Summary of max hourly PM_{10} measurements on February 21, 2022, compared to 5-year hourly PM_{10} 95th percentile.

Site Name	Time of hourly PM_{10} max (PST)	Hourly PM_{10} (μg/m^3)	5-year hourly PM_{10} 95th percentile (μg/m^3)	Hourly/5-year 95th percentile
Green Valley	15:00	592	46	13
Liberty High School	15:00	681	60	11
Jerome Mack	21:00	569	96	6
Sunrise Acres	20:00	522	102	5
Jean	13:00	641	51	13

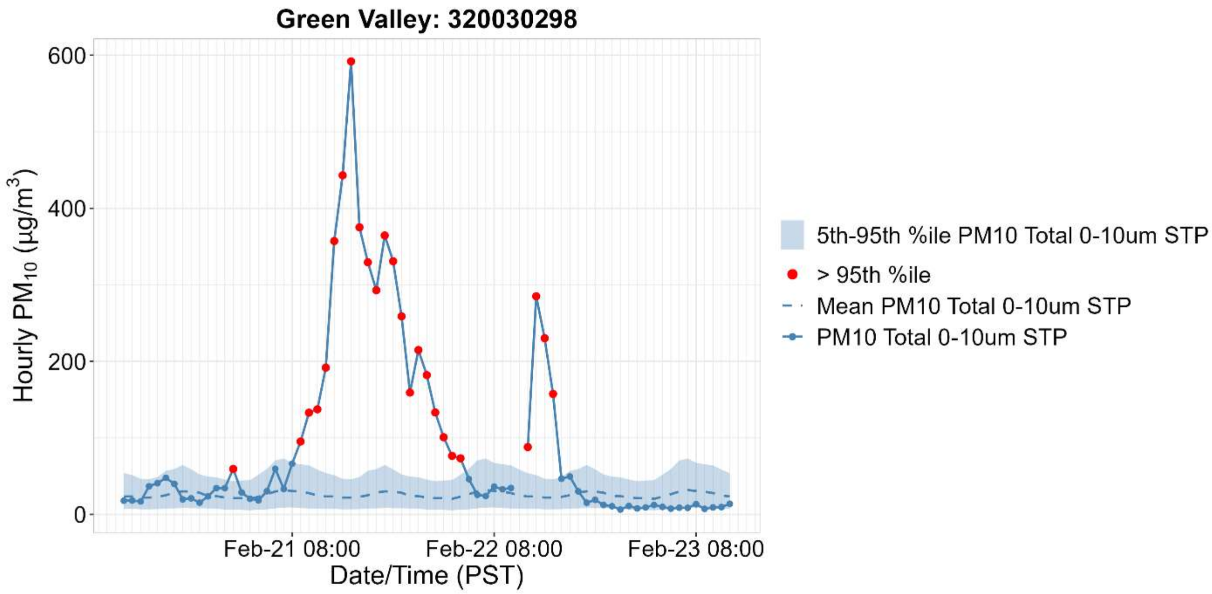


Figure 3.4-15. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th - 95th percentile (shaded area) hourly PM_{10} at Green Valley from 2018-2022.

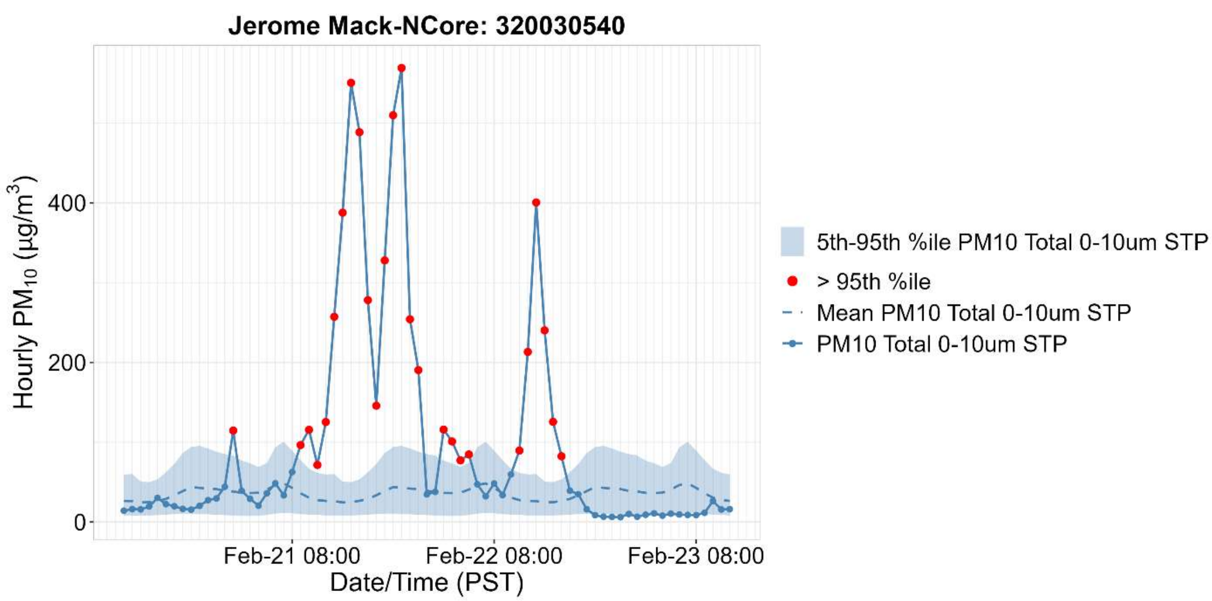


Figure 3.4-16. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th - 95th percentile (shaded area) hourly PM_{10} at Jerome Mack from 2018-2022.

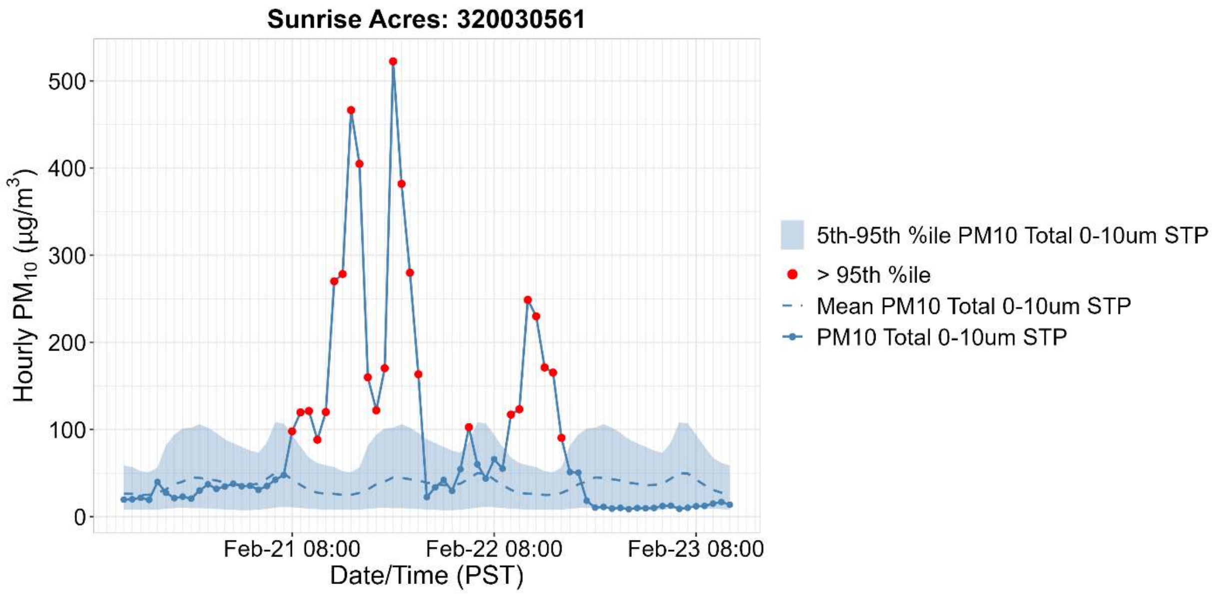


Figure 3.4-17. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th - 95th percentile (shaded area) hourly PM_{10} at Sunrise Acres from 2018-2022.

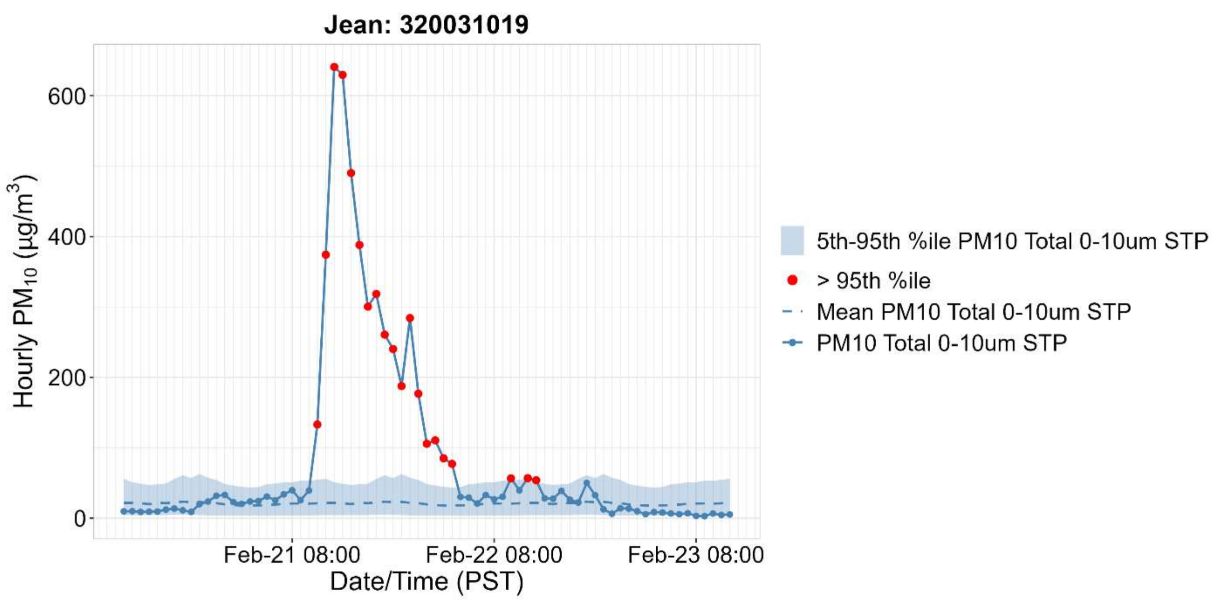


Figure 3.4-18. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th - 95th percentile (shaded area) hourly PM_{10} at Jean from 2018-2022.

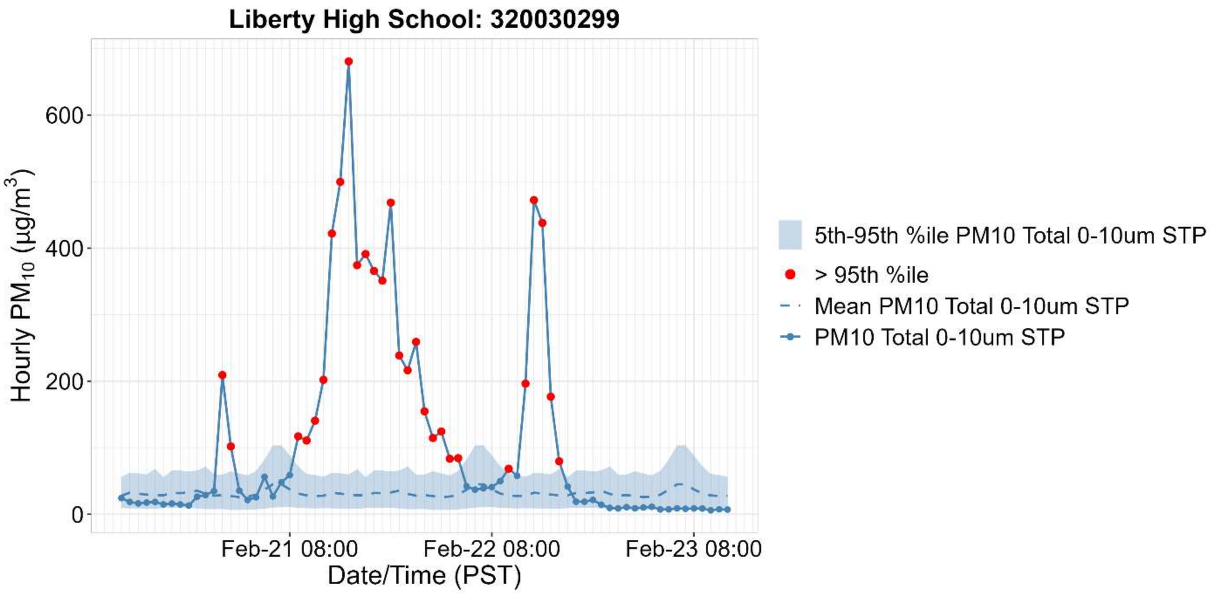


Figure 3.4-19. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th - 95th percentile (shaded area) hourly PM_{10} at Liberty High School from 2018-2022.

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. Temperature, volumetric soil moisture, and maximum wind speed 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 shows the seasonal December-January-February 30-year average for each variable in the top panel and the event date departure from the seasonal climatology in the bottom panel. Figure 3.4-20 shows the climatology compared with the event date for the source region. On the event date the source region is experiencing ground level temperatures at or greater than 15 °F above the long-term average, considerably lower than normal soil moisture, and max ground level wind speeds were well above average. Figure 3.4-21 shows the climatology compared with the event date for Clark County. On the event date, Clark County was experiencing ground level temperatures greater than 20 °F above the long-term average, lower than normal soil moisture, and max ground level wind speeds exceeding 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.

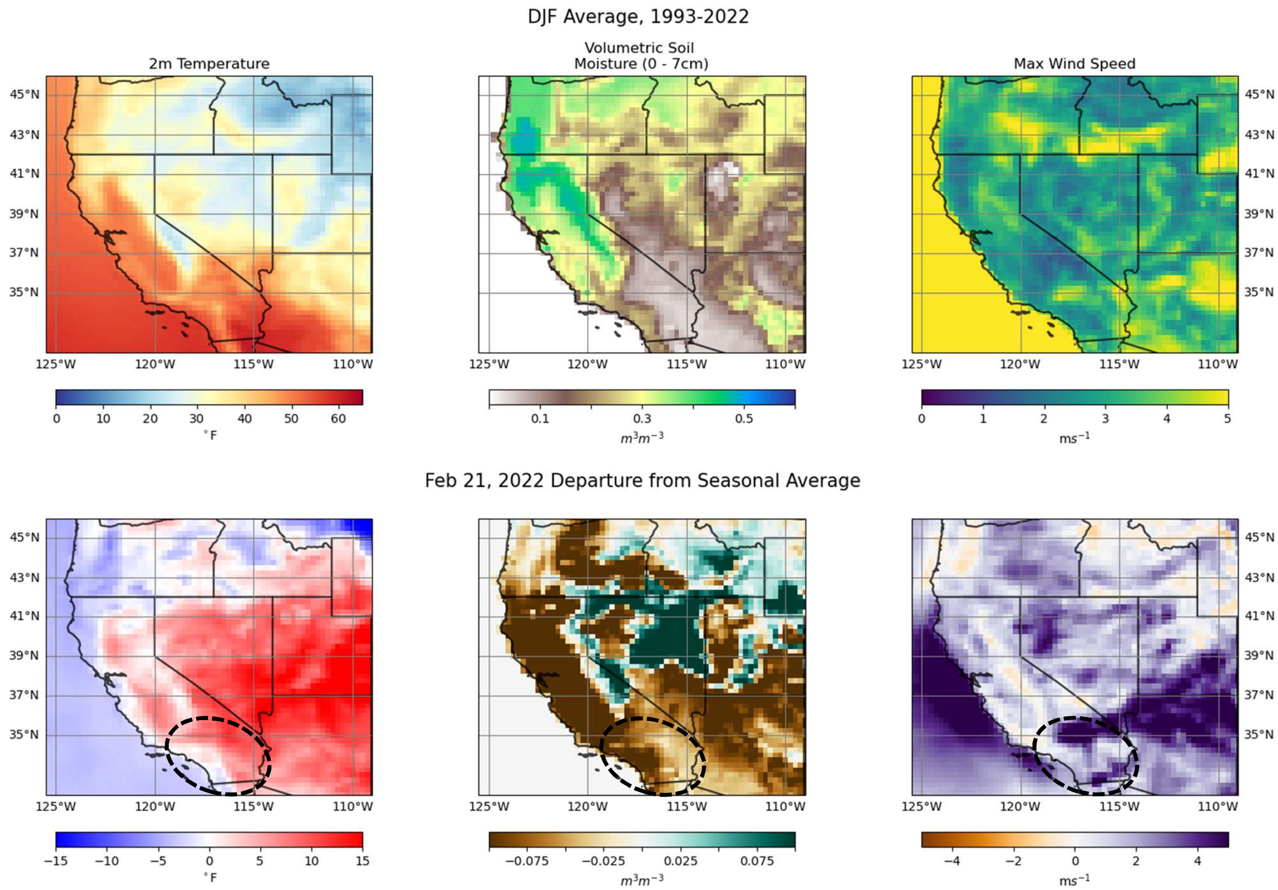


Figure 3.4-20. The 30-year December-February seasonal climatological average based on ERA5 reanalysis for 2-meter temperature, volumetric soil moisture of the first 7 centimeters, and maximum 10-meter wind speed (top row) and the daily departure for February 21, 2022, from the 30-year average (bottom row). The source region is circled.

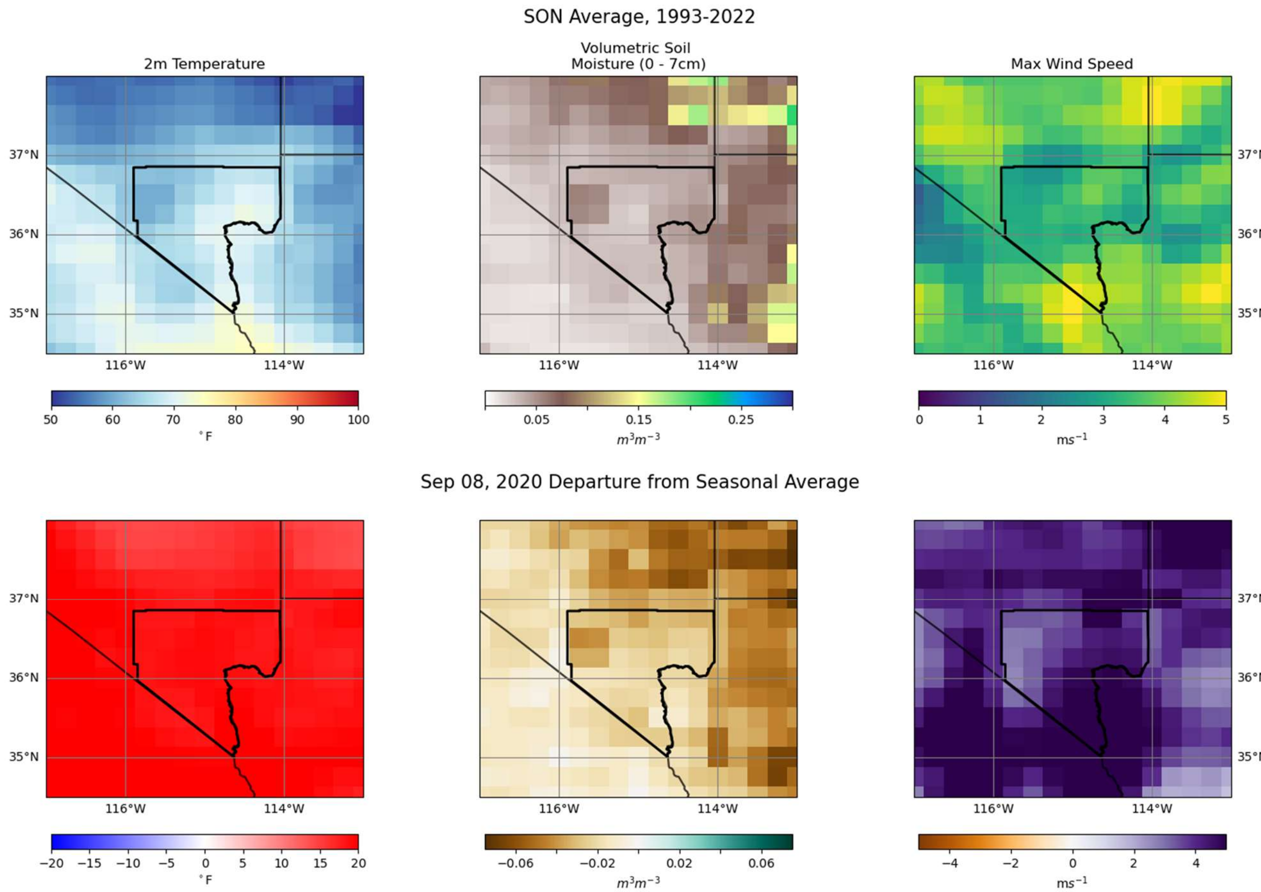


Figure 3.4-21. The 30-year December-February seasonal climatological average for Clark County based on ERA5 reanalysis for 2-meter temperature, volumetric soil moisture of the first 7 centimeters, and maximum 10-meter wind speed (top row) and the daily departure for February 21, 2022, from the 30-year average (bottom row). Clark County is outlined in black.

Overall, we find overwhelming evidence that the February 21, 2022, high-wind dust event in Clark County was well outside normal conditions, which suggests 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) 30-year climatology 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 February 21, 2022, created prime conditions to maintain the suspension of fine dust particles in the air in the midst of regional drought. The sustained wind speed was near or above 20 mph for the 7-hour period between 09:00

PST and 16:00 PST, and many wind gusts greater than 35 mph were recorded. The maximum gust for the day reached 43 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 February 21, 2022, during peak wind gusts.

The following sections compare surface-level wind and visibility on February 21, 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_{10} concentrations show key differences between each comparable wind event and the event date, February 21, 2022. All dates in the years 2016-2020 were considered when identifying days with a wind event comparable to the event date. Three criteria descriptive of the magnitude and length of the wind event on February 21, 2022, were applied to identify comparable dates: (1) seven or more hourly-reported wind speed observations >19 mph, (2) nine or more wind gusts >35 mph, and (3) peak daily wind gust ≥43 mph. Additionally, dates were filtered to those without enhanced PM_{10} (<100 µg/m^3) at monitors in Clark County. Seventeen dates were identified as comparable wind events without high PM_{10} concentrations, and the four closest in time to the event period are listed in Table 3.5-1 and examined in detail.

Table 3.5-1. Similar meteorological event days without enhanced PM_{10} concentrations identified by days with seven wind speed observations >19 mph, nine wind gusts >35 mph, and a peak wind gust ≥43 mph. PM_{10} concentrations are reported at Jerome Mack (JM), Green Valley (GV), Jean (J), Sunrise Acres (SA), and Garrett Jr. High (GJH).

			Daily PM_{10} (µg/m^3)				
Date	Daily Wind Speed (mph)	Peak Wind Gust (mph)	JM	GV	J	SA	GJH
2022-02-21 (event date)	13	43	199	192	197	169	167
2022-02-02	14	43	57	31	17	58	33
2022-03-10	16	49	56	26	20	41	28
2022-03-20	17	62	41	29	19	50	26
2022-04-21	17	44	45	42	40	47	34

A key condition that distinguished the event date from all identified comparable dates is low-altitude transport of air into the region that facilitated entrainment of dust from the source region along the course of travel. Air transport into Clark County on all comparable dates occurred at high altitudes, hindering surface-level transport from bare-ground sources of dust surrounding Las Vegas.

A specific comparison between February 21, 2022, and the closest comparable date, February 2, 2022, is outlined below. Comparisons between the event date the other similar dates can be found in **Appendix B**. **Figure 3.5-1, Figure 3.5-2, and Figure 3.5-3** below compare surface-level wind and visibility conditions on the event date and February 2, 2022. The wind profile on February 2, 2022, closely matches the intensity of winds experienced on the event date, with multiple wind gusts exceeding 40 mph and sustained winds exceeding 20 mph for most of the prolonged period between 08:00 and 17:00 (Figure 3.5-1). Figure 3.5-2 shows that the highest wind speeds were between 20 and 30 mph, and came from the southwest on the event date and the north on February 2. On February 2, visibility remained at the maximum value of 10 miles throughout the day (Figure 3.5-3). The maintenance of high visibility on February 2 confirms that the high-wind event did not dramatically affect levels of suspended dust particles, a claim supported by the fact that daily PM_{10} concentration was relatively low (<60 µg/m^3) at all examined sites. In contrast, visibility on the event date reached a minimum of 4 miles during peak winds. **Figure 3.5-4** compares 24-hour HYSPLIT back-trajectories from Las Vegas ending at 13:00 PST (21:00 UTC) on February 21, 2022, at the beginning of the event period, and 10:00 PST (18:00 UTC) on February 2, 2022, when PM_{10} concentrations were at a daily maximum. On the event date, near-surface transport toward Las Vegas occurred with trajectory paths below 200 m in altitude. This facilitated entrainment and transport of dust from the source region into Las Vegas. On February 2, 2022, the transport paths towards Las Vegas occurred at high altitudes greater than 500 m, inhibiting surface-level transport from dust sources surrounding Las Vegas. This key difference may account for the discrepancy in daily PM_{10} concentrations between February 2 and February 22, 2022, under comparable wind conditions.

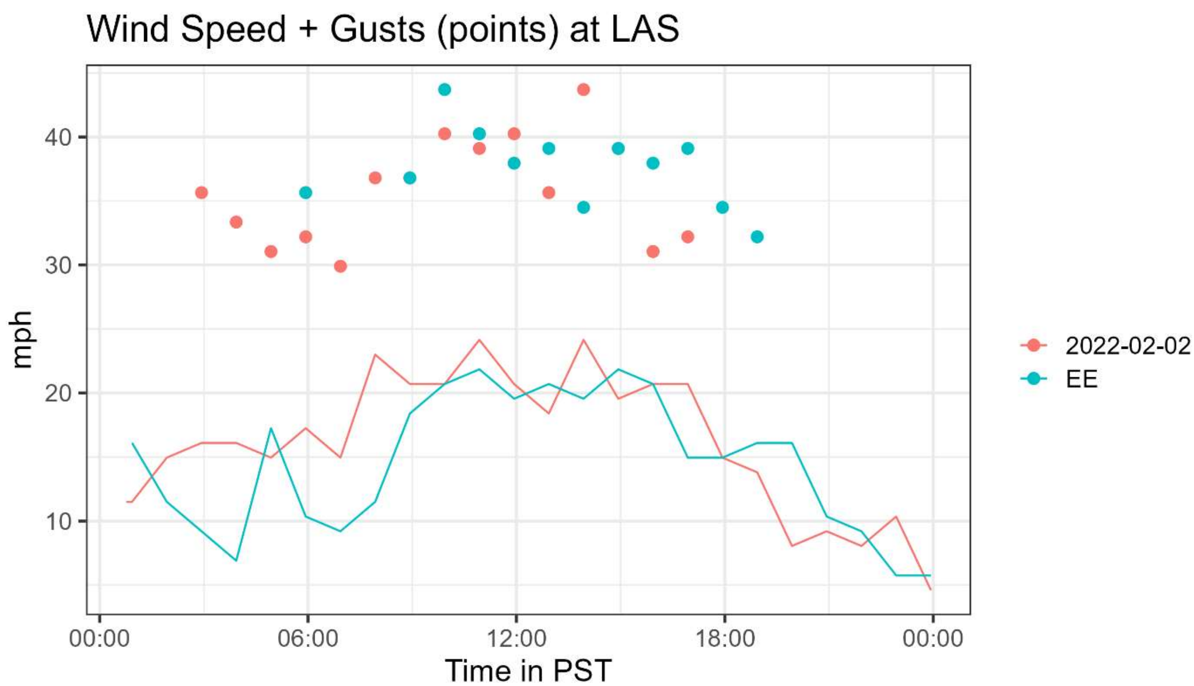


Figure 3.5-1. Wind speed and maximum hourly wind gust in mph at LAS for February 2, 2022 (pink), and the February 21, 2022, suspected exceptional event (EE) day (teal).

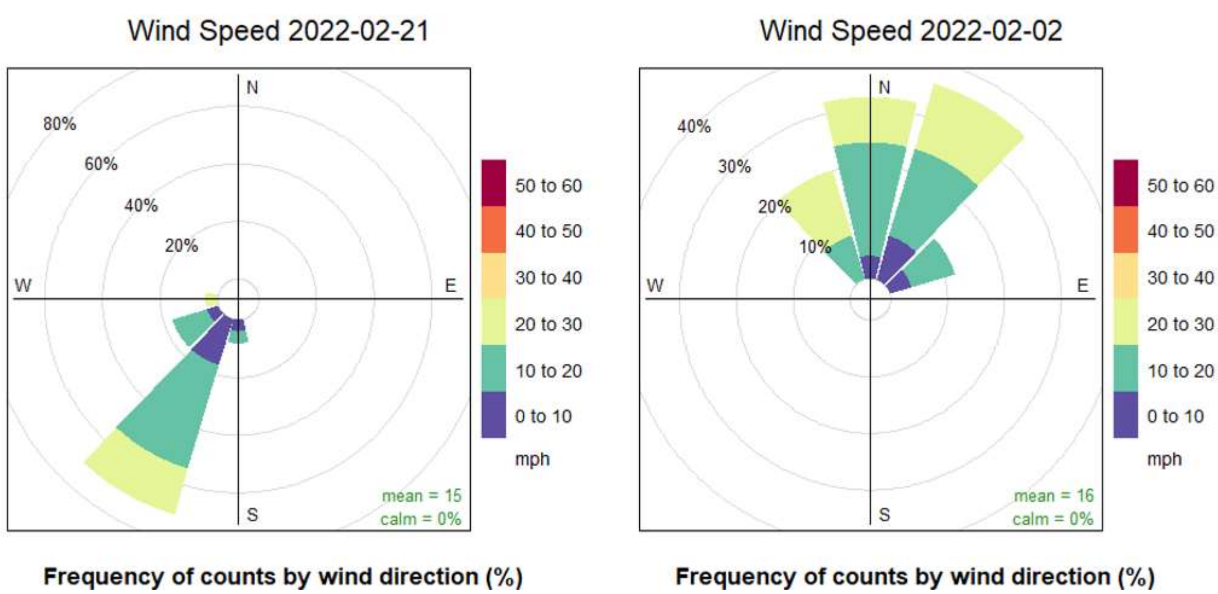


Figure 3.5-2. Wind speed (mph) and direction frequency for (left) February 21, 2022, the suspected exceptional event day, and (right) February 2, 2022.

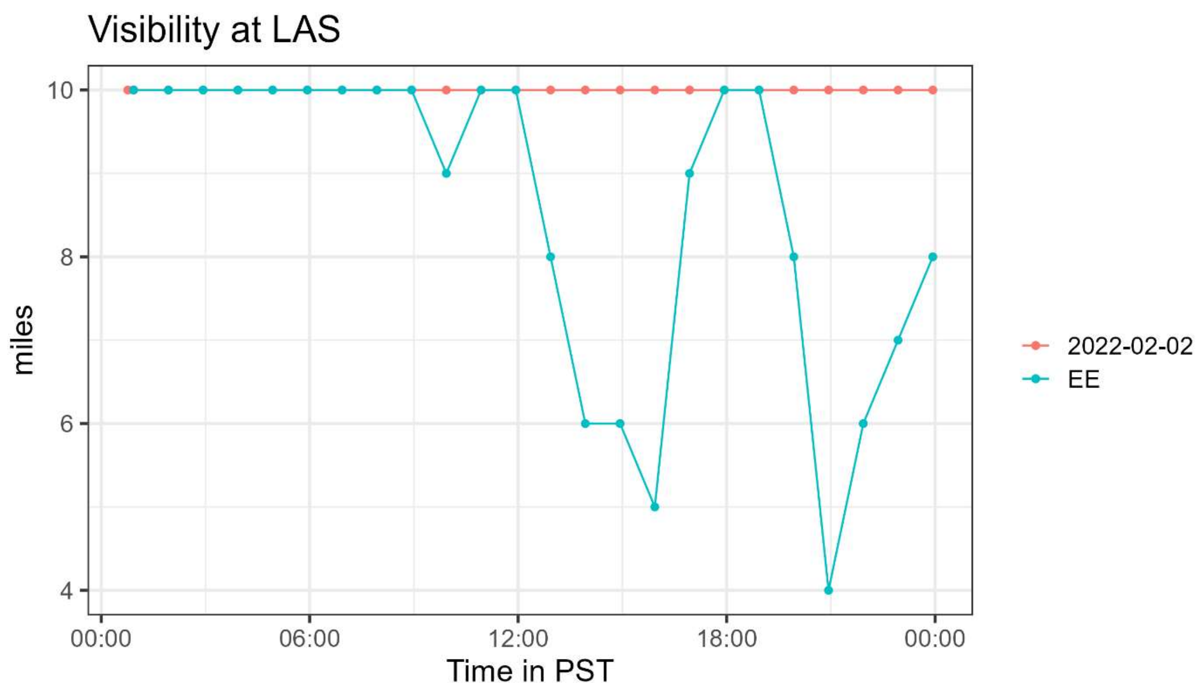


Figure 3.5-3. Hourly-reported visibility in miles at LAS for February 2, 2022 (pink), and the February 21, 2022, suspected exceptional event (EE) day (teal).

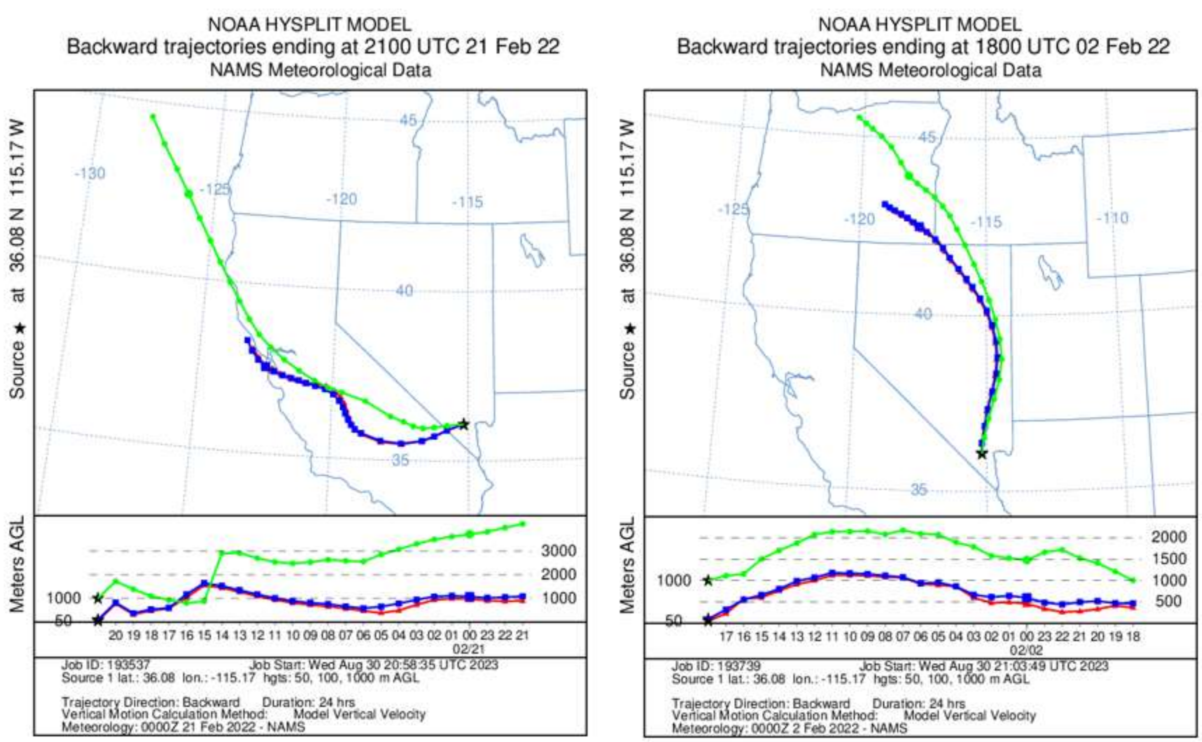


Figure 3.5-4. 24-hour HYSPLIT back-trajectories initiated from Las Vegas at (left) 21:00 UTC on February 21, 2022 (13:00 PST) (event date), and (right) 18:00 UTC on February 2, 2022 (10:00 PST), at 50 m (red), 100 m (blue) and 1,000 m (green).

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} concentration to compare surface meteorological conditions against conditions on the event date. All dates in the winter and spring seasons (December 2021-May 2022) were screened. The only other days when PM_{10} exceeded the NAAQS during this period were April 11, 2022, May 8, 2022, and May 28-29, 2022, which are also suspected high-wind dust exceptional 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**Error! Reference source not found.** provides evidence for natural and anthropogenic sources of PM_{10} near the Green Valley, Liberty High School, Jerome Mack, and Sunrise Acres monitoring sites of PM_{10} that could have contributed to the exceedance on February 21, 2022,. As shown in Section 3.2, however, the main source of PM_{10} was 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, NV, 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 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 February 21, 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 C**.

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.[2]

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

[2] 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[3]), 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

[3] 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.[4]

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.[5]

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[6].

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[7].

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

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

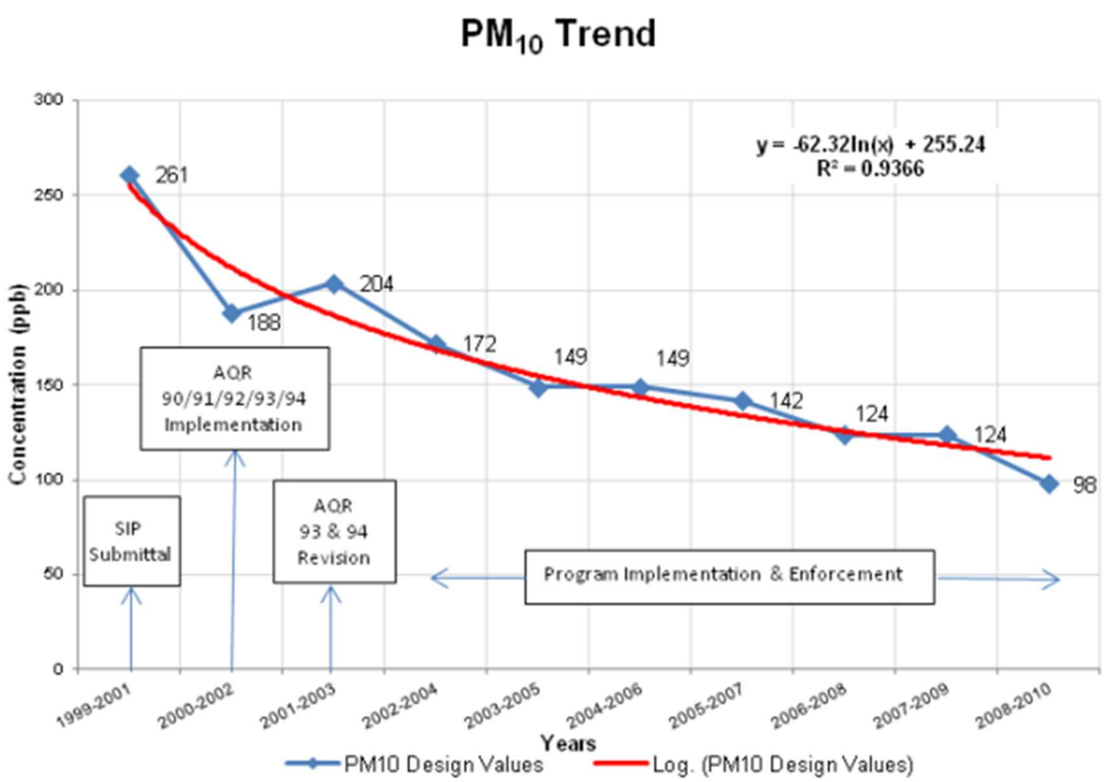


Figure 4.3-1. PM_{10} trends from the 2012 Maintenance Plan.

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.

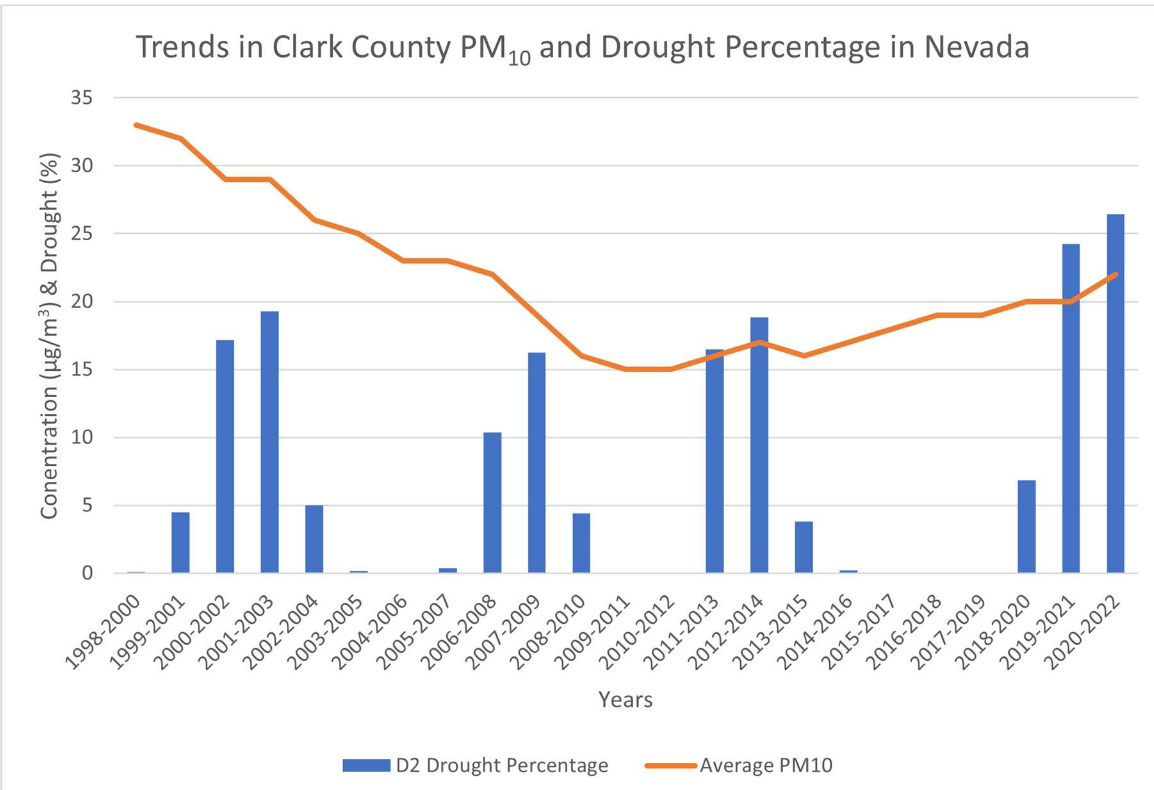


Figure 4.3-2. Three-year running average of PM_{10} concentrations (µg/m^3) at the long-running Paul Meyer monitoring site (AQS: 32-003-0043) (orange line) and the D2 (severe) drought percentage of Nevada (blue bars). Source: **https://www.drought.gov/states/nevada**.

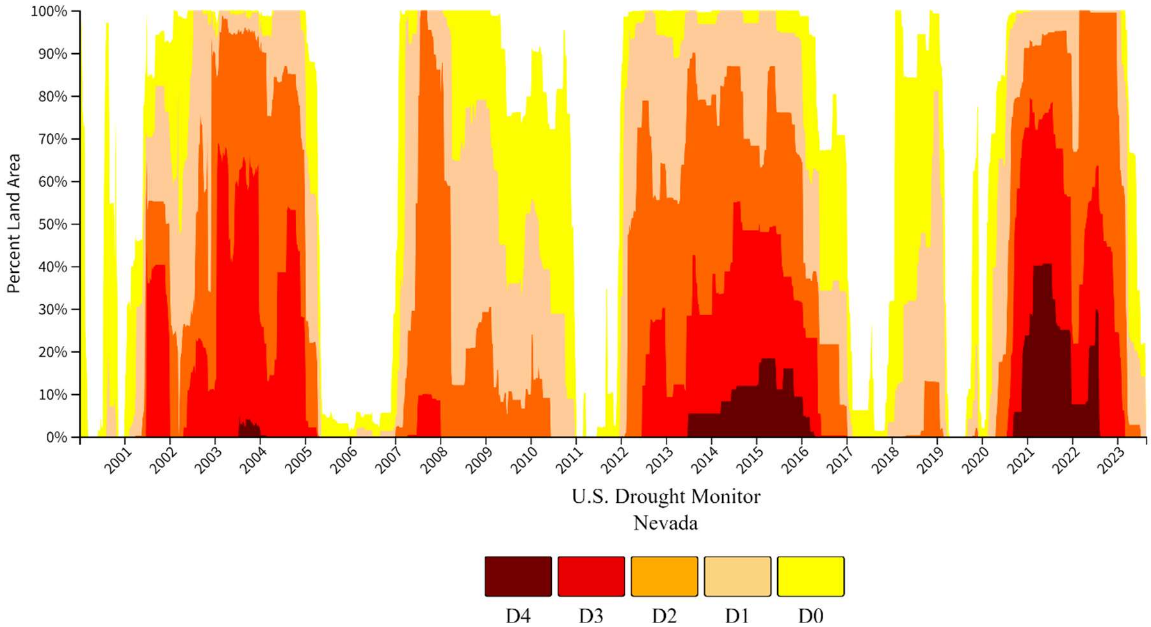


Figure 4.3-3. Drought statistics for Nevada from 2000-2023, colored by drought severity for D0 to D4. Source: **https://www.drought.gov/states/nevada**.

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.

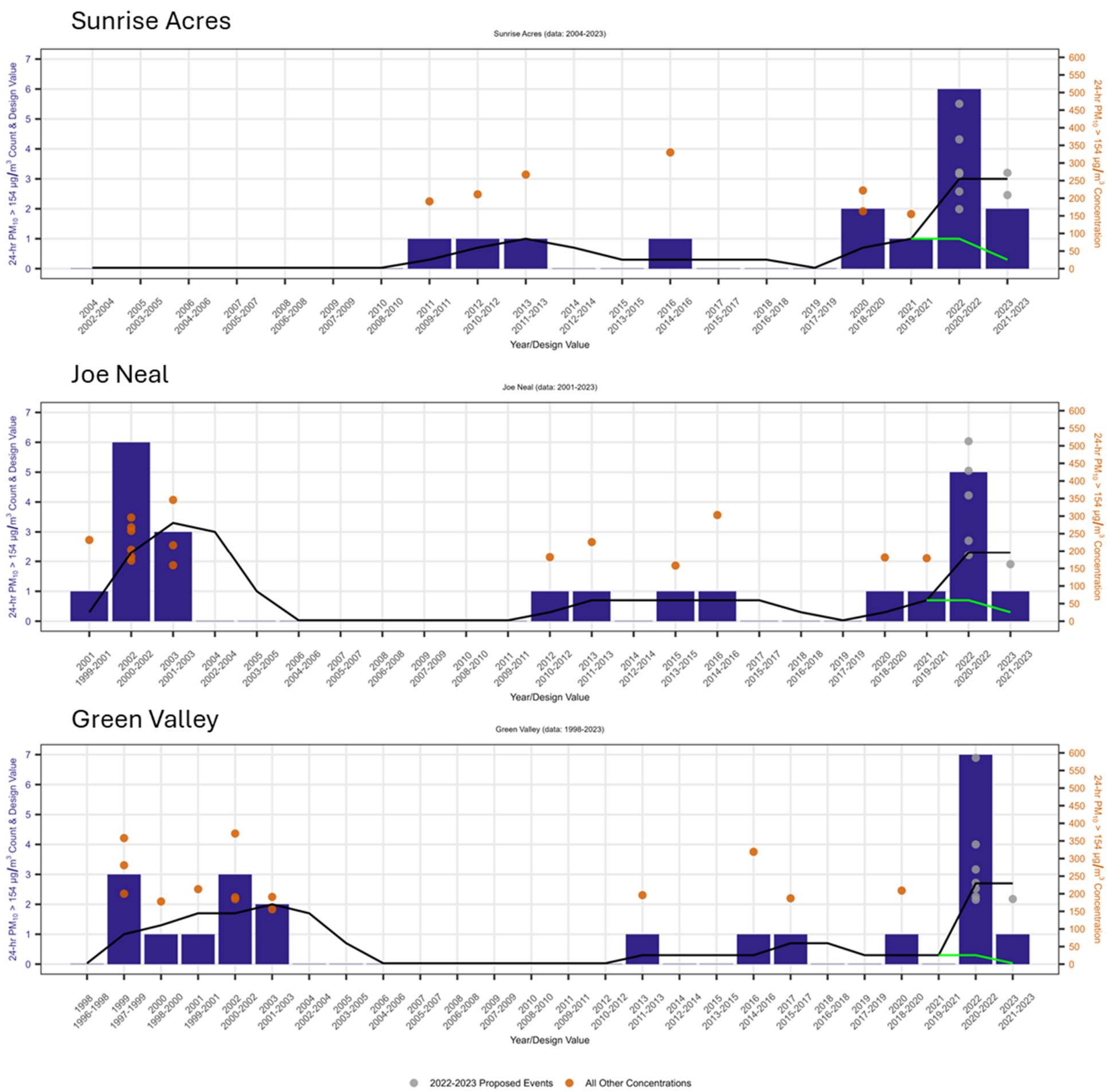


Figure 4.3-4. Historical 24-hour PM_{10} exceedance count (purple bars) and concentration (orange dots) per year/design value period at the Sunrise Acres, Joe Neal, and Green Valley monitoring sites (AQS: 32-003-0561; 32-003-0075; 32-003-0298). The gray dots represent the proposed 2022-2023 PM_{10} exceptional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

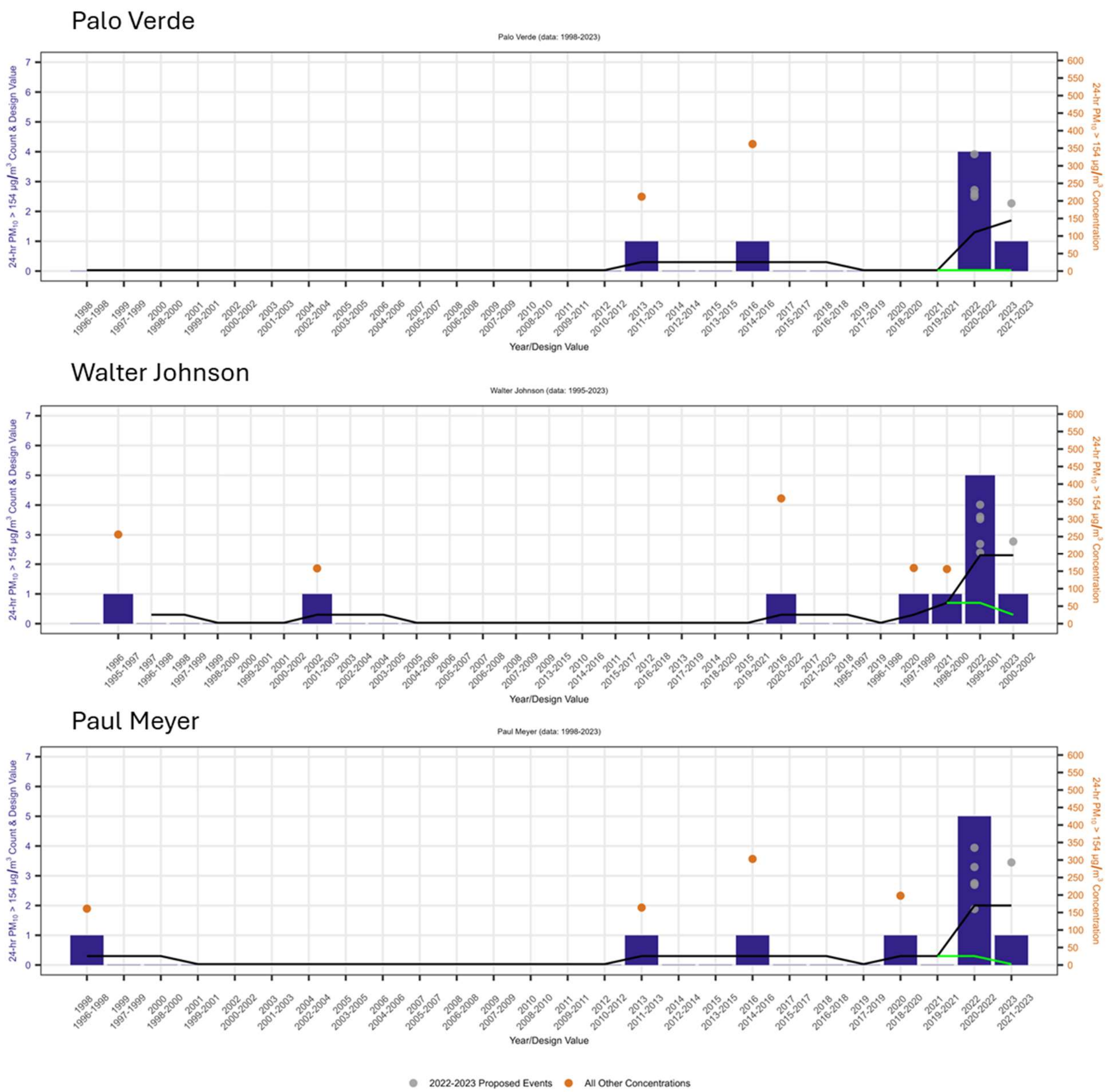


Figure 4.3-5. Historical 24-hour PM_{10} exceedance count (purple bars) and concentration (orange dots) per year/design value period at the Palo Verde, Walter Johnson, and Paul Meyer monitoring sites (AQS: 32-003-0073; 32-003-0071; 32-003-0043). The gray dots represent the proposed 2022-2023 PM_{10} 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)[8] and Rule 310 of Maricopa County's (Arizona) Air Pollution Control Regulations[9] 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 details 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

[8] https://www.mdaqmd.ca.gov/home/showpublisheddocument/8482/637393282546170000
[9] 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 February 21, 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 significantly across the Mojave Desert, which produced blowing dust in the late morning/early afternoon hours southwest of Las Vegas on February 21, 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. The hourly PM_{10} concentrations detailed in **Section 3.2.2** show an eastward progression of high PM_{10} concentrations and wind speeds consistent with the direction of travel of the cold front. By 14:00 to 15:00 PST, almost all sites in the Las Vegas Valley exceeded 300 $\mu g/m^3$, with four regulatorily significant sites exceeding 500 $\mu g/m^3$. 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 February 21, 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.[10] 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.[11] 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.

On February 21, 2022, a Construction Notice was issued 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. The following day, a Dust Advisory was issued 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 E**). In the case of a Dust Advisory, compliance officers inspect construction and stationary source sites during the episode to ensure BACM are being

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

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 implementation of BACM and enforcement procedures. **Appendix D** also provides all inspection information and notices of violation from the February 21, 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 E**. 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 February 21, 2022, PM_{10} event were not reasonably controllable or preventable.

5. Natural Event

The February 21, 2022, event is the result of a frontal passage with high winds caused by a pressure gradient over the Mojave Desert source region which produced winds that lofted, entrained, and transported dust into Clark County, NV. 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 (**Section 4.2**) during the high-wind dust event. Therefore, we conclude this event meets the EPA criteria for a natural event.

6. Conclusions

The evidence provided within this report demonstrates that the PM_{10} exceedances on February 21, 2022, were caused by a High Wind Dust Event where dust was lofted, entrained, and transported from the extremely dry Mojave Desert in southeastern California. Key elements and evidence associated with the event timeline include:

1. A low-pressure system and associated frontal passage from the north of Clark County caused a sharp rise in southwesterly wind speeds across an extremely dry desert source region in the Mojave Desert to the southwest of Clark County at approximately 07:00-10:00 PST on February 21, 2022. With this frontal passage, dust from the Mojave Desert was lofted, entrained, and transported to Clark County by 11:00 PST on February 21. 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. As the frontal passage pushed south, this caused a strengthening of the pressure gradient between Clark County and the source region, which led to high winds bringing dust from the Mojave Desert within a few hours of the exceedance. Satellite data, meteorological data, and visibility measurements all align to confirm event transport from the Mojave Desert. PM_{10} measurements along the frontal passage increase as winds push through Kern, Inyo, and San Bernardino counties in California, then Nye and Clark counties in Nevada, confirming high PM_{10} along the timeline and trajectories established.
3. Associated with the frontal passage, PM_{10} was extremely enhanced, construction and weather alerts were issued, visibility measurements indicate dusty conditions, and $PM_{2.5}/PM_{10}$ ratios dropped (indicating windblown dust).
4. PM_{10} concentrations increased at the same time that the frontal passage pushed into Clark County, starting at approximately 11:00 PST, and peaked in intensity by 13:00-15:00 PST, with some secondary peaks around 20:00-21:00 PST on February 21, 2022. The 24-hour PM_{10} concentrations were above the NAAQS threshold of 150 $\mu g/m^3$ at six sites (regulatory significance at four sites: Liberty High School at 225, $\mu g/m^3$, Green Valley at 192 $\mu g/m^3$, Jerome Mack at 199 $\mu g/m^3$, and Sunrise Acres at 169 $\mu g/m^3$). The other two sites exceeding the 24-hour PM_{10} NAAQS recorded concentrations above the 99th percentile but were not regulatorily significant in this case. Hourly PM_{10} concentrations at sites in Clark County peaked above 500 $\mu g/m^3$ through the event on February 21. The concurrent rise in PM_{10} at all sites around Clark County indicates a regional dust event.
5. All sites of regulatory significance exceeded the 5-year 99th percentile and the NAAQS on February 21, 2022. Hourly PM_{10} concentrations are also significantly outside typical diurnal, monthly, and seasonal ranges.

6. Clark County, NV, and the surrounding source region were under increasingly severe drought conditions on and before the February 21, 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 February 21, 2022. Dust lofted and transported from this natural, undisturbed area experiencing severe drought is considered to be a natural and not reasonable or controllable event.
7. Analysis comparing another date with a comparable wind profile to February 21, 2022, 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 F**).

The high-wind dust event that occurred on February 21, 2022, caused 24-hour PM_{10} NAAQS exceedances with regulatory significance at Green Valley (Monitor AQS ID 32-003-0298, POC 1), Liberty High School (Monitor AQS ID 32-003-0299, POC 1), Jerome Mack (Monitor AQS ID 32-003-0540, POC 1), and Sunrise Acres (Monitor AQS ID 32-003-0561, POC 1). On February 21, 2022, the 24-hour PM_{10} concentrations reached 225 $\mu g/m^3$ at Liberty High Schook, 199 $\mu g/m^3$ at Jerome Mack, 192 $\mu g/m^3$ at Green Valley, and 169 $\mu g/m^3$ at Sunrise Acres. Six additional suspected wind-blown dust events occurred between 2020 and 2022. Without EPA concurrence that the wind-blown dust event on February 21, 2022, and the other suspected events qualify as an exceptional event, the 2020-2022 design values are 2.7 at Green Valley, 3.0 at Liberty High School, 3.7 at Jerome Mack, and 3.0 at Sunrise Acres. This is outside of the attainment standard of 1.0. With EPA concurrence on February 21, 2022, and the other seven suspected events, the 2021-2023 design values are 0.0 at

Green Valley, 0.3 at Liberty High School, 0.3 Jerome Mack, and 0.3 at Sunrise Acres – 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 February 21, 2022, and agree to exclude the event from regulatory decisions regarding PM_{10} attainment.

7. References

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