Exceptional Event Documentation for the July 3, 2013, 8-Hour Ozone NAAQS Exceedance in Clark County Caused by a Wildland Fire Event

June 2015
Final Draft

ACKNOWLEDGMENTS

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

Acronyms

AOD	Aerosol Optical Depth
AOT	Aerosol Optical Thickness
AQI	Air Quality Index
CAA	Clean Air Act
CFR	Code of Federal Regulations
DAQ	Clark County Department of Air Quality
EER	Exceptional Events Rule
EPA	U.S. Environmental Protection Agency
HYSPLIT	Hybrid Single Particle Lagrangian Integrated Trajectory Model
MDA8	Maximum Daily 8-hr Average
NAAQS	National Ambient Air Quality Standards
PST	Pacific standard time
VOC	volatile organic compound

Abbreviations

°C	degrees Celsius
CO	carbon monoxide
mb	millibars
MSL	mean sea level
NO_x	oxides of nitrogen
O_3	ozone
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
ppb	parts per billion

1.0 INTRODUCTION

On July 3, 2013, elevated ozone concentrations and exceedances of the ozone (O_3) National Ambient Air Quality Standards (NAAQS) were recorded across the Clark County air quality monitoring network. The Clark County Department of Air Quality (DAQ) has determined these exceedances were caused by smoke plumes from the Carpenter 1 wildfire in the Spring Mountains west of the Las Vegas Valley, making them subject to the Exceptional Events Rule (EER), Title 40, Part 50 of the Code of Federal Regulations (40 CFR 50).

1.1 STATEMENT OF PURPOSE

The EER governs the review and handling of air quality monitoring data influenced by events for which the normal planning and regulatory process established by the Clean Air Act (CAA) is not appropriate (*Federal Register*, vol. 72, p. 13560). The U.S. Environmental Protection Agency (EPA) intended the rule to

> [i]mplement section 319(b)(3)(B) and 107(d)(3) authority to exclude air quality monitoring data from regulatory determinations related to exceedances or violations of the [NAAQS] and avoid designating an area as nonattainment, redesignating an area as nonattainment, or reclassifying an existing nonattainment area to a higher classification if a State adequately demonstrates that an exceptional event has caused an exceedance or violation of a NAAQS.

This document petitions the EPA Region 9 administrator to exclude the data gathered on July 3, 2013, at specific ozone monitors in Clark County from normal CAA planning and regulatory requirements because of an exceptional event. It demonstrates that the NAAQS violations would not have occurred but for the Carpenter 1 wildfire.

1.2 SCOPE OF DEMONSTRATION

On March 11, 2014, DAQ flagged Clark County ozone data from July 3, 2013, in EPA's Air Quality System (AQS) to indicate that any NAAQS exceedances were likely caused by ozone precursor emissions produced by smoke plumes from a wildfire. The procedures and criteria states must use in petitioning EPA to exclude data from regulatory considerations because of an exceptional event are set forth in the EER, as outlined below.

Section 2 describes the conceptual model for ozone air pollution and wildfire impacts in Clark County, based on technical studies completed to date. It covers topography, land use, and meteorology in the context of conditions leading to elevated ozone concentrations, then summarizes the role of local emissions and transport into southern Nevada.

Section 3 describes the "clear causal relationship" between the NAAQS concentrations and the exceptional event, including laboratory speciation, historical fluctuation, smoke trajectories, and the wildfire's impacts on pollutant concentrations. It demonstrates compliance with the following criteria, required by the EER to exclude air quality monitoring data from the normal planning and regulatory process established by the CAA:

1. The event satisfies the criteria set forth in 40 CFR 50.1(j).
2. There is a clear causal relationship between the measurements under consideration and the event that is claimed to have affected air quality in the area.
3. The event is associated with measured concentrations in excess of normal historical fluctuations, including background.
4. There would have been no exceedance or violation but for the event.
5. The submittal includes documentation that the public comment process was followed.

Section 4 provides evidence for the "but for" argument. It uses concentration calculations in lieu of measured concentrations to show that the exceedance would not have occurred but for the event.

The EER further requires that Clark County prove it took reasonable and appropriate actions to inform the public of deteriorating air quality caused by wildfire smoke plumes and a possible exceedance of the ozone NAAQS. Section 5 documents these actions.

Table 1-1. Document Organization

Required EER Element	Section
Regional background and conceptual model	2
Demonstration of clear causal relationship between exceedance and event	3
Demonstration that concentrations exceeded historical fluctuations	3.3
"But for" demonstration	4
Documentation of public participation	5

An effort was made to separate documentation and/or explanations of each EER element; however, some explanations can and should overlap.

This demonstration package underwent public review and comment before submittal to EPA.

1.3 COMPLIANCE WITH CRITERIA FOR EXCEPTIONAL EVENTS

40 CFR 50.1(j) defines an exceptional event as

> an event that affects air quality, is not reasonably controllable or preventable, is an event caused by human activity that is unlikely to recur at a particular location or a natural event, and is determined by the Administrator in accordance with 40 CFR 50.14 to be an exceptional event. It does not include stagnation of air masses or meteorological inversions, a meteorological event involving high temperatures or lack of precipitation, or air pollution relating to source noncompliance.

However, EPA notes that natural events, which are one form of exceptional events, may recur, sometimes frequently. This is certainly true for natural events like Western wildfires.

1.3.1 Wildfire Season in the West

The wildfire season in 2013 was somewhat mild, with only 5.6 million acres burned in the U.S. According to the National Interagency Fire Center, slightly more than half (2.7 million) of those acres were in the West. Table 1-2 lists the number of fires and the acreage burned per state.

The Carpenter 1 Fire was a catastrophic wildfire that raged through the Spring Mountains in Nevada. It started on July 1 and lasted until mid-September, consuming 28,000 acres.

Table 1-2. Fires in the West in 2013

State	# Fires	Acres Burned
AZ	1,694	136,296
CA	8,457	590,391
CO	1,244	201,243
ID	1,560	754,549
MT	1,930	141,610
NM	1,064	233,037
NV	710	189,314
OR	2,164	250,009
UT	1,321	80,301
WA	1,200	105,402
WY	458	48,667
Total:	21,802	2,730,819

Source: http://www.nifc.gov/fireInfo/fireInfo_stats_YTD2013.html

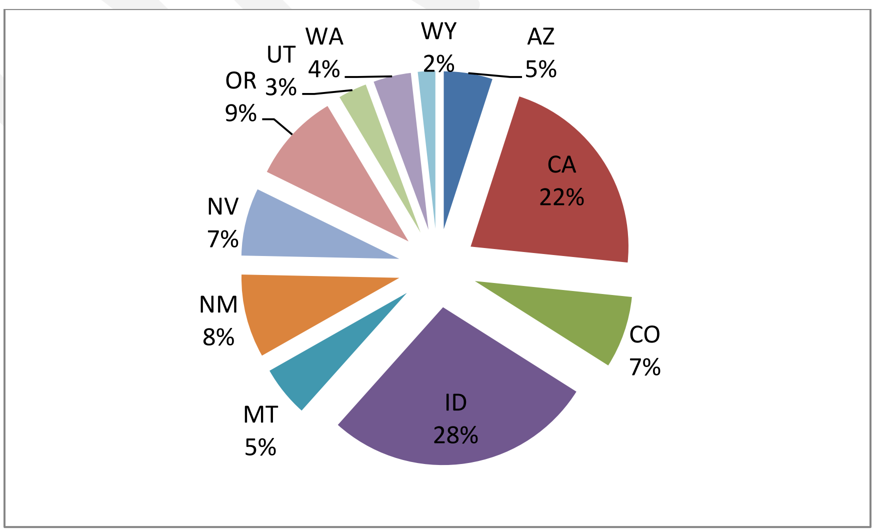


Figure 1-1. Percentage of Acres Burned per State.

1.3.2 Carpenter 1 Fire on Mount Charleston, NV

Carpenter 1 was a large wildfire on Mount Charleston, 25 miles (40 km) northwest of Las Vegas, that began on July 1, 2013, near Pahrump before spreading eastward. The largest fire to occur on Mount Charleston in decades, it could be seen for miles across the Las Vegas metropolitan area. Parts of Nevada State Routes 156 and 157 had to be closed, resulting in the evacuation of residents and the closure of businesses and portions of the Spring Mountains National Recreation Area.

The fire, which spanned elevations between 5,000–11,000 feet (1,500–3,400 m), was fought by hundreds of firefighters and eight Hotshot crews, as well helicopters, fire engines, water tenders, and a DC-10 tanker plane. According to the National Interagency Fire Center, the Carpenter 1 fire was considered “the highest ranked priority fire in the nation” at the time of its occurrence.[1] After eight weeks of battling, it was considered fully contained on August 18, 2013, after consuming nearly 28,000 acres (11,000 ha).

Although DAQ recorded elevated ozone concentrations throughout the fire event, the NAAQS was exceeded only once: on July 3, 2013, smoke impacts from the Carpenter 1 fire overwhelmed any local contributions to elevated ozone levels at several ozone monitors in the DAQ network. The western most monitors in the valley were affected the most, exceeding the NAAQS. The highest ozone concentrations reached a maximum daily 8-hour average (MDA8) of 87 ppb during this one-day episode.

On July 2, a well-established Pacific Ridge dominated the southwest, causing an easterly flow into Clark County at all levels. By July 3, the ridge (i.e., high-pressure system) had moved far enough to the south to cause a directional change in wind flow from the northeast at all levels.

Surface smoke impacts were documented through laboratory analysis of samples of particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) to determine concentrations of wildfire markers (e.g., levoglucosan).

Table 1-3 lists maximum ozone levels by monitoring site on July 3, as well as on the days before and after. Figure 1-2 depicts the diurnal cycles for July 1–July 5.

[1] www.wikipedia.org.

Table 1-3. Maximum 8-Hour Ozone Concentrations (ppb)

Site	July 2013				
	1	2	3	4	5
Apex	56	62	66	62	52
Mesquite	50	52	51	53	52
Paul Meyer	66	59	87	64	64
Walter Johnson	71	60	87	64	64
Palo Verde	71	60	83	65	66
Joe Neal	69	70	81	68	63
Winterwood	53	60	60	59	49
Jerome Mack				59	49
Boulder City	51	56	64	59	49
Jean	58	60	64	59	66
J.D. Smith	64		71	63	55

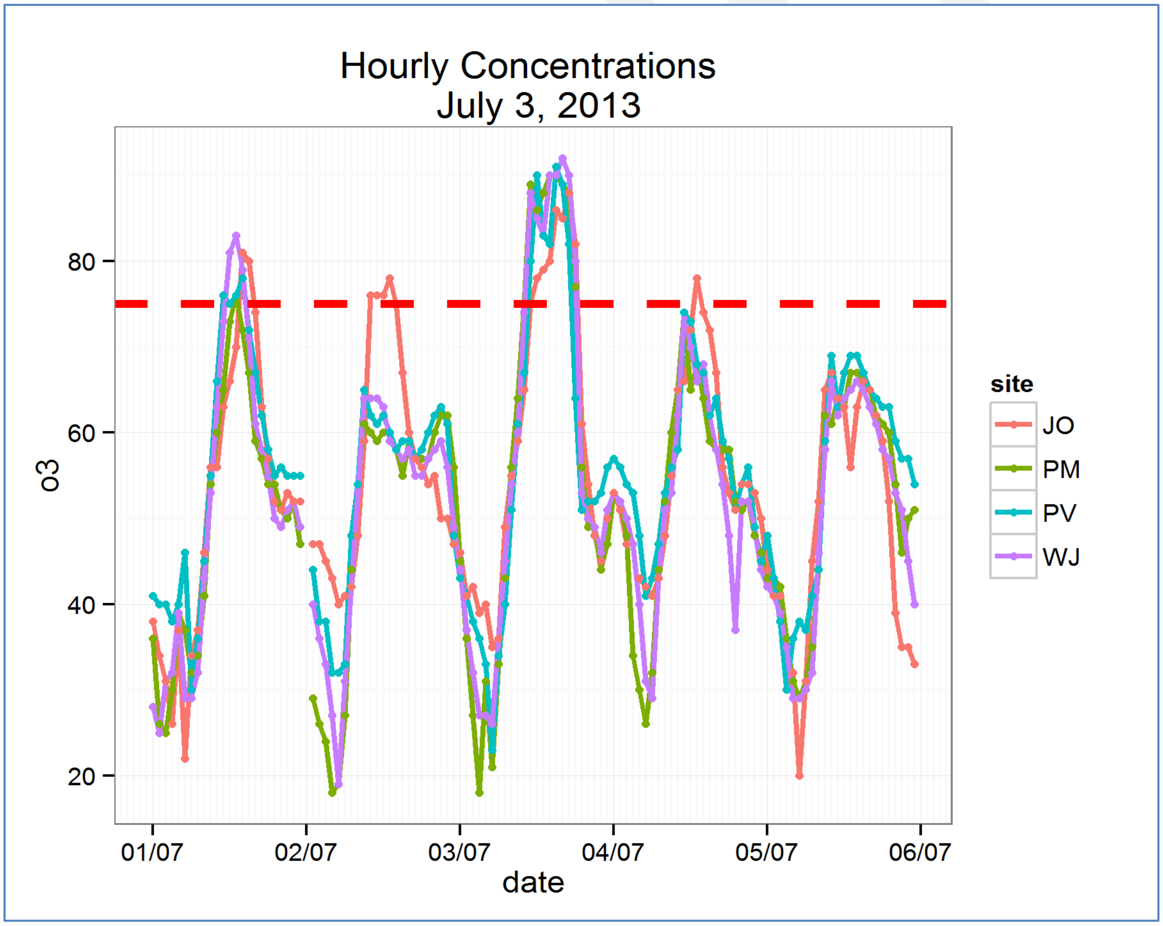


Figure 1-2. Diurnal Ozone Patterns Around July 3.

Figure 1-3 depicts the O_3 and $PM_{2.5}$ concentrations for July 1–3. The $PM_{2.5}$ concentrations on July 3 were extremely high compared to previous days. Figure 1-4 shows the CO concentrations for July 1–5, which almost doubled on July 3. Figures 1-5 and 1-6 show particle cross-sections from the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model at 1300 and 1600 on July 3; the smoke plume covers most of Las Vegas and reaches the valley floor. Figure 1-7 shows nitrogen oxide (NO_x) concentrations for July 1–5. Concentrations were higher than normal on July 3, indicating an abundance of NO_x most likely generated by the fire. Since NO_x is an ozone precursor, it is reasonable to assume these higher levels contributed to high ozone concentrations.

The combination of these data shows the Las Vegas Valley was clearly impacted by the smoke plume from the Carpenter 1 fire. The following sections will add information to the "but for" and weight-of-evidence portions of the EER. They will demonstrate that Clark County was impacted by an exceptional event on July 3, and that the ozone monitoring data should be excluded from any regulatory requirements.

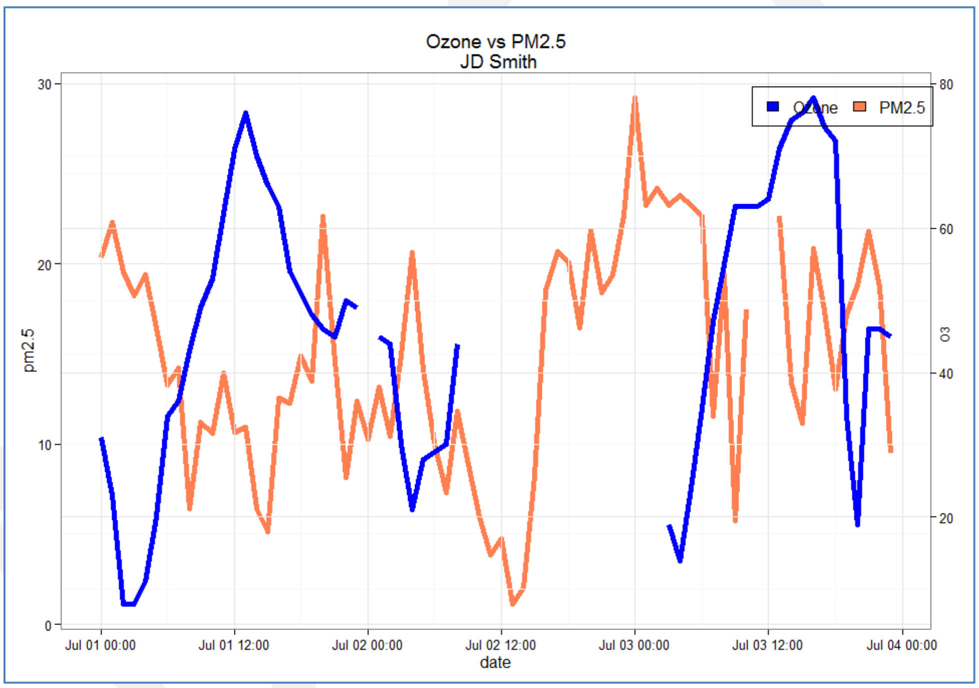


Figure 1-3. Ozone and $PM_{2.5}$ Diurnal Patterns.

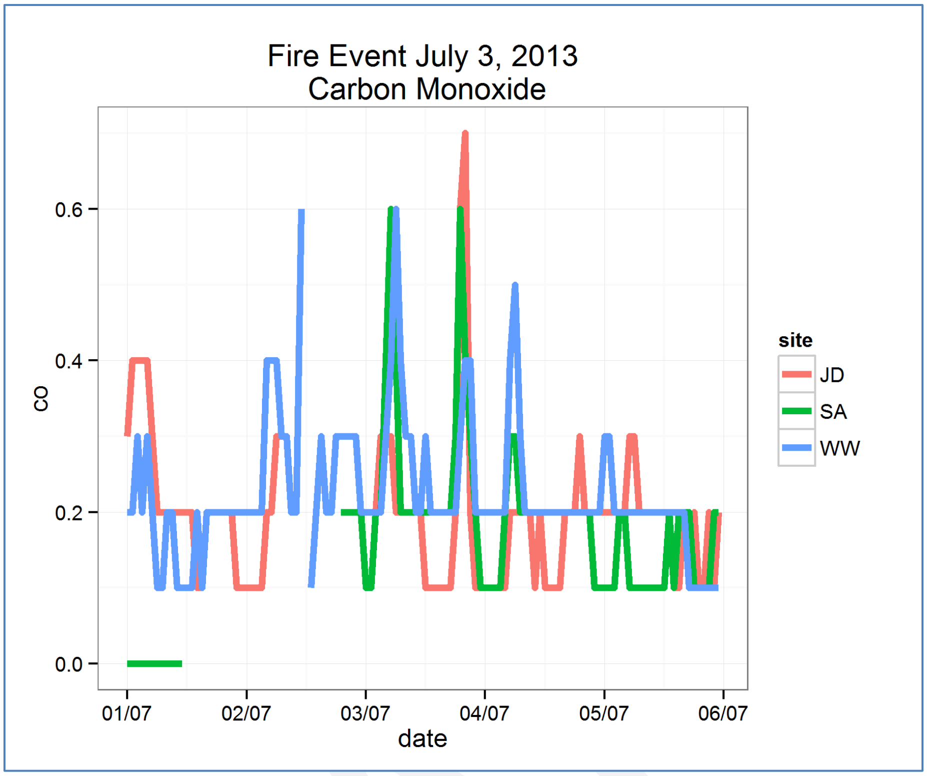


Figure 1-4. Carbon Monoxide Diurnal Patterns.

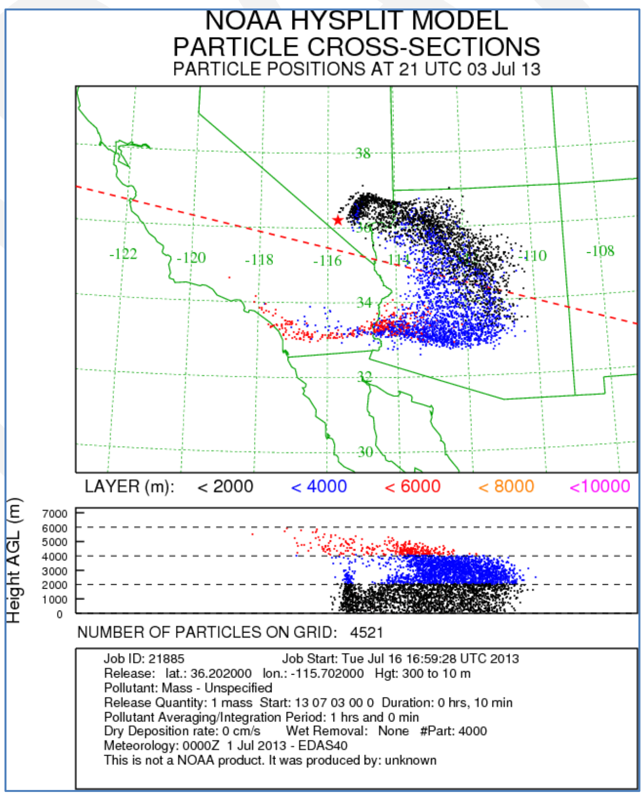


Figure 1-5. Particle Distribution in Smoke Plume at 1300.

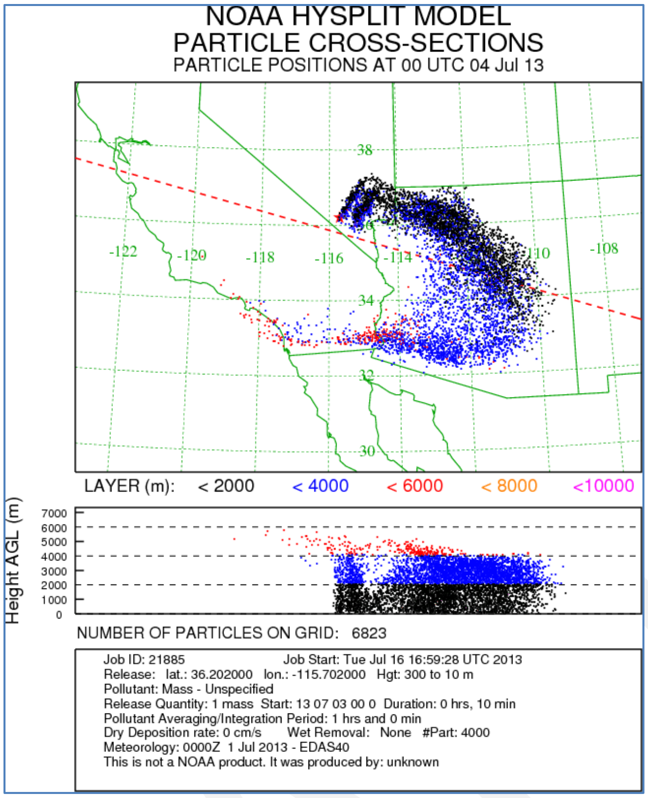


Figure 1-6. Particle Distribution in Smoke Plume at 1600.

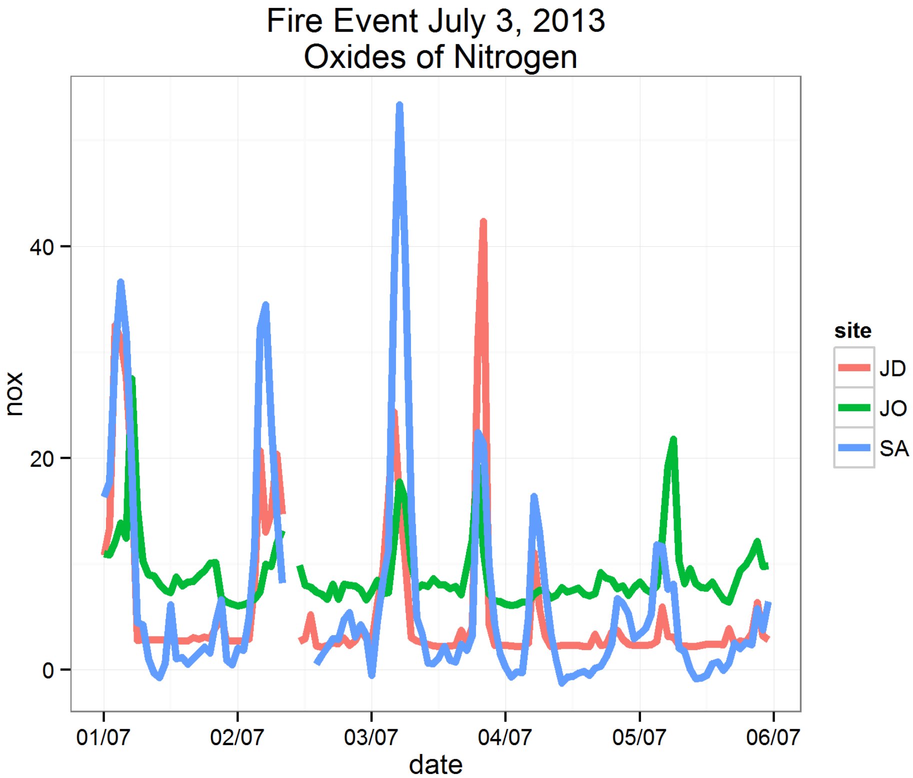


Figure 1-7. NO_x Concentrations.

Figure 1-8 is a satellite image showing the smoke plume on July 3. Wind direction during the duration of the event was coming from the South; however, on July 3 winds shifted and blew the plume over the Las Vegas Valley. Figure 1-9 show the location of the fire on Mt Charleston.

Figure 1-8. Smoke Plume.

Figure 1-9. Location of Carpenter 1 Fire.

Figure 1-10 depicts the burned area as the fire progressed, and Figure 1-11 maps the highest MDA8 values across the Clark County monitoring network on July 3. It includes the Pauite monitoring site just outside the valley, with a concentration of 92 ppb.

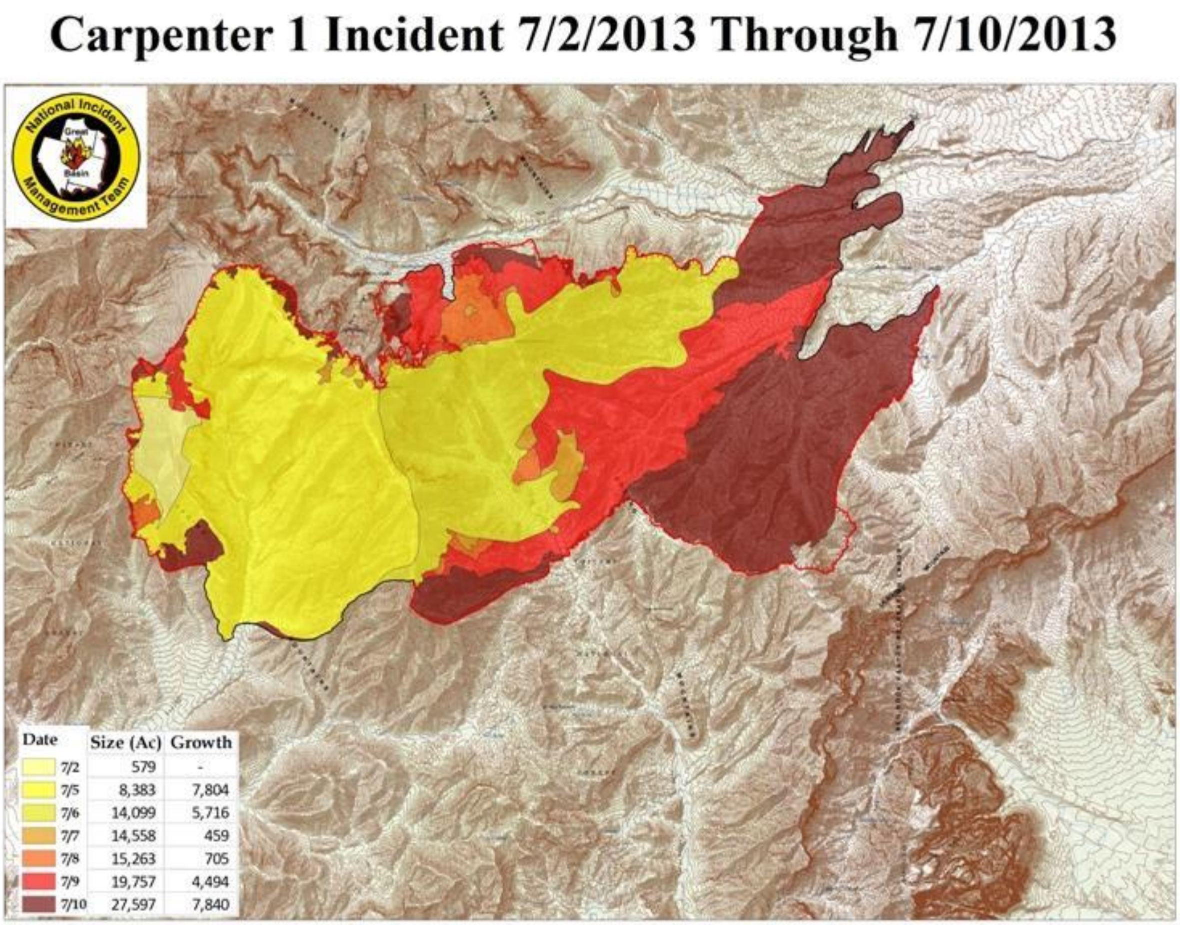


Figure 1-10. Area Burned in Carpenter 1 Fire.

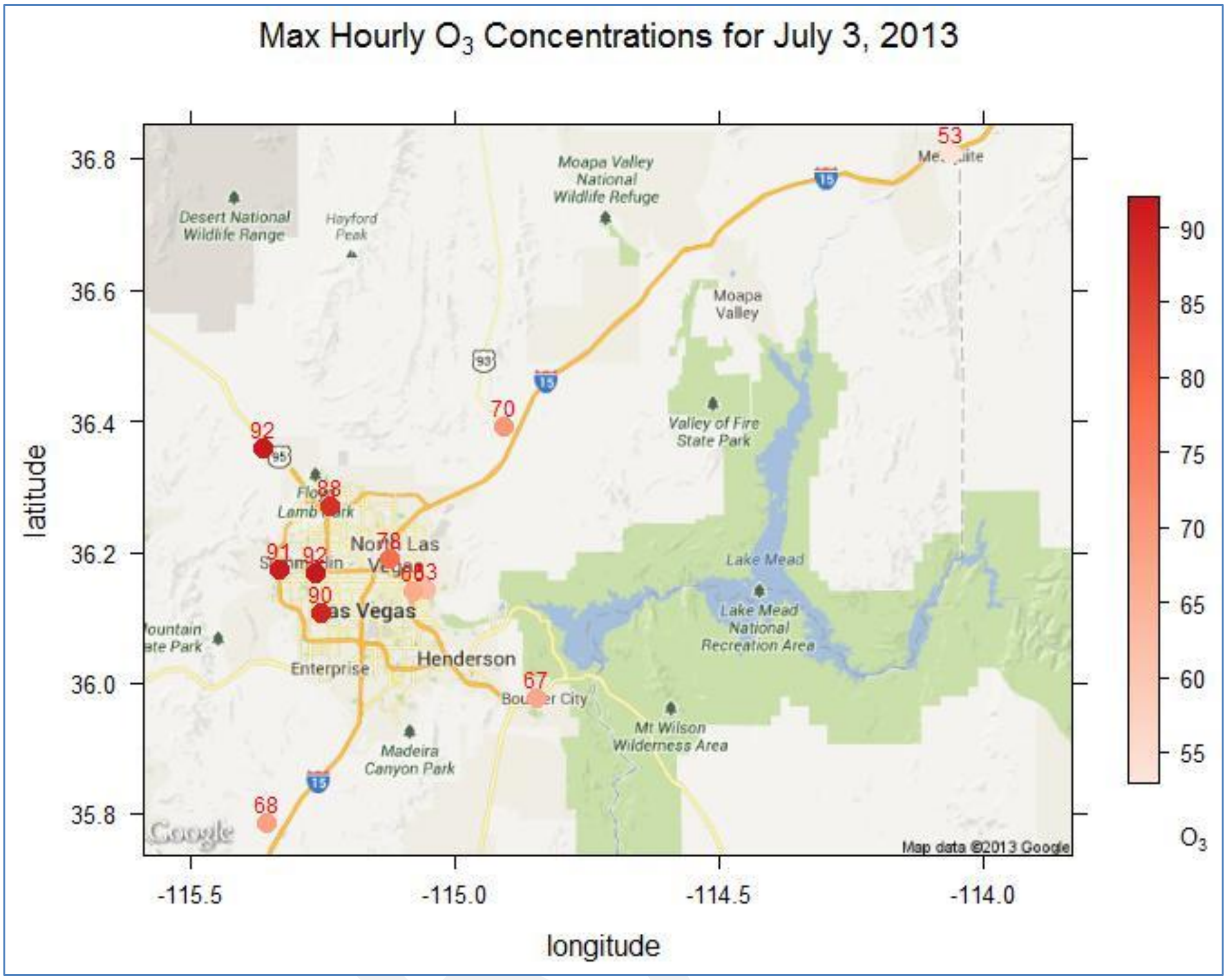


Figure 1-11. Ozone Concentrations on July 3, 2013.

Figures 1-12 and 1-13 are the pollution roses for the Paul Meyer and Joe Neal monitoring sites, respectively.

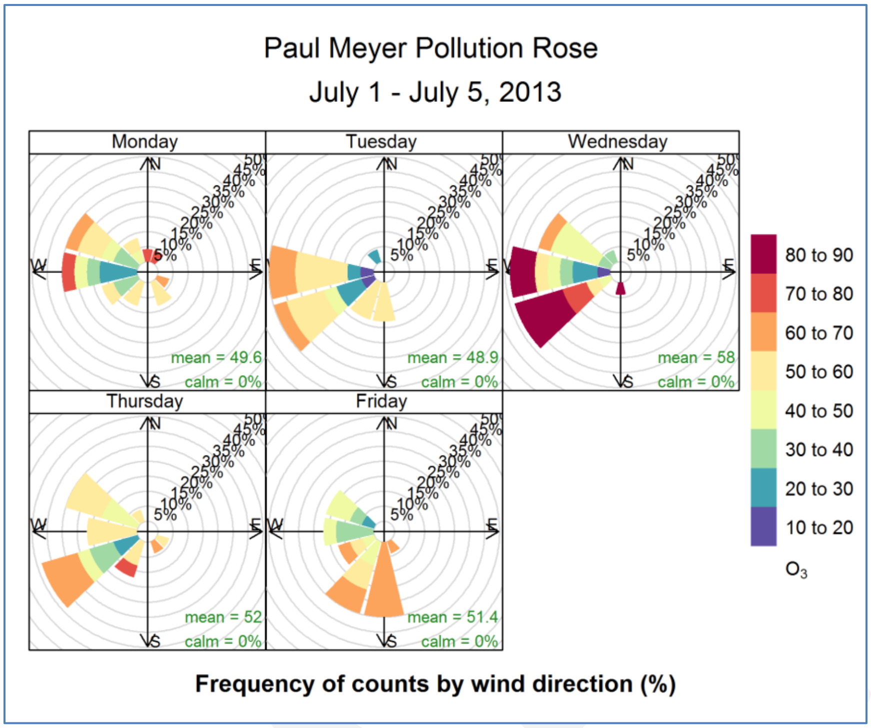


Figure 1-12. Pollution Rose for Paul Meyer.

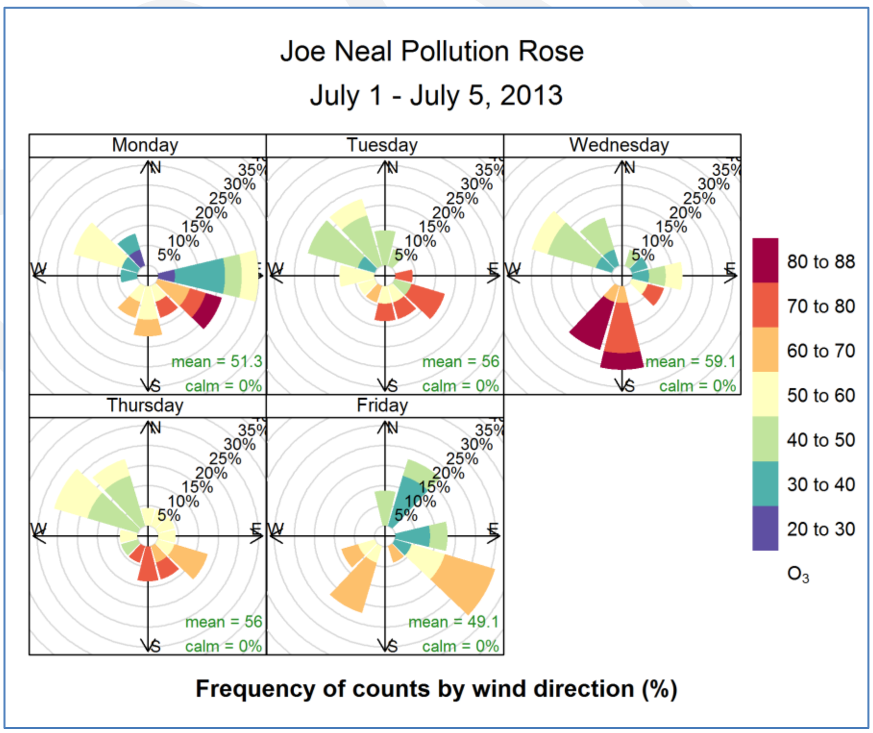


Figure 1-13. Pollution Rose for Joe Neal.

1.4 PREVIOUS RESEARCH ON OZONE FORMATION AND SMOKE IMPACTS[2]

Wildfires can generate both NO_x and VOC emissions, with different burning stages generating different types of emissions. Biogenic VOCs are generated by vegetation throughout the burning cycle. NO_x is generated primarily during the hot, flaming stage of the fire, and small reactive hydrocarbons, such as ethane and acetylene, are generated during the smoldering phase (Finlayson-Pitts and Pitts 2000; Jaffe et al. 2008).

Ozone concentrations may be suppressed near fires despite the increase in ozone precursors that wildfires generate. Bytnerowicz et al. (2010), Finlayson-Pitts and Pitts (2000), and Sandberg et al. (2002) give two reasons for this: (1) thick smoke can prevent sufficient ultraviolet light from reaching the surface, inhibiting photochemical reactions, and (2) the wildfire plume typically contains high NO_x concentrations, which can titrate ozone concentrations. Downwind of the fire or at the top of the plume (Sith et al. 1981), away from fresh NO_x sources and with reduced aerosol optical depth (AOD), considerable amounts of ozone can be generated. The plume does not have to be very far downwind of fire emissions to generate ozone: Sandberg et al. (2002) cites a study in which Sith et al. (1981) found ozone beginning 10 km downwind of wildfires in plumes less than one hour old. Ozone and ozone precursors can also be transported quite far from a wildfire site (Finlayson-Pitts and Pitts 2000; Jaffe et al. 2008). This shows that, similar to the impacts of anthropogenic emissions in urban airsheds, the highest ozone concentrations caused by wildfires are often seen downwind of the area of greatest precursor emissions.

The impact of wildfires on ozone concentrations at both the local and regional level has been extensively evaluated in recent years. Field observations of ozone formation in smoke plumes from fires date back nearly 25 years, when aircraft measurements detected elevated ozone at the edge of forest fire smoke plumes far downwind (Sandberg et al. 2002). More recently, aircraft flights through smoke plumes have demonstrated increased ozone concentrations of 15–30 ppb in California (Bush 2008), while ozonesonde measurements in Texas found enhanced ozone aloft (ranging from 25–100 ppb) attributable to long-range transport of smoke plumes from Canada and Alaska (Morris 2006).

In addition, air quality modeling has shown increased levels of ozone from a number of large fires. McKeen (2002) found that Canadian fires in 1995 enhanced ozone concentrations by 10–30 ppb throughout a large region of the central and eastern United States. Lamb (2007) found similar results simulating the impacts of fires in the Pacific Northwest in 2006, with increases of over 30 ppb. Junquera (2005) further found that within 10 km of a fire, ozone concentrations could be enhanced by up to 60 ppb. Finally, in one of the most recent studies, Pfister (2008) simulated the large 2007 fires in both northern and southern California. The author found ozone increases of approximately 15 ppb in many locations and concluded: “Our findings demonstrate a clear impact of wildfires on surface ozone nearby and potentially far downwind from the fire location, and show that intense wildfire periods frequently can cause ozone levels to exceed current health standards” (Pfister 2008).

[2] “Exceptional Events Demonstration for 1-Hour Ozone Exceedances in the Sacramento Regional Nonattainment Area Due to 2008 Wildfires” (CARB 2011).

2.0 CONCEPTUAL MODEL OF OZONE AIR POLLUTION

2.1 TOPOGRAPHY AND METEOROLOGY

Located in southern Nevada, Clark County consists of 8,091 square miles characterized by basin and range topography. It is one of the nation's largest counties, with an area bigger than the states of Connecticut and Delaware combined. The Las Vegas Valley sits in a broad desert basin surrounded by mountains rising from 2,000 feet to over 10,000 feet above the valley floor. The relief map in Figure 2-1 illustrates the basins and mountain ranges surrounding the valley. Terrain within the Las Vegas Valley rises significantly, from approximately 1,200 feet at Lake Mead to 2,000 feet in downtown Las Vegas to over 2,800 feet in the suburbs on the west side of the valley, near the Spring Mountain Range.

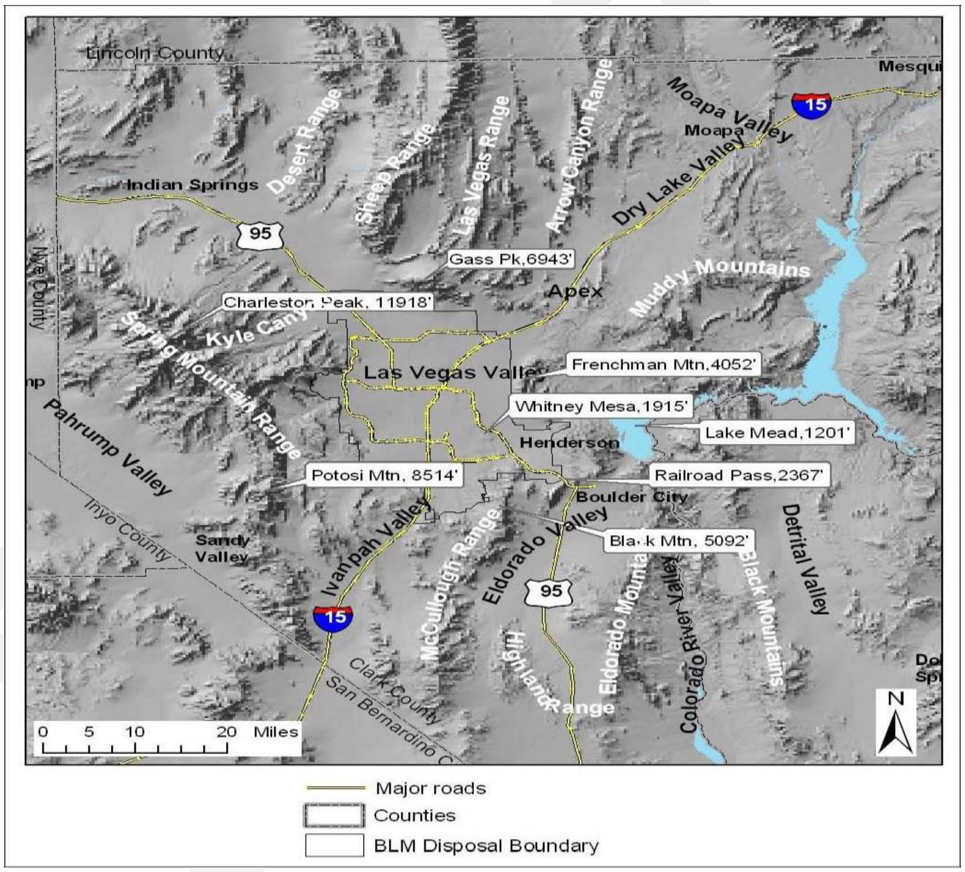


Figure 2-1. Mountain Ranges and Basins Surrounding the Las Vegas Valley.

Although located in the Mojave Desert, Clark County has four well-defined seasons. Summers display the classic characteristics of the desert Southwest: daily high temperatures in the lower elevations often exceed 100ºF, with lows in the 70s. The summer heat is usually tempered by low relative humidity, which may increase for several weeks during July and August in association with moist monsoonal wind flows from the south. Average annual rainfall in the valley, measured at McCarran International Airport, is approximately 4.5 inches. Table 2-1 lists temperature and rainfall averages in Clark County from 1981–2010.

Table 2-1. Monthly Averages for Temperature and Rainfall (1981-2010)

Month	Maximum (°F)	Minimum (°F)	Average (°F)	Rainfall (inch)
January	58	39.4	48.7	0.54
February	62.5	43.4	52.9	0.76
March	70.3	49.4	59.9	0.44
April	78.3	56.1	67.2	0.15
May	88.9	65.8	77.3	0.12
June	98.7	74.6	86.7	0.07
July	104.2	80.9	92.5	0.4
August	102	79.3	90.6	0.33
September	94	71.1	82.6	0.25
October	80.6	58.5	69.5	0.27
November	66.3	46.5	56.4	0.36
December	56.6	38.7	47.7	0.5

Source: http://www.ncdc.noaa.gov

2.2 POPULATION AND LAND USE

The population of Clark County is just over two million. More than 95 percent reside in the Las Vegas Valley, which encompasses the cities of Las Vegas, North Las Vegas, and Henderson, along with portions of Boulder City near Hoover Dam. Figure 2-2 depicts land use and vegetation in Clark County, along with the two major transportation routes, Interstate 15 and U.S. Highway 95.

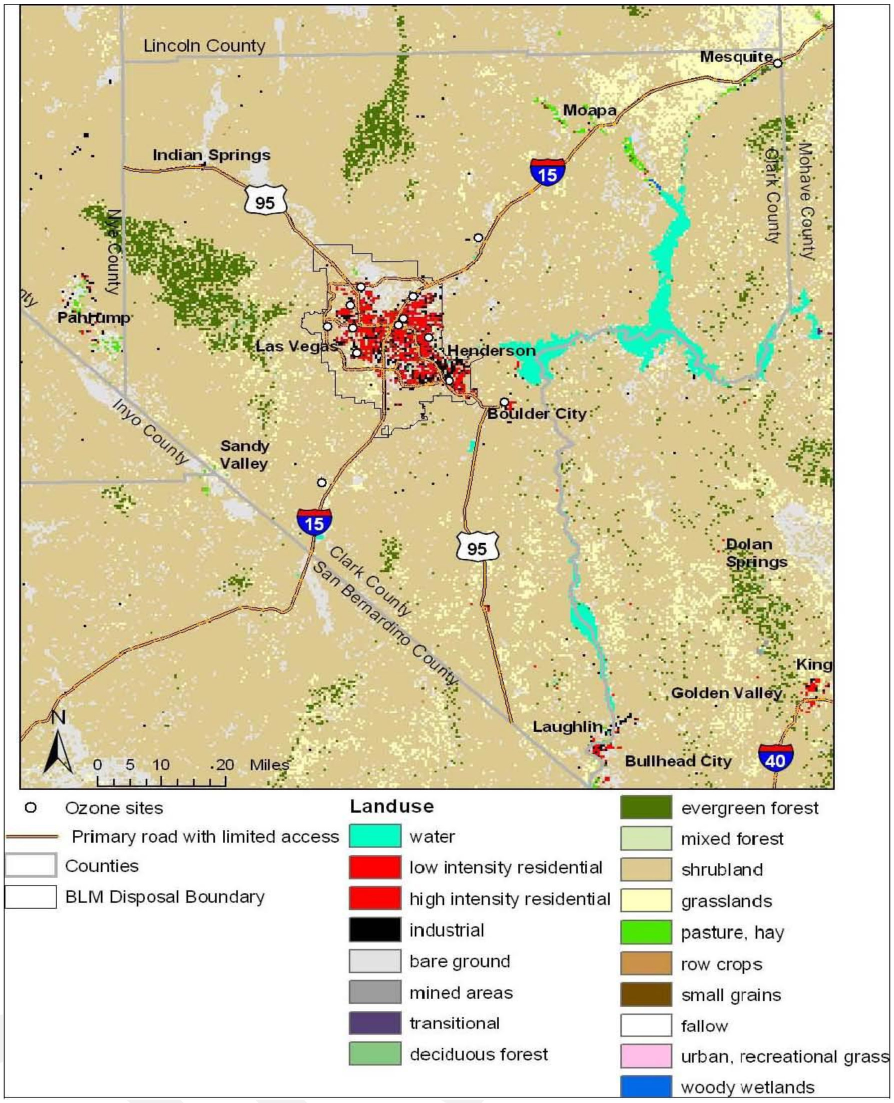


Figure 2-2. Land Use and Vegetation in Clark County.

2.3 OZONE AIR POLLUTION IN CLARK COUNTY

In 2006, DAQ embarked on a research study to characterize and identify meteorological features that affect the timing and locations of elevated ozone levels in Clark County (DAQEM 2006a).

In the study, synoptic weather patterns during the ozone season (May–August) were analyzed using 500 millibar (mb) constant-pressure maps. Specific measured weather parameters were used, including the 500 mb height and the ambient air temperature at the 700 mb level at the Desert Rock National Weather Service (NWS) upper-air site. Temperatures aloft at the 700 mb level indicate the mixing potential (stability) of the regional air mass dominating the area at the time of measurement: warmer air at 700 mb (~10,000 ft [3,000 m]) indicates a stable atmosphere and poor dispersion conditions, while cooler air aloft is associated with more vigorous vertical mixing of pollutants and better dispersion. From the analysis, it was determined that weather patterns could be characterized into five basic weather types: Pacific Trough, Interior Trough, Pacific

Ridge, Interior Ridge, and Flat Ridge. The characteristics and criteria for each weather type are described below.

2.3.1 Pacific Trough

The axis of the long-wave 500 mb trough, or series of short-wave troughs, is located off or along the Pacific Coast, producing falling 500 mb heights and wind increases from a westerly to southwesterly flow. By convention, the lowest 500 mb heights during this weather type are west of the Sierra Nevada Mountains. This type of trough influences atmospheric dispersion conditions in the interior southwestern U.S. by slowly eroding the strength and longevity of stable anti-cyclonic air masses; this which results in the breaking down of the broad-scale subsidence needed to sustain poor dispersion conditions. Also by convention, the Pacific Trough designated weather type includes zonal flow situations characterized by light to moderate straight west-to-east flow across the western U.S. The southerly component of the onshore flow characteristic of the Pacific Trough may also allow for increased moisture aloft over the interior regions. In general, the 700 mb temperature at the Desert Rock upper-air station is less than 10ºC during Pacific Trough occurrences.

2.3.2 Interior Trough

When the axis of a long- or short-wave trough, or of a closed cyclonic system, resides in the interior of the southwestern U.S., the designated synoptic weather type is an Interior Trough. In this type, the lowest 500 mb heights are east of the Sierra Nevada Mountains. The most significant characteristic of this pattern is the advent of cool air aloft in the interior southwest and resultant well-mixed dispersion conditions. Temperatures at 700 mb are usually below 8ºC, and may be as low as 0ºC during the early part of the ozone season. When advected moisture is available aloft, considerable cloudiness and escalated precipitation potential may also accompany the Interior Trough synoptic type.

2.3.3 Pacific Ridge

The Pacific Ridge synoptic weather type is directly associated with the mean eastern Pacific ridge, with the axis of highest pressure situated along or west of the Pacific coast. The convention for this feature requires that the highest 500 mb heights be located west of the Sierra Nevada Mountains. The maximum 500 mb heights usually exceed 5,900 meters near the core of the ridge, but these heights may be considerably lower at the Desert Rock upper-air site.

Another convention for the Pacific Ridge designation requires that the 500 mb flow over southern Nevada be from a northerly direction (west-northwesterly to northeasterly), reflecting the counterclockwise motion around the anti-cyclonic air mass to the west. During the first half of the ozone season, the northerly flow aloft results in the advection of cooler, less stable air into the region; during the latter second half of the season, the northerly flow often brings in warmer, drier air. The Desert Rock 700 mb temperature may be as low 5ºC (in the early season) or as high as 12ºC (in the late season). The Pacific Ridge weather type usually marks the beginning of an anti-cyclonic situation and often will follow a cyclonic event, especially in the earlier part of the season. It is also not unusual for this type to be the result of the retro-gradating of a ridge located farther east. The Pacific Ridge weather type is usually more transient than other ridging situations and thus tends to occur for shorter durations, often as a transition into other, longer-lived anti-cyclonic regimes.

2.3.4 Interior Ridge

The primary characteristic of the Interior Ridge weather type is the existence of a discernible high-pressure ridge at the 500 mb level over the interior southwestern U.S. The convention for this feature is that the highest 500 mb heights be located east of the Sierra Nevada Mountains. The interior ridge typically occupies the Great Basin and Intermountain region and is often centered near the Four Corners area, about 500 miles east of Las Vegas. The height of the 500 mb surface over the Desert Rock upper-air site is usually above 5,900 m, and can reach as high as 5,990 meters. The 700 mb temperature in this pattern usually exceeds 12ºC, and can go as high as 16ºC. The warm temperatures aloft indicate strong air mass subsidence in the interior region, meaning valley capping and limited thermodynamic mixing prevail; however, because of the lack of cool air advection, the hottest local surface temperatures of the year are usually recorded during Interior Ridge events, although mixing-layer depths may be deeper due to intense surface heating. Flow aloft at Desert Rock is usually very light and potentially variable when the ridge axis is over southern Nevada, but easterly to southeasterly winds predominate when the ridge center is farther east.

2.3.5 Flat Ridge

When the eastern Pacific Ridge broadens to extend over the ocean and the interior West, with little transitory movement, the resulting weak anticyclonic air mass is classified as a Flat Ridge. In this pattern, all of the synoptic-scale energy lies well to the north and the pressure gradients, both at the surface and aloft, are very weak. The 500 mb surface may not always be as high as in the stronger ridging types (i.e., Pacific and Interior), but it is still typically greater than 5,900 m over most of the region. Because of the relatively weak anticyclonic pattern, significant air mass subsidence is prevalent; as a result, interior valleys remain capped and stable. This scenario is the most conducive to increased episodic pollution carryover from one day to the next.

2.4 SYNOPTIC WEATHER PATTERNS ASSOCIATED WITH THE EVENT

The 250, 500 and 850 mb time-series images for July 2–3, 2013, and the 500 mb chart for July 4, 2013 were examined to determine the synoptic weather patterns prior, during and after the July 3, 2013 event. The synoptic weather patterns are as follows.

<u>July 2</u>

Prior to the event the four 250 mb, 500 mb and 850 mb time-series images in Figures 2-1 through 2-3 show a high pressure Pacific Ridge centered primarily over Nevada. All levels show an easterly flow into Clark County.

<u>July 3</u>

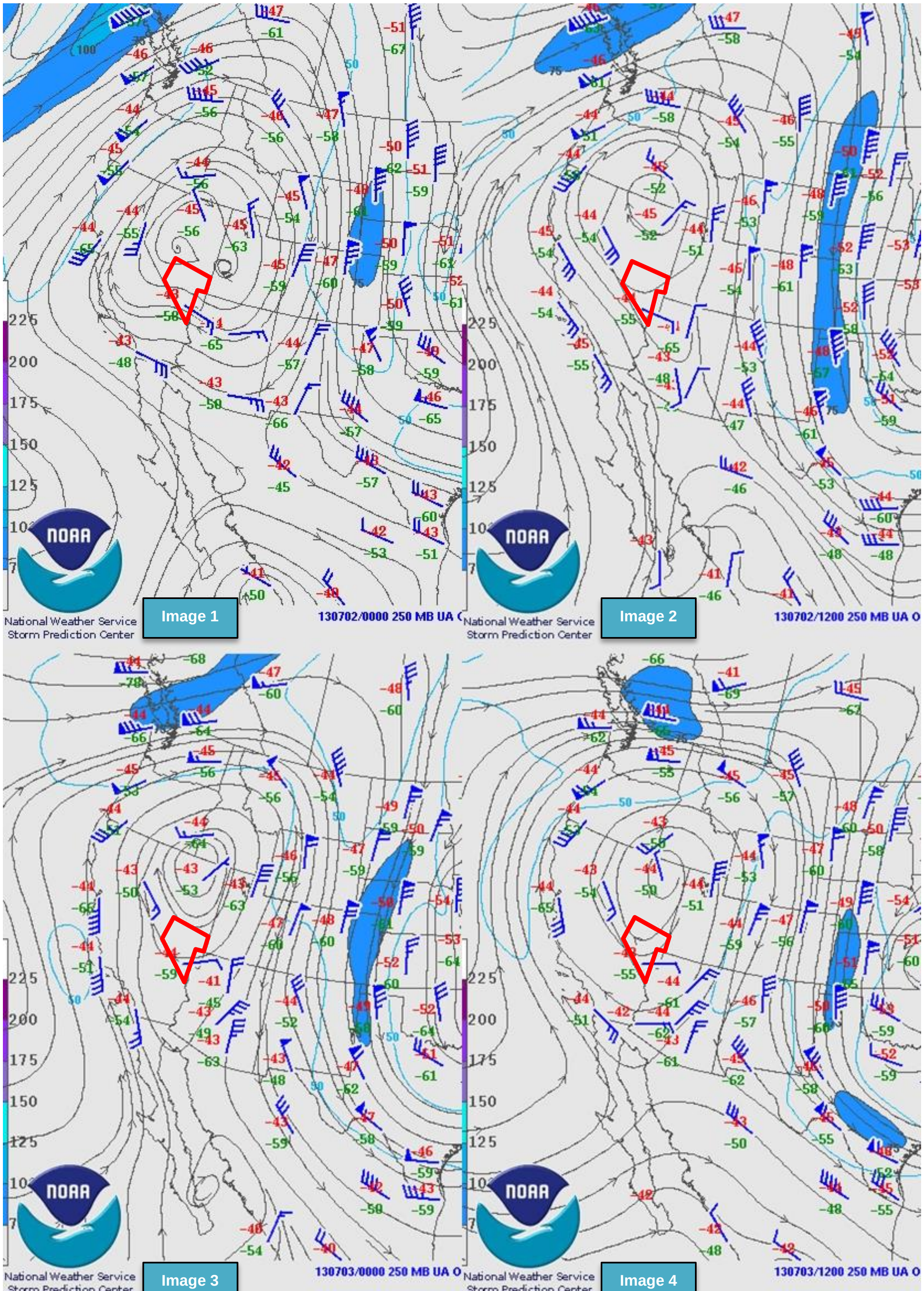
During the event, the Pacific Ridge slightly weakened and retrogressed to the south.200 mb time-series images in Figure 2-4 (Images 1–3). As a result, the directional flow repositioned from the northeast. The three 500 mb time-series images in Figure 2-5 (Images 1–3) show the weakening of a closed high to a ridge, which has retrograded to the south. The 850 mb time-series images in Figure 2-6 (Images 1–3) show the Pacific Ridge retrograding to the west off the California coast-line. All levels show northeast-to-easterly regional airflow giving way to a southwesterly airflow at the end of the period.

<u>July 4</u>

After the event, the four 500 mb time-series images in Figure 2-7 (Images 1–4) show the Pacific Ridge continued to weaken and slowly retrograde south. The weakening and retrogression of the Pacific Ridge resulted in a slight shift of the directional airflow from southwesterly to south-southwesterly.

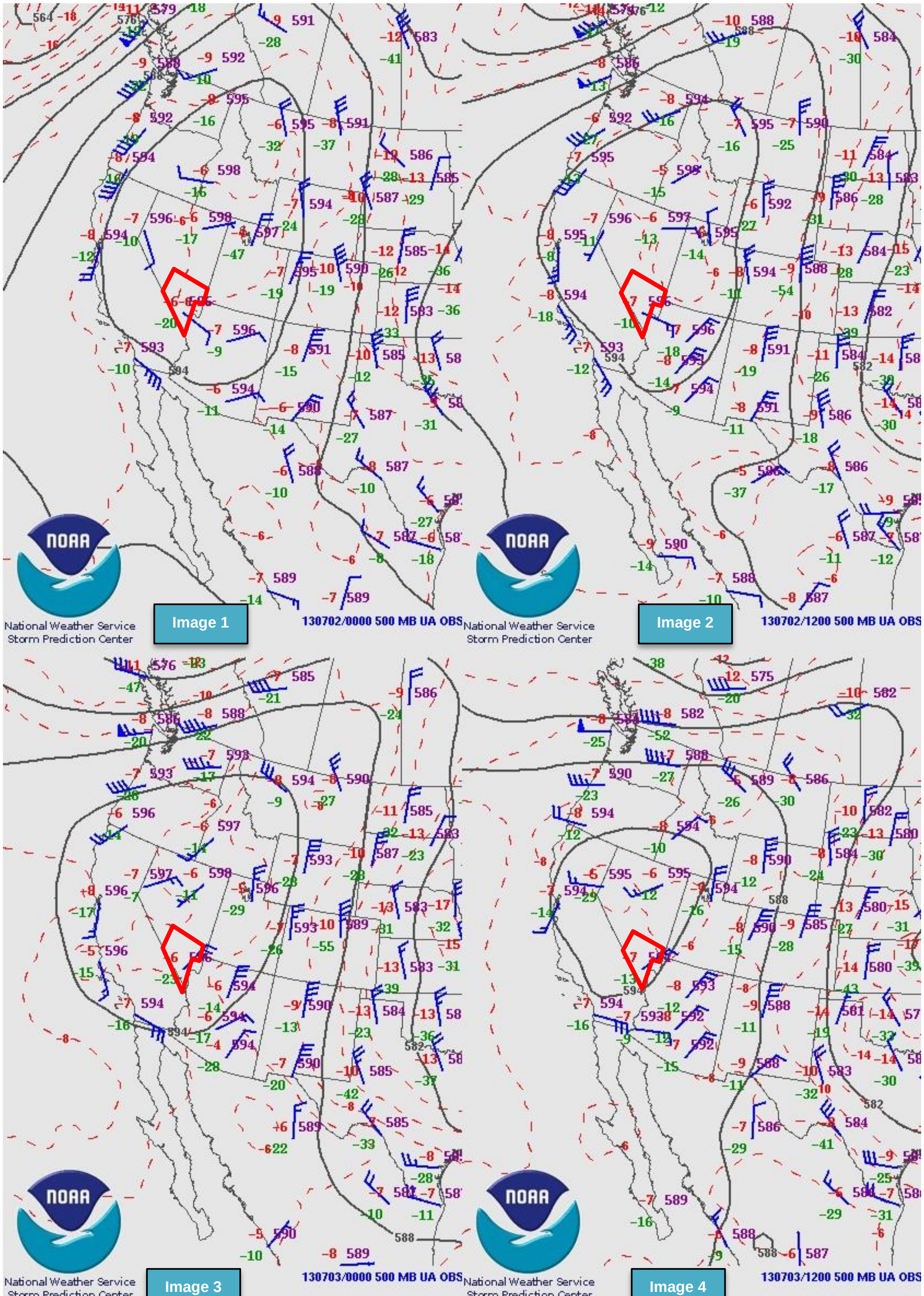
<u>Conclusion</u>

On July 2, a well-established Pacific Ridge dominated the southwest causing an easterly flow, at all levels, into Clark County. By July 3, the ridge (or high-pressure system) moved enough to the south to cause a directional change in flow from the northeast at all levels.



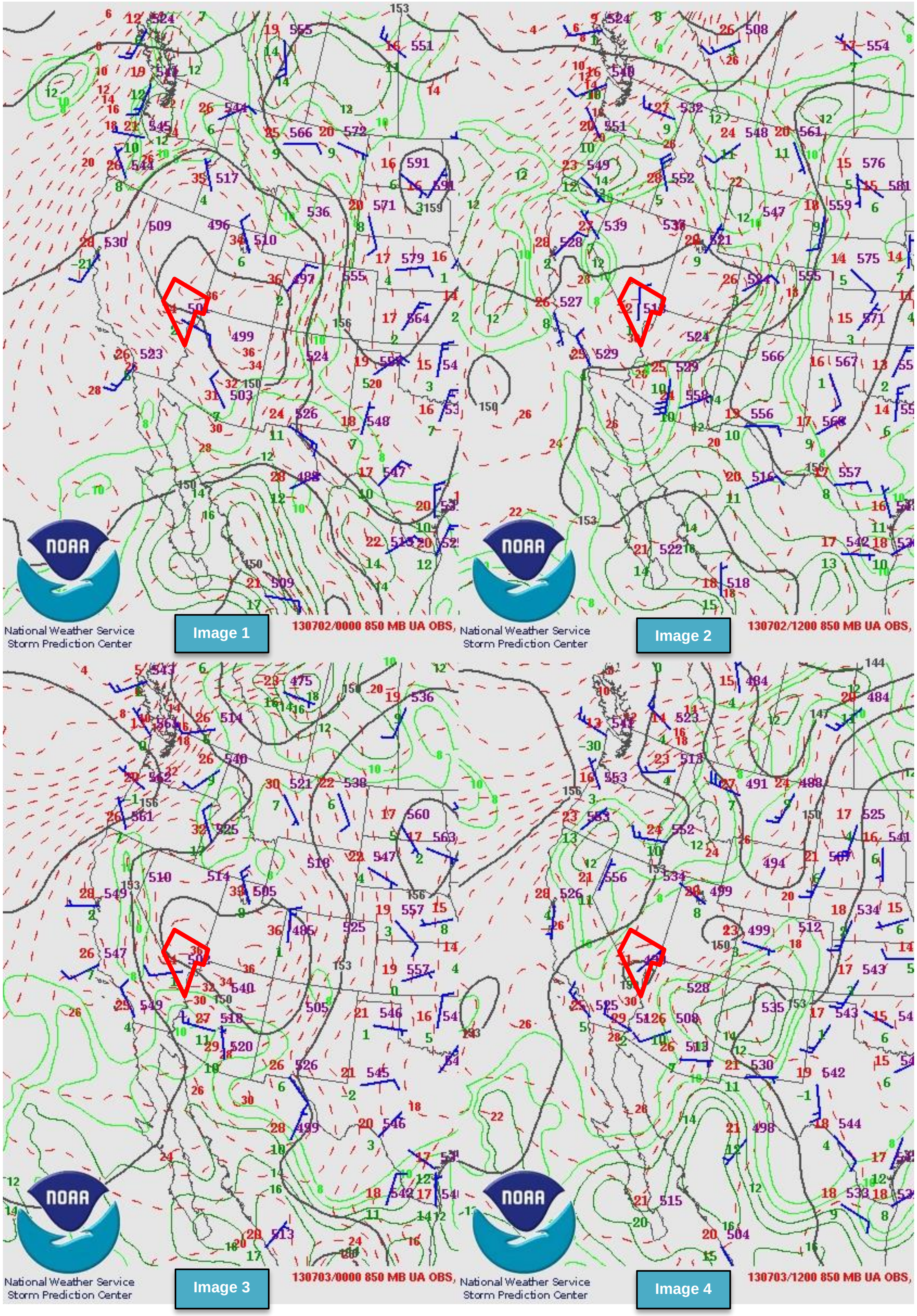
Represents Clark County, NV

Figure 2-1. 250 mb Weather Images for 7/2/13.



Represents Clark County, NV

Figure 2-2. 500 mb Weather Images for 7/2/13.



Represents Clark County, NV

Figure 2-3. 850 mb Weather Images for 7/2/13.

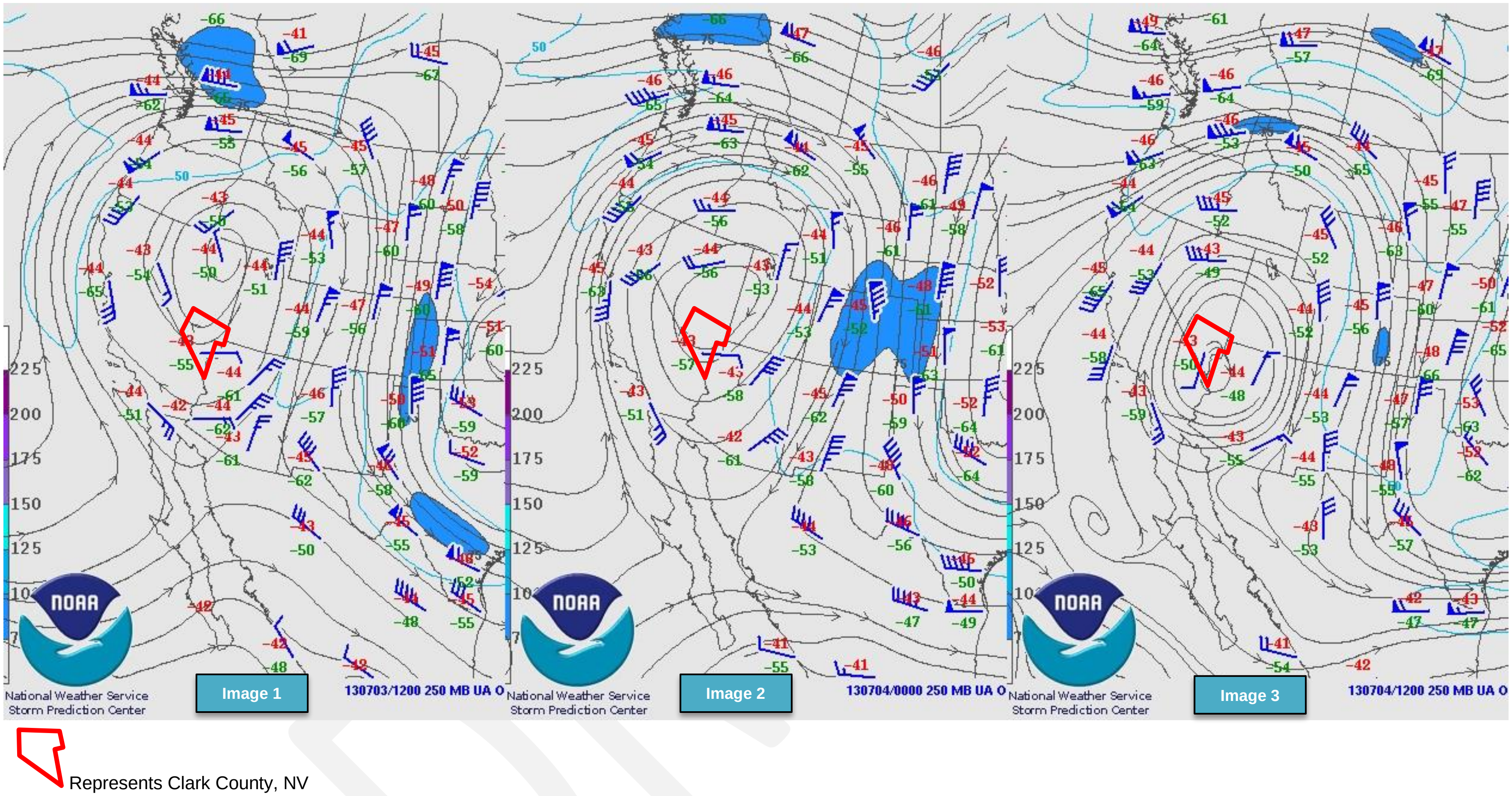


Figure 2-3. 250 mb Weather Images for 7/3/13.

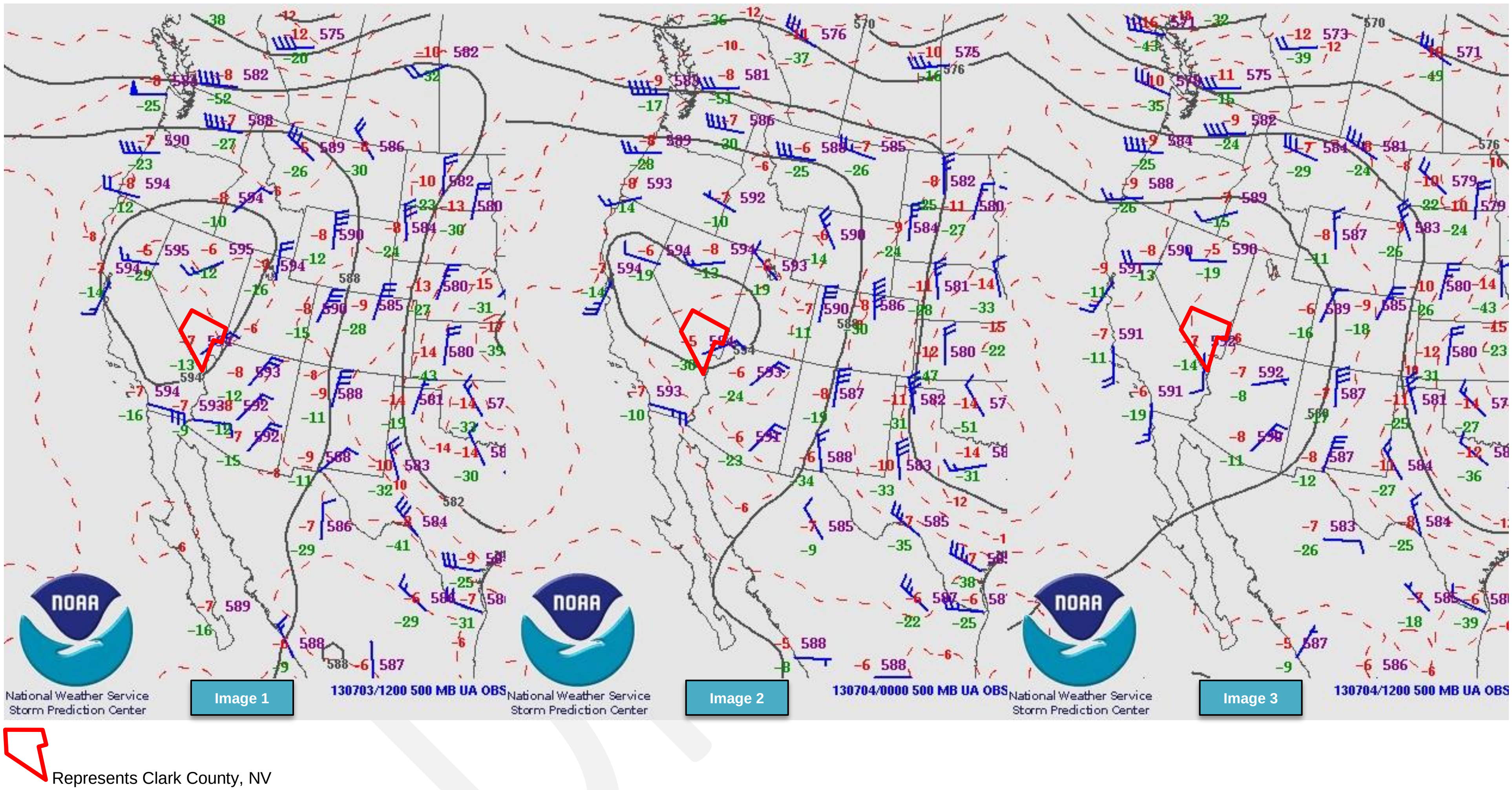
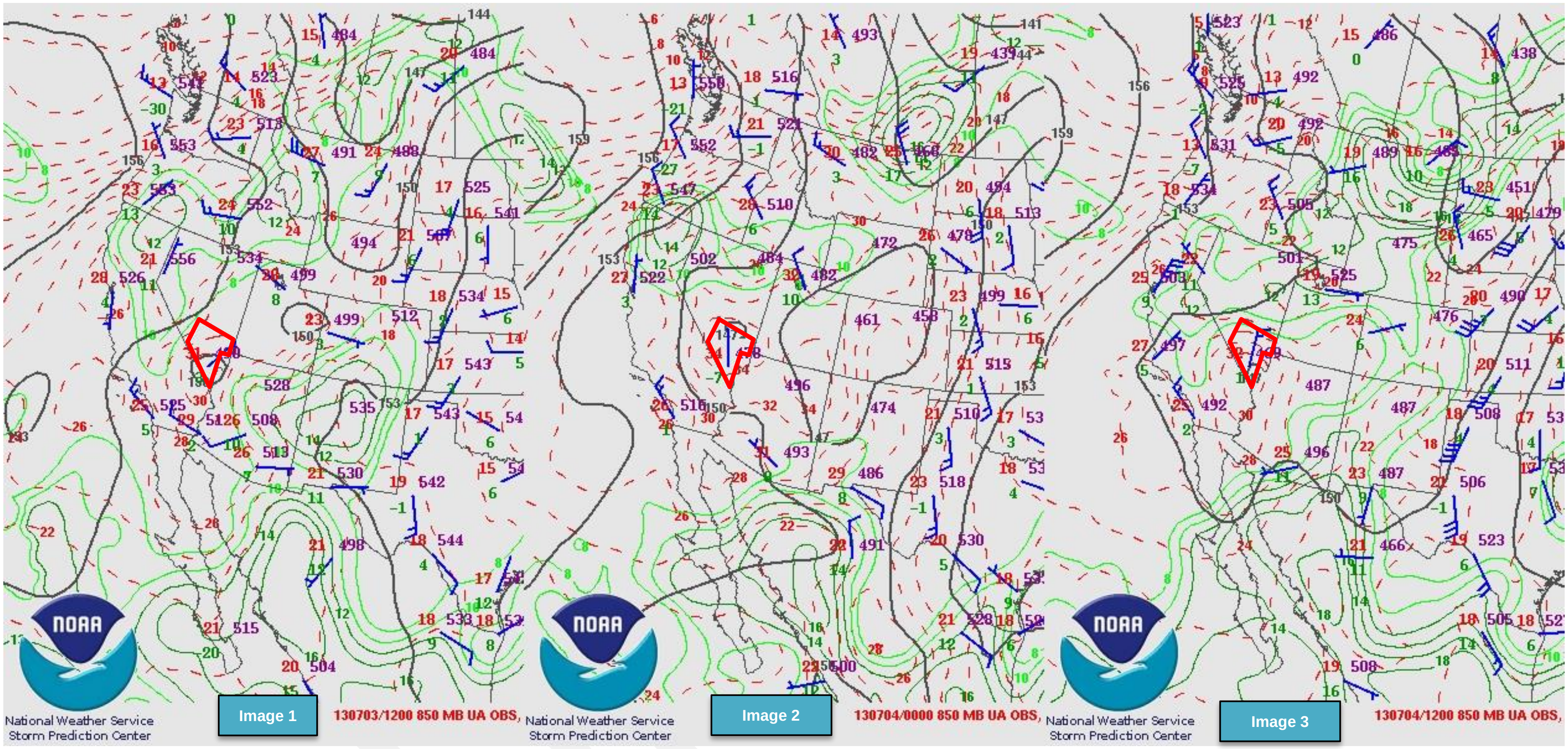


Figure 2-4. 500mb Weather Images for 7/3/13.



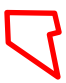
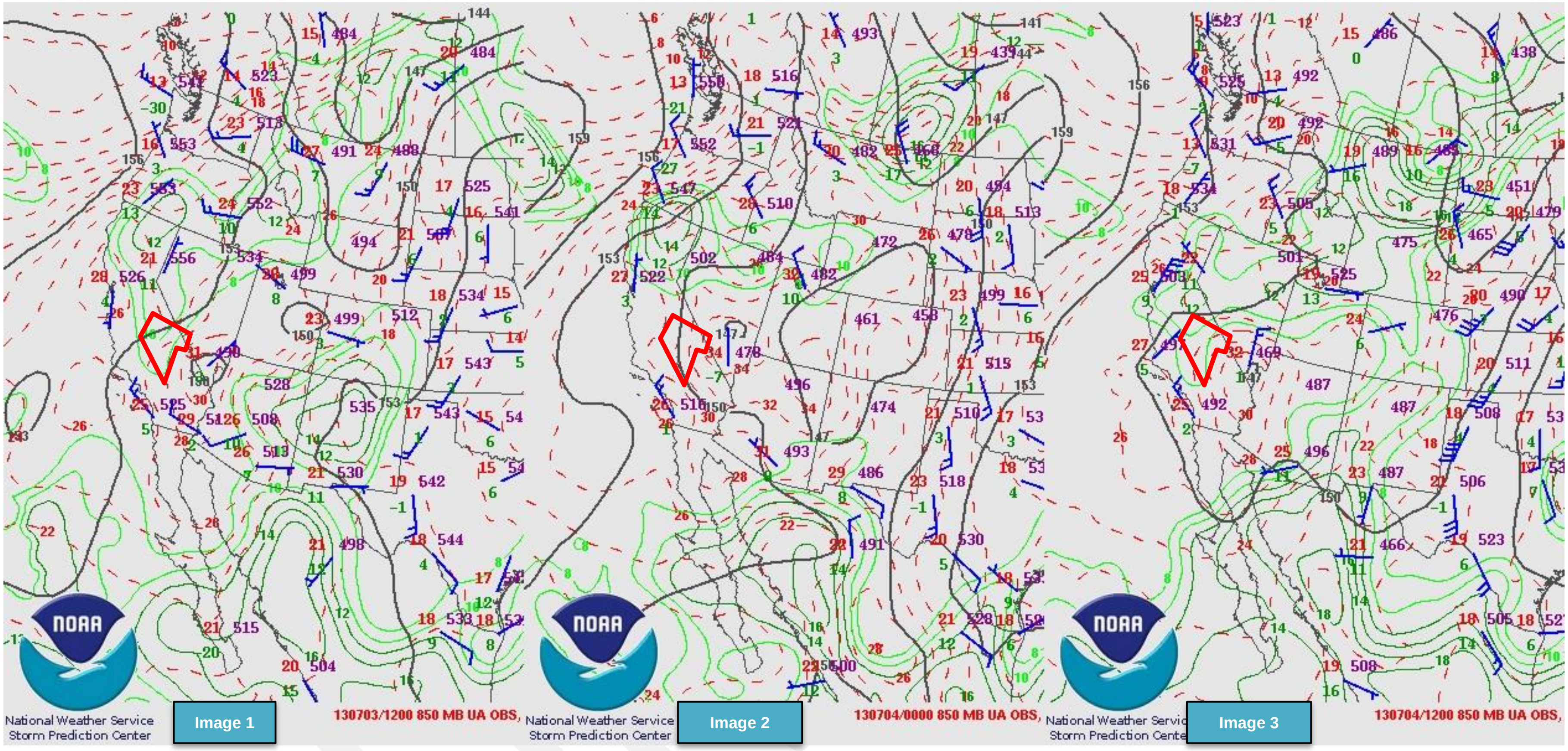
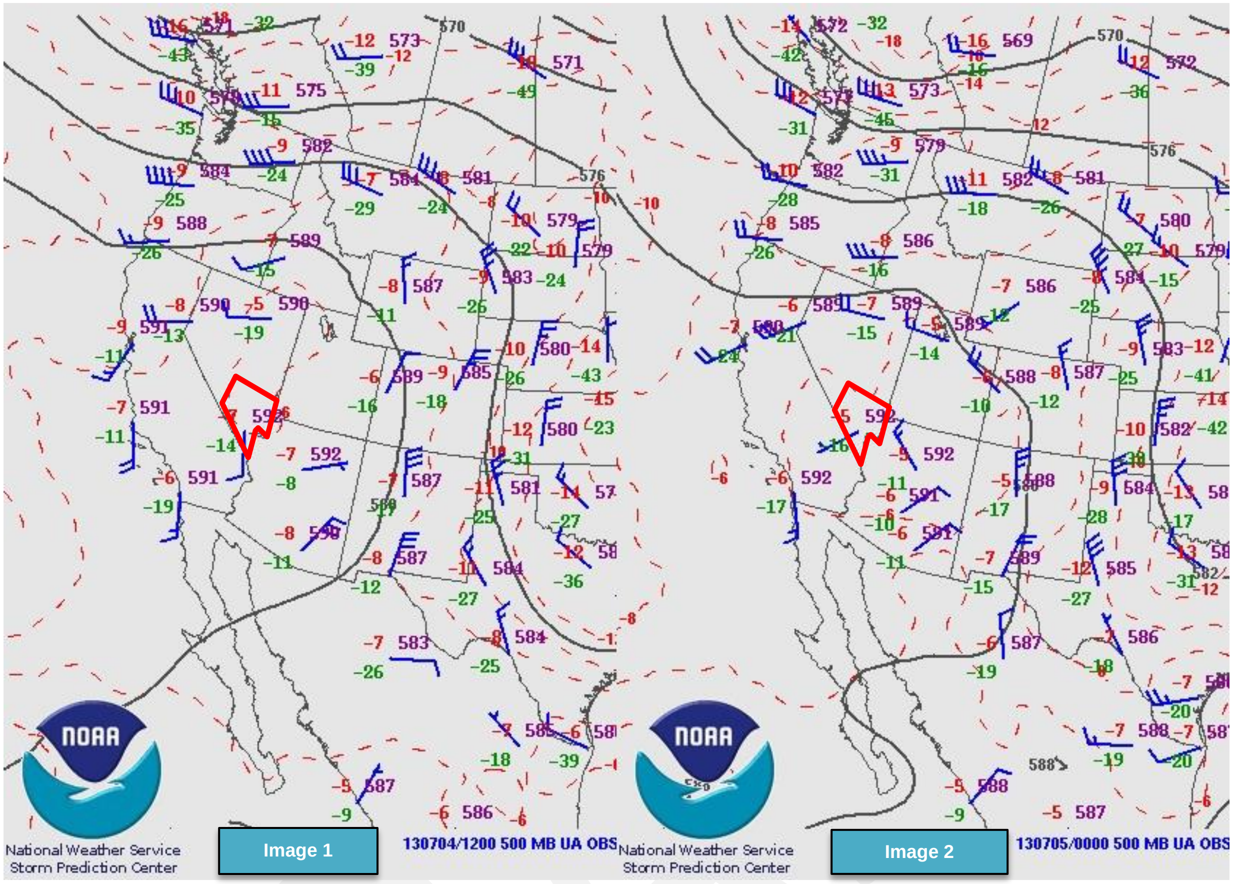

Represents Clark County, NV

Figure 2-5. 850mb Weather images for 7/3/13.



Represents Clark County, NV.

Figure 2-6. 850mb Weather Images for 7/3/13.



 Represents Clark County, NV

Figure 2-7. NOAA 500mb Storm Prediction Images for 7/4/13.

3.0 CLEAR CAUSAL RELATIONSHIP

3.1 INTRODUCTION

Smoke plumes from wildfires contain a variety of pollutants, including VOCs and NO_x—both precursor pollutants in the formation of ozone—and particulate organic and inorganic compounds. Plumes affect air quality not only through emissions of primary pollutants, e.g., CO, PM, VOCs, and NO_x, but also through production of secondary pollutants when VOCs and NO_x undergo photochemical processing during atmospheric transport, e.g., ozone and secondary organic aerosols. Table 3-1 lists the range of pollutants emitted, expressed as emission factors, which are defined as the mass of compounds released per mass of dry fuel consumed. The table demonstrates that significant amounts of VOCs are released during wildfires; in fact, total VOC emissions exceed those of $PM_{2.5}$, accounting for 1–2 percent of the carbon fuel burned.

Table 3-1. Chemical Compositions and Emission Factors for Wildfires

Compound or Compound Class	Emission Factors (g/kg)	
	Temperate Forest	Temperate Rangeland
$PM_{2.5}$	11.7	9.7
Organic carbon (wt. percent of $PM_{2.5}$)	45 - 55	40 - 70
Elemental carbon (wt. percent of $PM_{2.5}$)	4 - 8	4 - 10
Elemental Species (wt. percent of $PM_{2.5}$):	~ 3	~ 6
• Potassium (K, wt. percent of $PM_{2.5}$)	~ 1	~ 3
• Chloride (Cl, wt. percent of $PM_{2.5}$)	0.3	2
CO	89.6 ± 13.2	69 ± 17
CO_2	1619 ± 112	1684 ± 45
Alkanes (C2-C10)	0.8	0.4
Alkenes (C2-C9)	2.2	1.8
Aromatics (BTEX)	0.64	0.42
Oxygenated VOCs:	10.9 – 12.9	N/A
• Methanol	0.31 – 2.03	0.14
• Formic acid	1.17	N/A
• Acetic acid	3.11	N/A
• Formaldehyde	2.25	N/A
• Acetaldehyde	0.24	0.25
• Acetone	0.347	0.25
• Acrolein (propenal)	0.123	0.08
• Furan	0.445	0.1
• 2-methyl-furan	0.521	N/A
• 3-methyl-furan	0.052	N/A
• 2,5-dimethyl-furan	0.053	N/A
• Benzofuran	0.038	N/A

N/A = not available; BTEX = benzene, toluene, ethylbenzene, and xylenes.

3.2 CAUSAL RELATIONSHIP

3.2.1 Meteorological Conditions

On July 2, a well-established Pacific Ridge dominated the southwest causing an easterly flow, at all levels, into Clark County. By July 3, the ridge – or high-pressure system – moved enough to the south to cause a directional change in flow from the northeast at all levels.

3.2.2 Laboratory Analysis of $PM_{2.5}$ Samples

Concentrations of $PM_{2.5}$ track closely with those of levoglucosan, a key chemical tracer for biomass burning (Simoneit et al., 1999; Fraser and Lakshmanan, 2000). Levoglucosan, a 1,6-anhydride of glucose, is one of the major organic components of ambient PM from burning biomass (e.g., plants or wood); it is formed by the pyrolysis of cellulose at temperatures over 300ºC.

Researchers use individual chemical markers or chemical ratios to attribute ambient PM concentrations to specific sources, such as biomass combustion, vehicle emissions, or industrial sources. Ideally, these markers should be unique to the source, stable in the atmosphere, and present in measurable quantities. Levoglucosan is unique to the combustion of cellulose, relatively stable under atmospheric conditions, and emitted in quantities large enough for it to serve as an ideal tracer for general biomass burning.

$PM_{2.5}$ samples from the Clark County monitoring network (Figure 3.1) were analyzed for the presence of levoglucosan. Concentrations of levoglucosan were used to determine the composition of the biomass burned and, therefore, the area in which the wildfire likely originated. DAQ then examined the correlation between concentrations of $PM_{2.5}$, O_3, and levoglucosan to establish smoke impacts on the area at ground level.

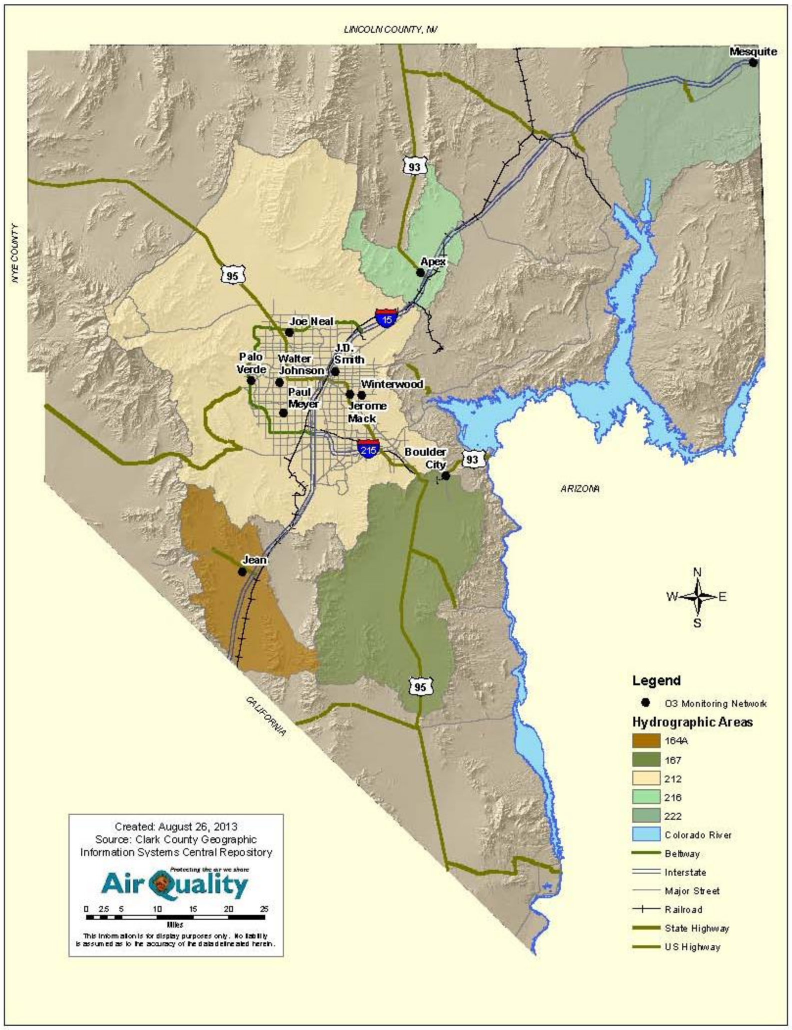


Figure 3-1. Clark County Ozone Monitoring Network.

In 2011, RTI International analyzed six $PM_{2.5}$ filters for traces of levoglucosan to determine the background concentrations at the Jean and Jerome Mack monitoring sites. Three days without any fire impacts—one in June, one in July, and one in August—were chosen for the analysis. Table 3-2 shows the filter numbers and dates.

Table 3-2. Filter and Sample Days

Date	Jerome Mack	Jean
June	FD-T0728928-110620	FD-T0728929-110620
July	FD-T0728978-110720	FD-T0728979-110720
August	FD-T0729017-110810	FD-T0729018-110810

The results of the analysis (outlined in Table 3-3) show that there were no detectable levoglucosan concentrations for non-fire days; therefore, the background concentration for levoglucosan during non-fire days is zero.

Table 3-3. Filter Analysis Results

Sample Name	µg/mL
FD-T0728928-110620	0.000
FD-T0728929-110620	0.000
FD-T0728978-110720	0.000
FD-T0728979-110720	0.000
FD-T0729017-110810	0.000
FD-T0729018-110810	0.000

During the wildfire event, DAQ collected ambient $PM_{2.5}$ samples at Jerome Mack, Jean, and Sunrise Acres; filter samples collected on July 3 were sent to RTI for analysis. Table 3-4 lists the results of the analyses, which showed that levoglucosan concentrations were elevated on July 3. The results show that the monitors were impacted at ground level by the smoke plume from the Carpenter 1 fire.

Table 3-4. Analyses Results for July 3

Sample ID	Site	Levoglucosan $_{(\mu g)}$
T3536396	SA	0.000
T3536397	$SA_{(col)}$	0.000
T3536398	JN	0.000
T3536399	JM	0.103

Although levoglucocan levels were detected on the $PM_{2.5}$ filter from Jerome Mack, there were major technical problems at the Jerome Mack monitoring station. No values for CO, PM_{10} and $PM_{2.5}$ were recorded during the day, and only limited readings were recorded for O_3. However, levoglucosan concentrations detected on the filters show that smoke plumes from the Carpenter 1 fire did in fact impact the Las Vegas Valley.

3.2.3 Smoke Plume Trajectory Model

The Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model computes simple air parcel trajectories. Its calculation method is a hybrid between the Lagrangian approach, which uses a moving frame of reference as the air parcels move from their initial location, and the Eulerian approach, which uses a fixed three-dimensional grid as a frame of reference. HYSPLIT back-trajectories show the path an air parcel took to reach an area. Applications include tracking and forecasting the release of radioactive material, volcanic ash, and wildfire smoke.

The HYSPLIT plots in Figure 3-2 show 24-hour back-trajectories for July 3. The 24-hour back-trajectories demonstrate that the air masses went directly over the fire and smoke plume and doubled back over Las Vegas.

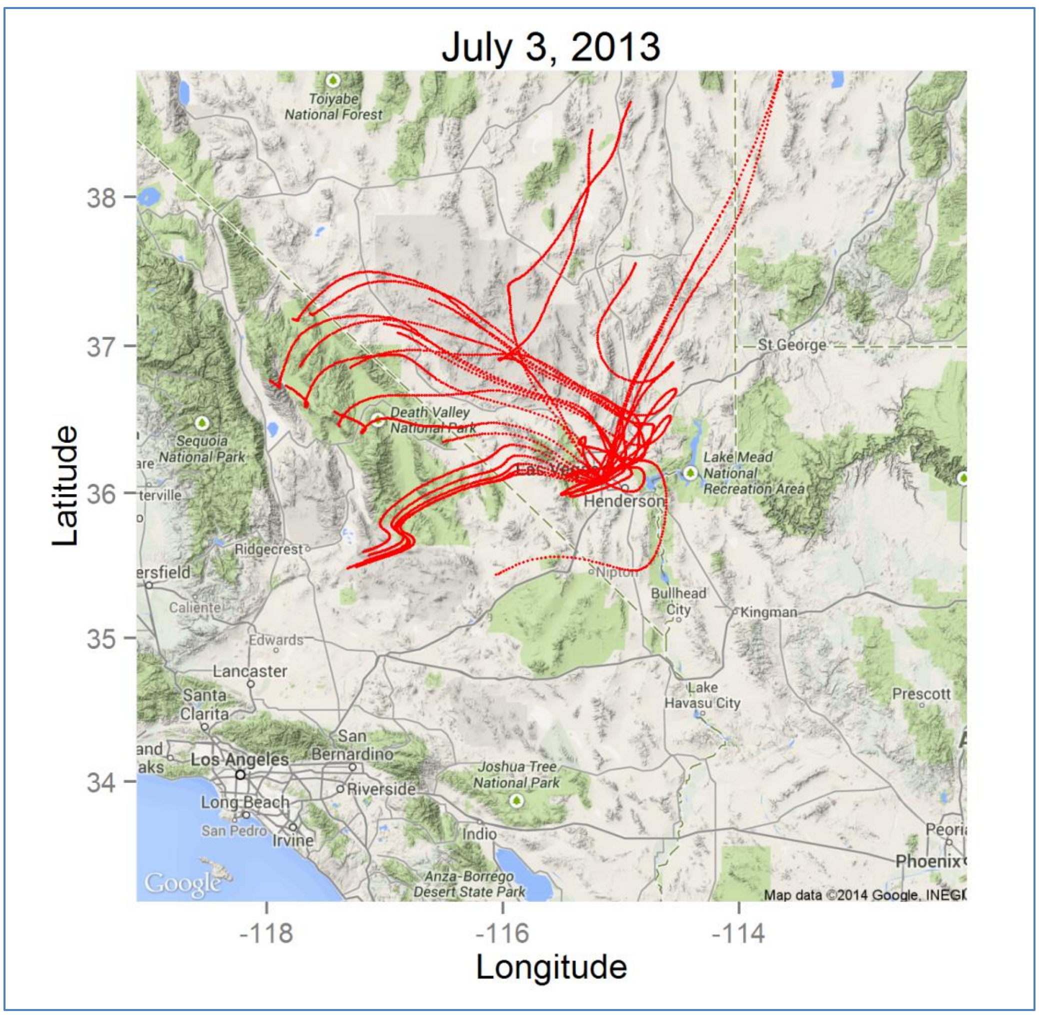


Figure 3-2. Back trajectories.

3.2.4 Pollutant Concentrations and Wildfire Impacts

Ozone concentrations started to increase at 0900 at most stations within the network, with concentrations reaching 90 ppb at Walter Johnson and Paul Meyer at 1400. A total of 4 out of 11 stations violated the O_3 NAAQS in Clark County. Table 3-5 lists the hourly concentrations for the ozone monitors in the network, with exceeding values highlighted in orange.

Table 3-5. Ozone Concentrations for July 3

Site	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Apex	32	30	44	33	30	*28*	31	45	55	60	61	60	66	69	68	70	67	67	61	46	56	47	45	44
Mesquite	42	36	35	*21*	26	23	28	36	45	48	49	52	52	53	53	53	52	51	49	43	49	41	34	21
Paul Meyer	45	36	27	*18*	31	21	33	43	56	64	75	89	86	88	90	90	89	88	77	56	49	49	44	47
Walter Johnson	44	37	32	27	27	*26*	36	45	54	60	74	88	85	83	90	90	92	90	80	53	50	49	46	51
Palo Verde	43	41	38	36	33	*23*	34	40	51	61	67	80	90	83	82	91	89	82	64	51	52	52	53	56
Joe Neal	46	41	42	39	40	*35*	36	49	55	59	65	75	78	79	80	86	85	88	82	61	54	48	45	50
Winterwood	48	51	44	43	35	22	*13*	34	49	52	56	58	58	60	62	62	63	61	59	41	33	34	45	45
Jerome Mack										54	57	60			66	64	66	66	61	37	*28*	36	45	43
Boulder City	49	48	46	44	43	*41*	43	48	51	57	61	62	64	65	67	67	67	66	60	55	57	53	47	47
Jean	55	52	52	51	50	*42*	46	53	54	57	59	63	66	67	67	68	64	61	56	53	49	47	61	52
J.D. Smith				19	*14*	24	35	47	55	63	63	63	64	71	75	76	78	74	72	34	19	46	46	45

Figures 3-3 thru 3-6 illustrate the diurnal cycle at four ozone monitoring sites from July 1–7. On a normal day, ozone values climb in the morning, peak around noon, plateau through the afternoon, and recede in the early evening. The highest ozone concentrations occur during the most intense hours of sunlight, often referred to as the prime ozone cooking period. On July 3, however, the highest O_3 concentrations occurred in the early morning and throughout the evening.

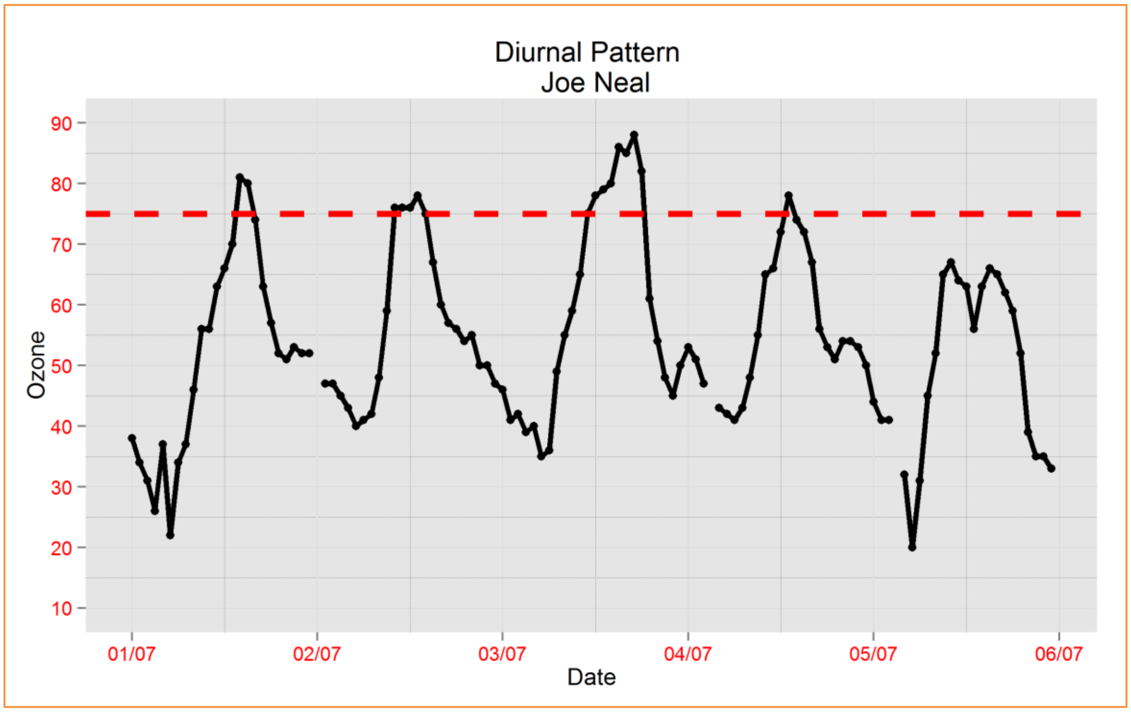


Figure 3-3. Diurnal Cycle for Joe Neal.

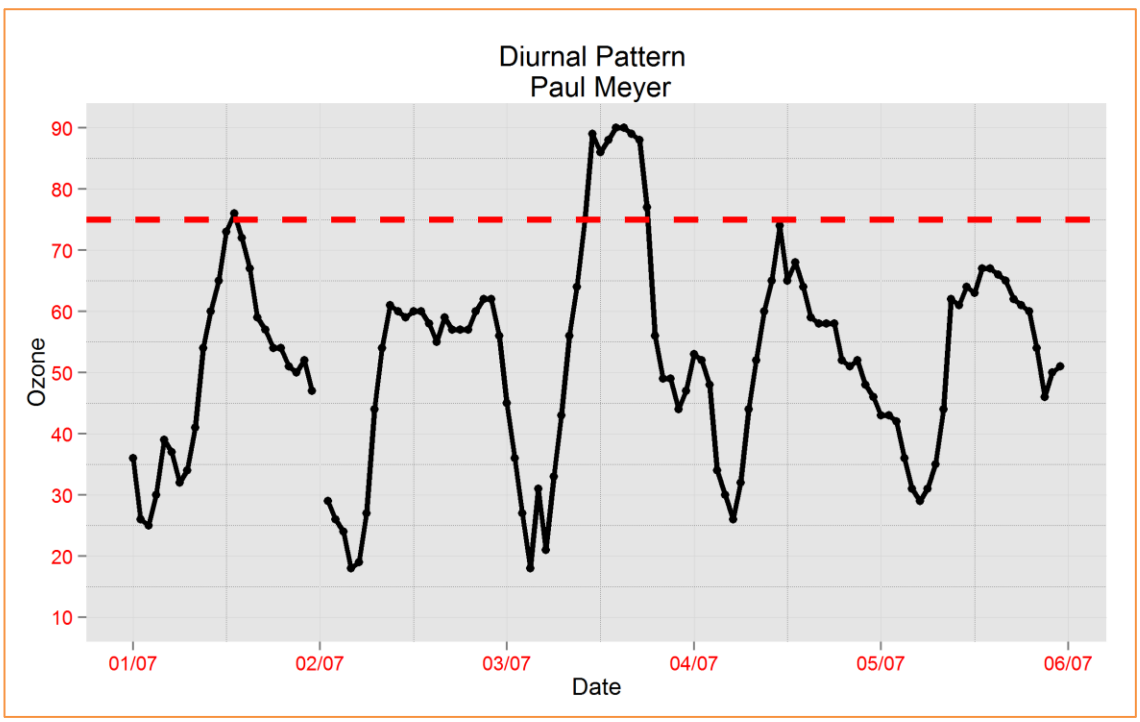


Figure 3-4. Diurnal Cycle for Paul Meyer.

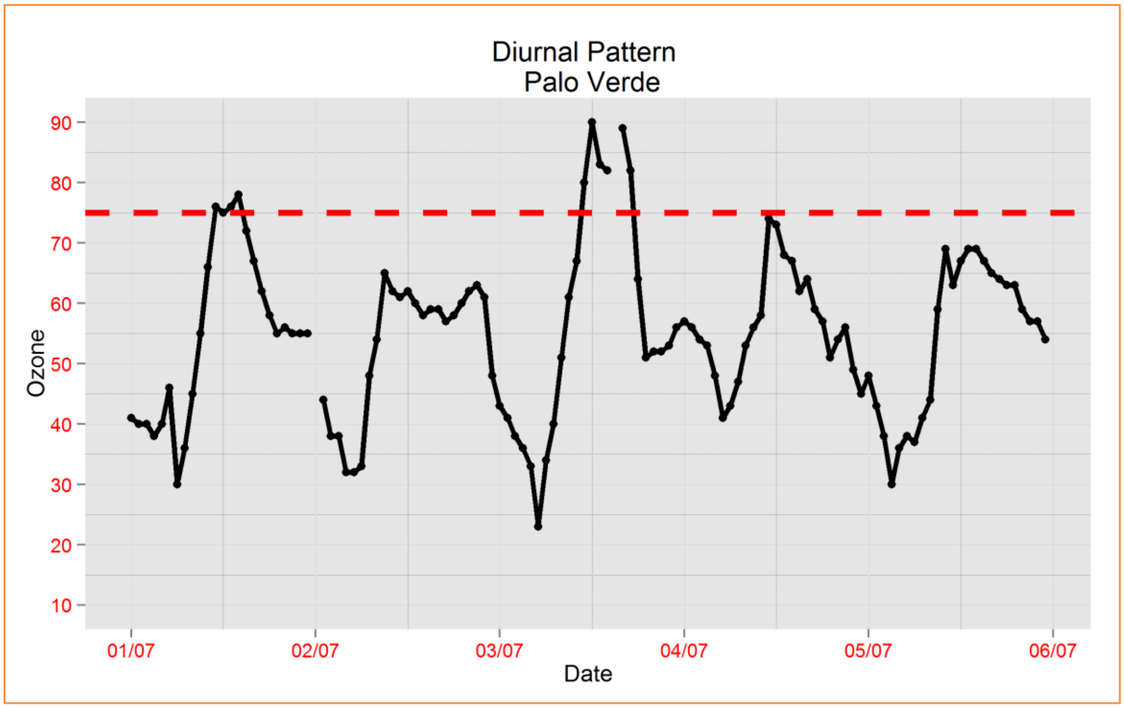


Figure 3-5. Diurnal Cycle for Palo Verde.

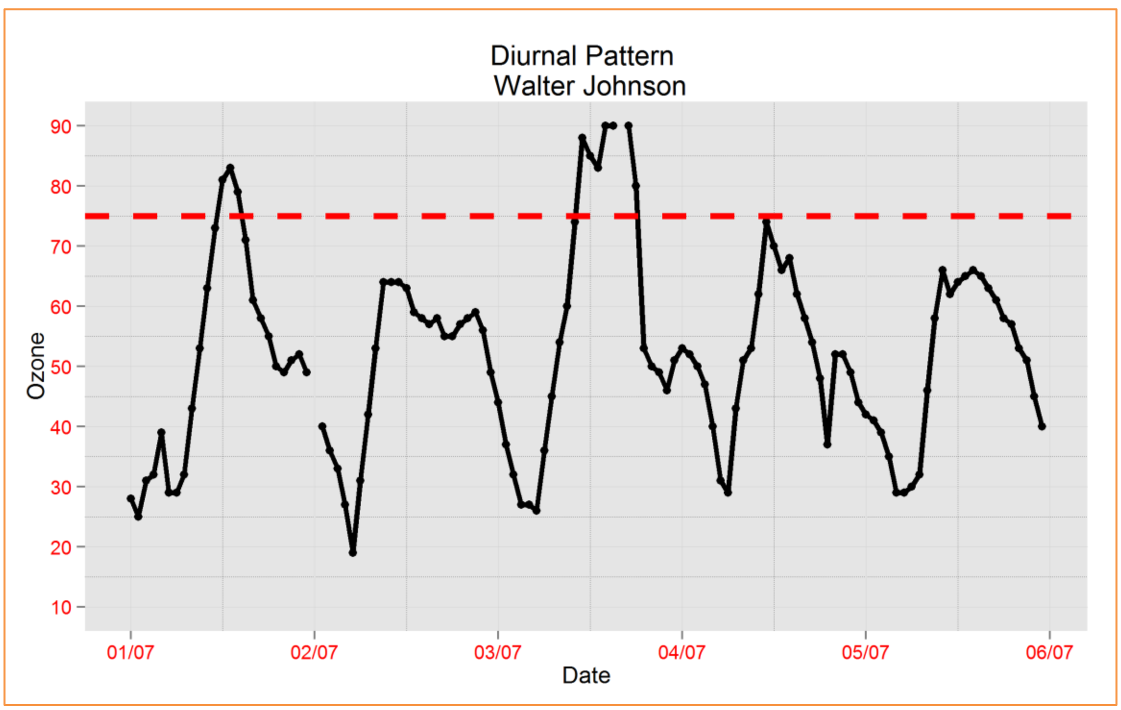


Figure 3-6. Diurnal Cycle for Walter Johnson.

To further illustrate that the ozone concentrations on July 3 were due to an exceptional event, $PM_{2.5}$, CO, and O_3 concentrations were compared before, during, and after the event. The data show the relationship between the different pollutants; this provides strong evidence that the elevated concentrations were due to the smoke from the wildfire, since these pollutants are the products of combustion. Figure 3-7 shows the time series for O_3, CO, and $PM_{2.5}$ levels at J.D. Smith. All values were elevated on July 3, and remained high throughout the evening of July 4; however, the elevated $PM_{2.5}$ levels on July 4 were caused by fireworks during Independence Day celebrations.

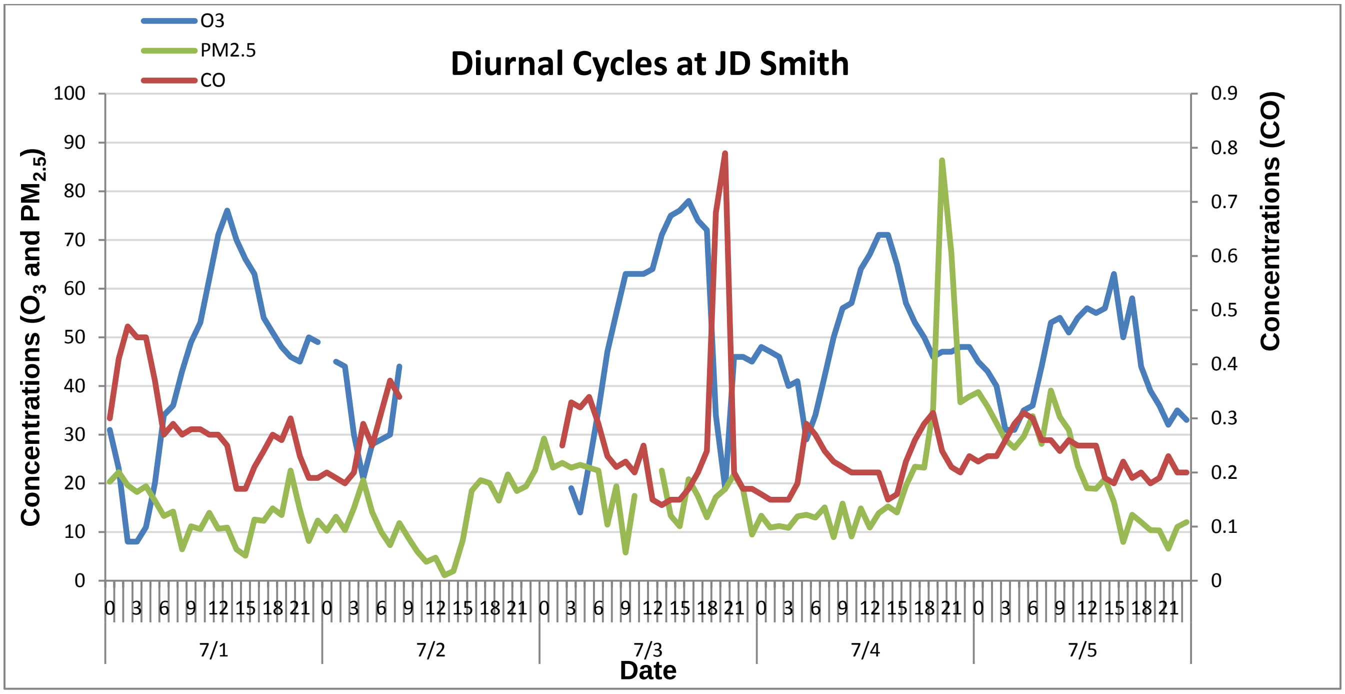


Figure 3-7. Diurnal Cycle at J.D. Smith.

Table 3-6 lists AQI values for O_3, CO, PM_{10}, and $PM_{2.5}$ from July 1–5, 2013. Figure 3-8 demonstrates how closely the AQI values for ozone**,** $PM_{2.5}$, and CO tracked wildfire impacts. Concentrations of the three pollutants were elevated on wildfire days, providing strong evidence of the causal effect of the Carpenter 1 Fire.

Table 3-6. Pollutant AQI Values

Date	PM_{10}	O_3	$PM_{2.5}$	CO
1-Jul	40	87	54	3
2-Jul	33	77	58	3
3-Jul	54	129	64	5
4-Jul	52	77	72	5
5-Jul	57	77	73	3

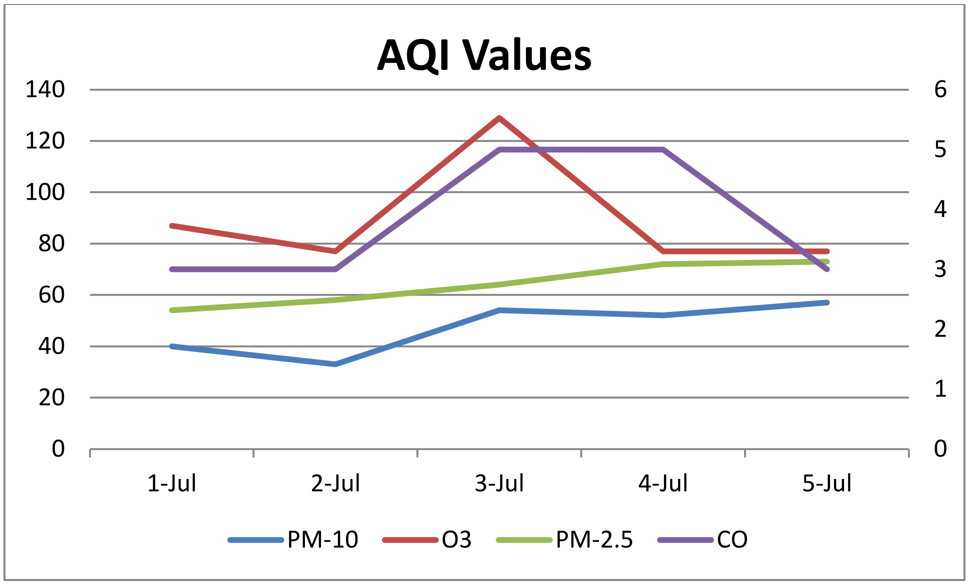


Figure 3-8. Correlation for July 1–5, 2013.

3.3 OZONE CONCENTRATIONS RELATIVE TO HISTORICAL FLUCTUATIONS

In the EER preamble, EPA states that the magnitude of measured concentrations on days affected by an exceptional event relative to historical, temporally adjusted air quality levels can guide the level of analysis and documentation needed to demonstrate that the event affected air quality. For example, EPA acknowledges that less documentation or evidence may be required for extremely high concentrations relative to historical values (i.e., concentrations greater than the 95th percentile). This "weight of evidence" approach reflects how the EPA has historically treated exceptional events.

On July 3, smoke plumes from the Carpenter 1 wildfire resulted in some of the highest ozone concentrations for the season throughout the Clark County air quality monitoring network. Hourly concentrations reached up to 92 ppb (Table 3-5), and some of the highest MDA8 readings of the season were recorded at Paul Meyer and Walter Johnson (Table 3-7).

Table 3-7. Four Highest O_3 Concentrations in 2013

Stations	Highest		Second Highest		Third Highest		Fourth Highest	
	Date	*Value*	*Date*	*Value*	*Date*	*Value*	*Date*	*Value*
Apex	6/21/2013	**78**	4/30/2013	**74**	5/5/2013	**73**	5/4/2013	**73**
Mesquite	5/22/2013	**68**	5/16/2013	**68**	6/21/2013	**67**	6/18/2013	**67**
Paul Meyer	7/3/2013	**87**	5/4/2013	**80**	5/25/2013	**76**	6/21/2013	**75**
Walter Johnson	7/3/2013	**87**	5/4/2013	**80**	5/25/2013	**75**	7/19/2013	**74**
Palo Verde	7/3/2013	**83**	5/4/2013	**82**	5/25/2013	**76**	7/19/2013	**74**
Joe Neal	7/3/2013	**81**	6/21/2013	**77**	5/4/2013	**77**	7/20/2013	**76**
Winterwood	5/4/2013	**76**	6/21/2013	**75**	5/25/2013	**73**	5/21/2013	**71**
Jerome Mack	5/4/2013	**74**	5/25/2013	**73**	6/21/2013	**72**	5/21/2013	**69**
Boulder City	6/21/2013	**74**	5/22/2013	**72**	5/21/2013	**72**	6/22/2013	**71**
Jean	5/4/2013	**84**	5/21/2013	**78**	5/25/2013	**76**	6/21/2013	**75**
J.D. Smith	6/21/2013	**76**	5/25/2013	**74**	5/4/2013	**74**	6/5/2013	**72**

Ozone concentrations recorded during the wildfire event were compared to temporally adjusted air quality levels during the previous three years (2010-2012). A four-year historical analysis was considered reasonable, since attainment/non-attainment classifications are based on a three-year average; ozone concentrations before 2010 would not reflect emission control programs implemented recently.

The technical analyses provided in this document, the documentation on the location and extent of the wildfire, and the laboratory analysis of $PM_{2.5}$ samples that shows high concentrations of wildfire markers on July 3, 2013, together demonstrate that the elevated concentrations of ozone Clark County experience on that day are exceptional relative to historical fluctuations and were caused by wildfire impacts.

Figures 3-9 through 3-12, which depict four years of MDA8 ozone data from five ozone monitoring sites in Clark County, show that concentrations on July 3 reflect an exceptional event.

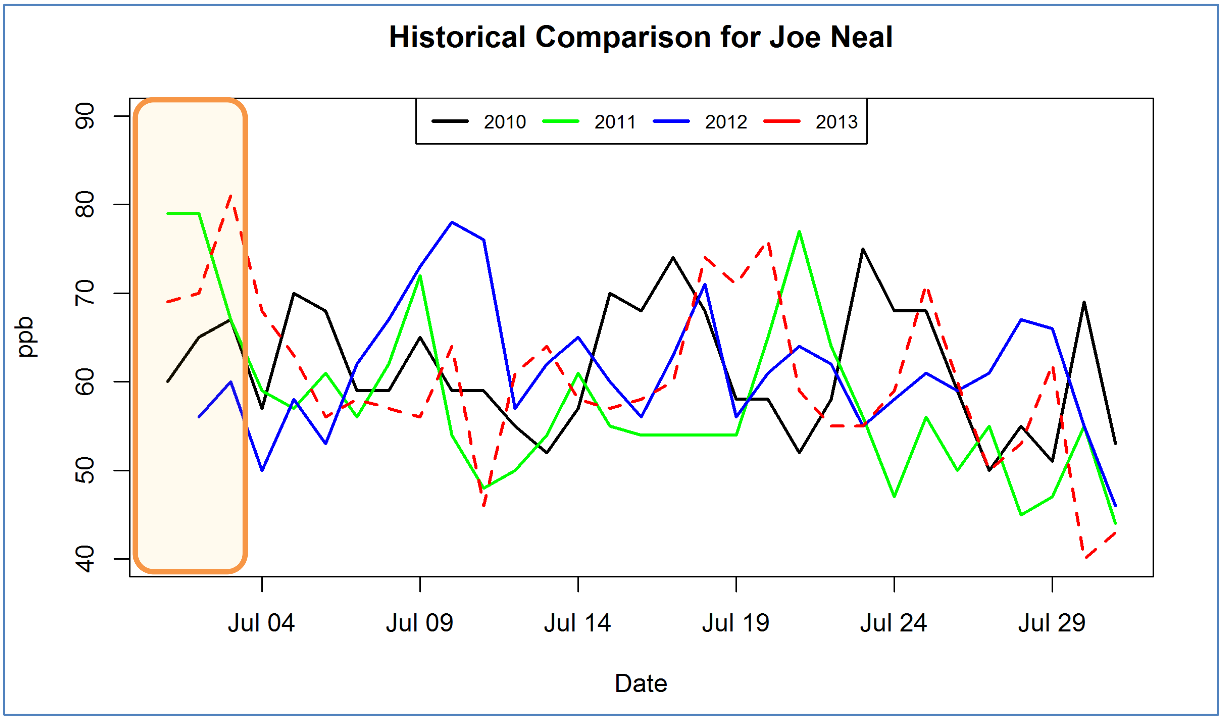


Figure 3-9. Four-Year Comparison for Joe Neal Site.

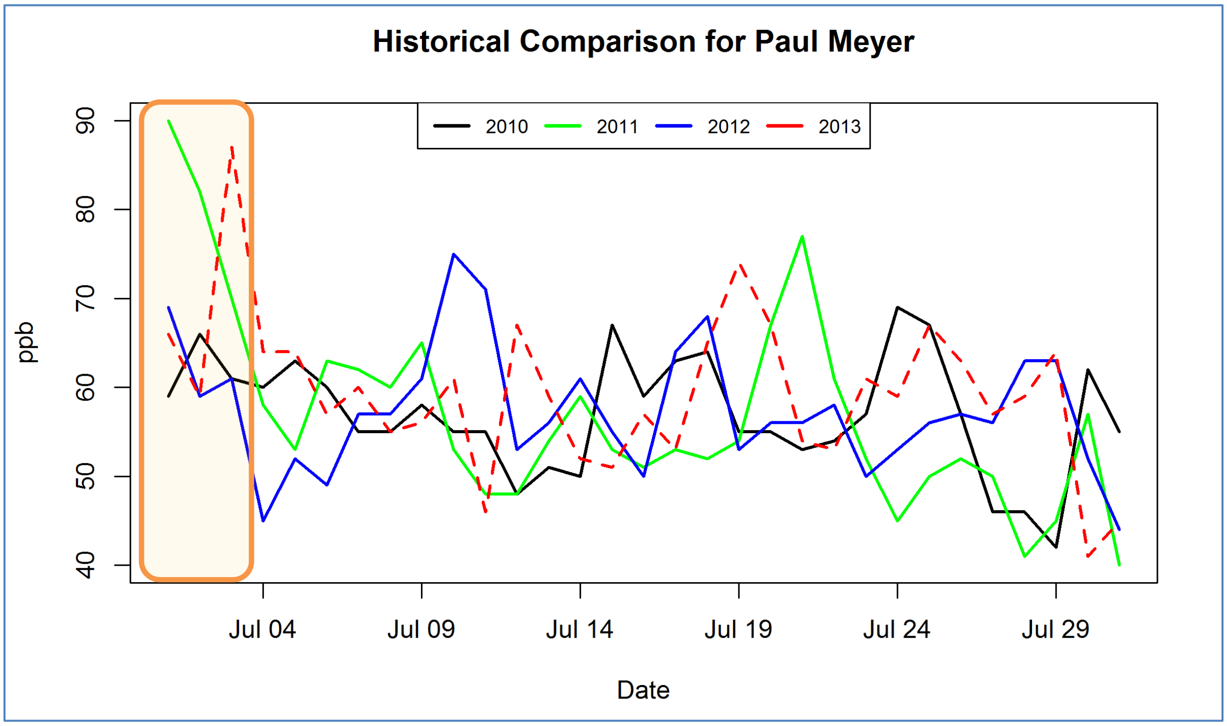


Figure 3-10. Four-Year Comparison for Paul Meyer Site.

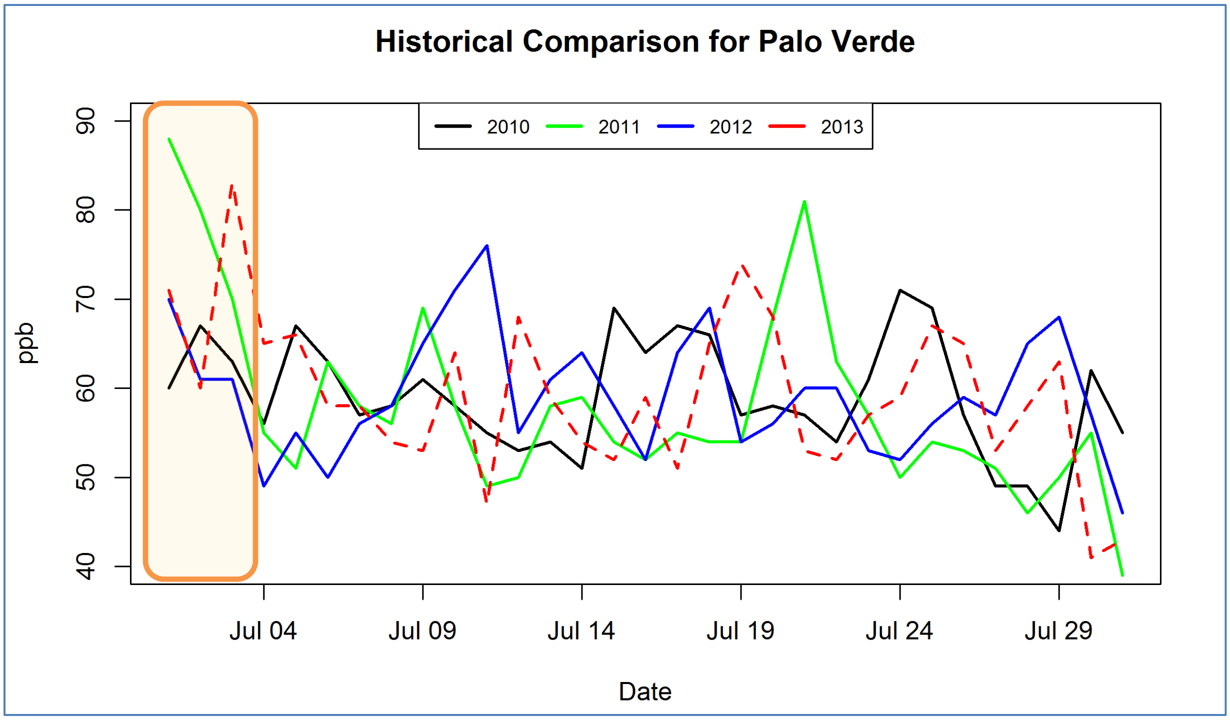


Figure 3-11. Four-Year Comparison for Palo Verde Site.

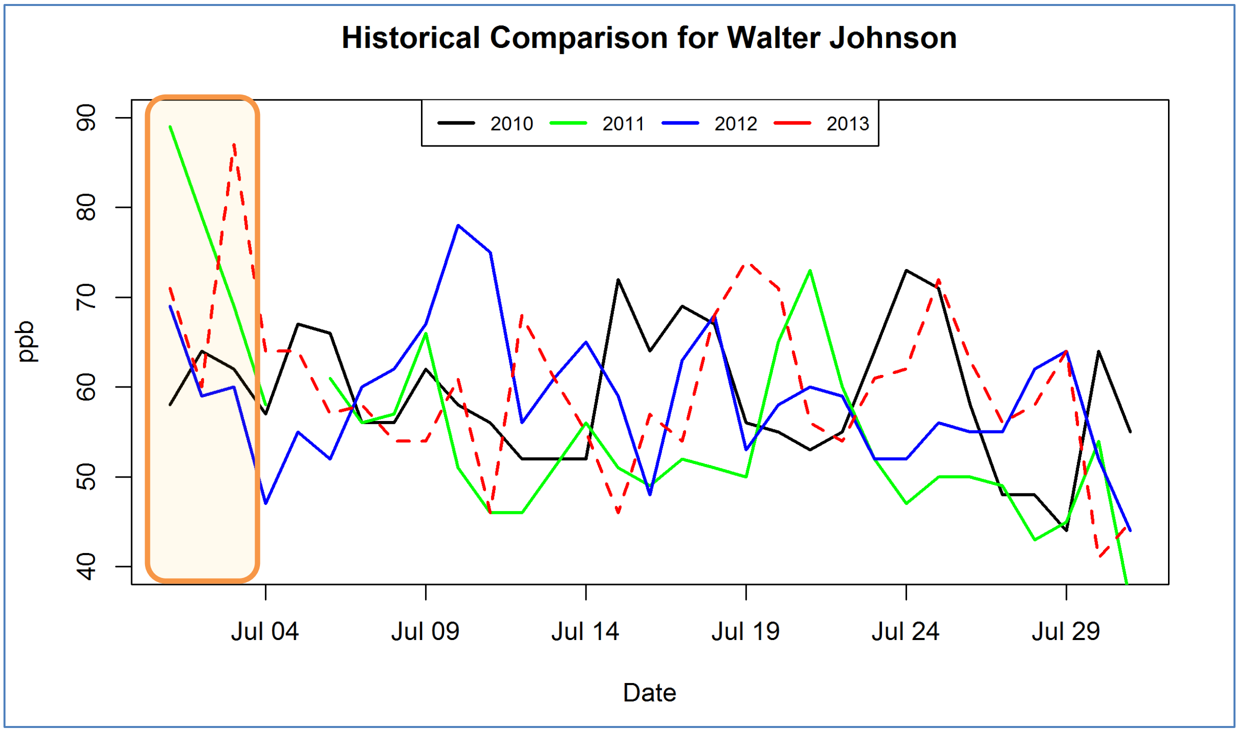


Figure 3-12. Four-Year Comparison for Walter Johnson Site.

To get a statistical perspective, average MDA8 ozone concentrations were calculated for all days in July over the three-year period of 2010–2012. These data were plotted against the MDA8 concentrations for July 2013 (Figure 3-13). The figure shows the MDA8 values for July 3 were much higher than the average of the values for the three previous years.

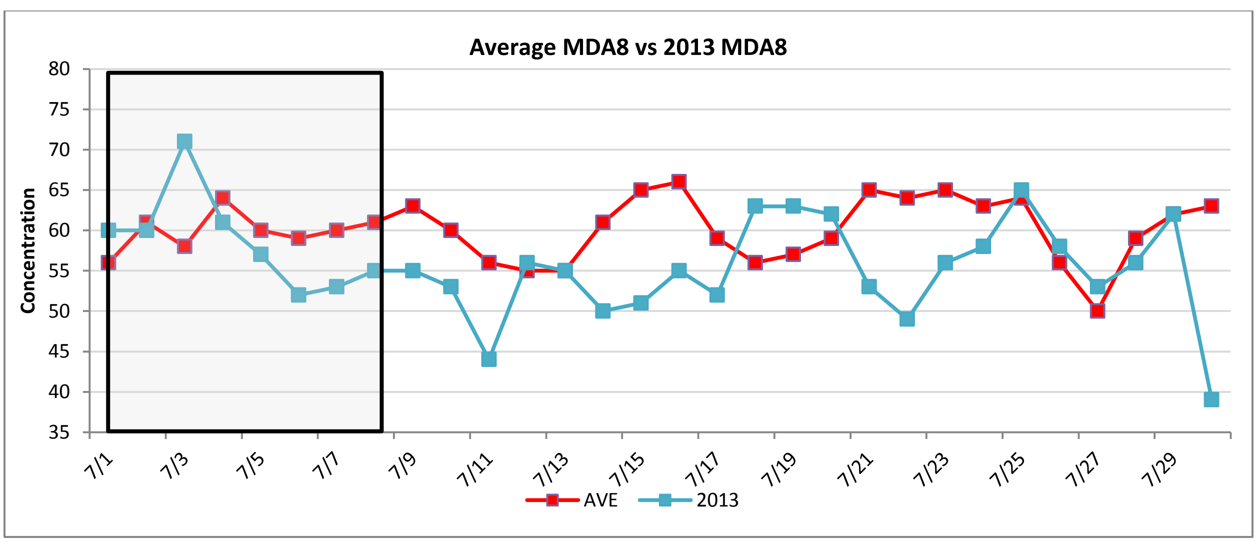


Figure 3-13. Average vs. 2013 MDA-8 Values.

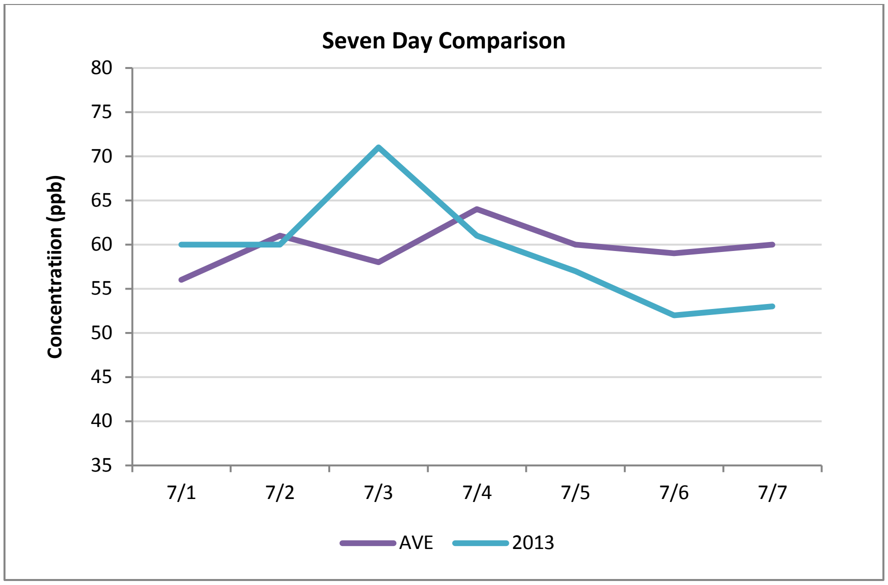


Figure 3-14. Average vs. 2013 Concentrations over Seven-Day Period.

During the seven-day period depicted in Figure 3-14, ozone concentrations on July 3 were 10 ppb higher than the average on that day from 2010–2012.

Figures 3-15 through 3-18 show the AQI values for O_3, $PM_{2.5}$, and CO from July 1 to July 7 of each year during a four-year period. As noted previously, the levels in some years were impacted by significant regional transport; however, O_3, $PM_{2.5}$, and CO never reached the AQI values they reached in 2013. The data show that concentrations on July 3 were exceptionally high.

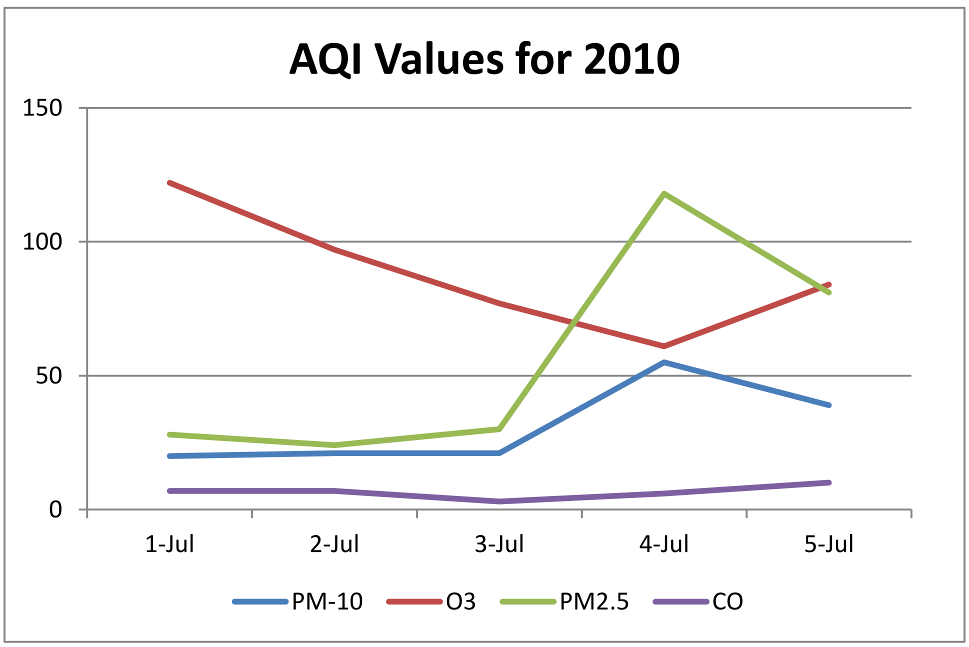


Figure 3-15. O_3, CO, and $PM_{2.5}$ Concentrations in 2010.

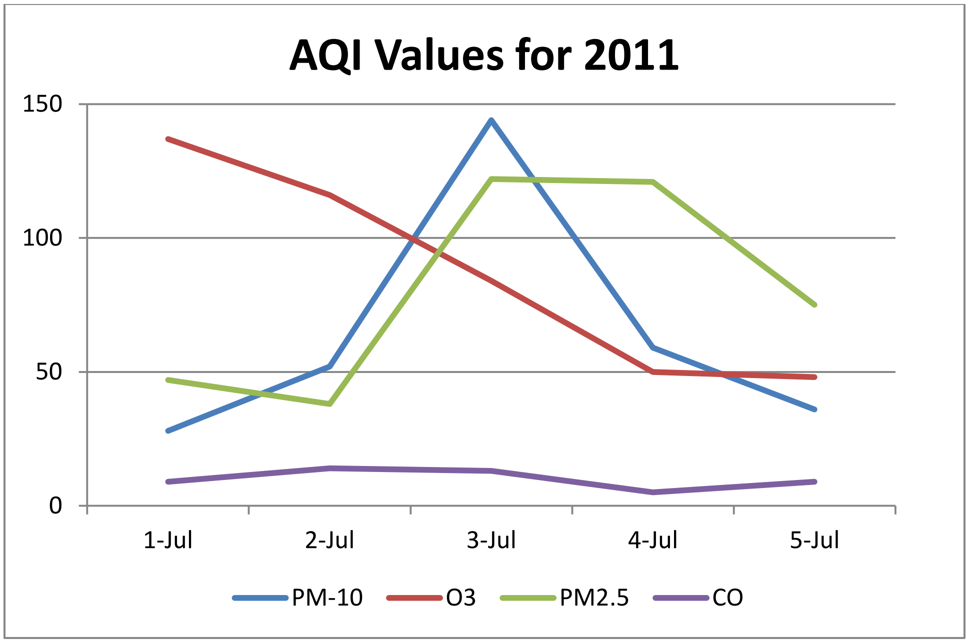


Figure 3-16. O3, CO, and $PM_{2.5}$ Concentrations in 2011.

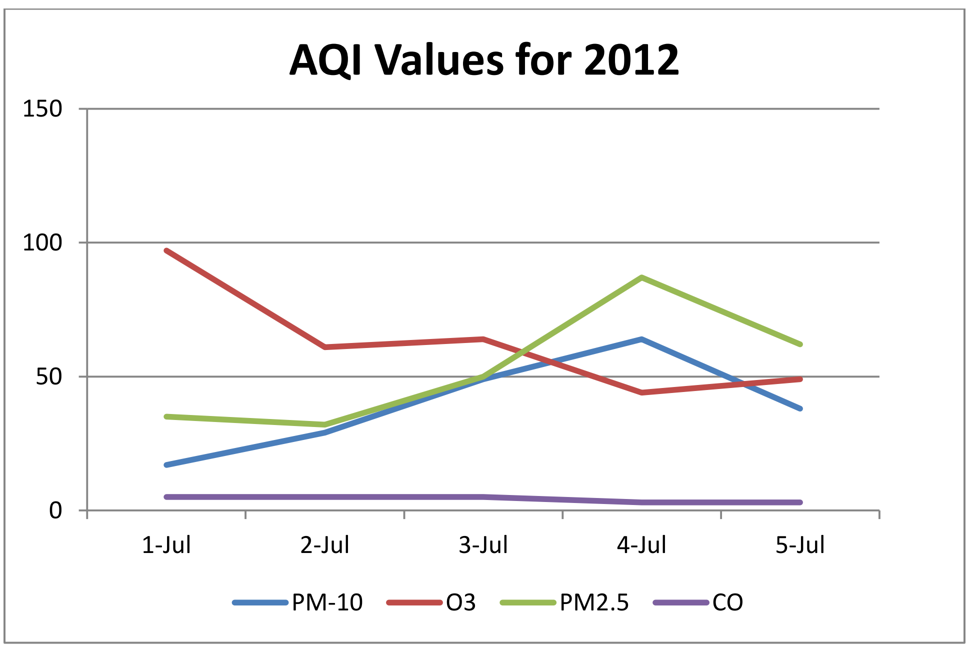


Figure 3-17. O_3, CO, and $PM_{2.5}$ Concentrations in 2012.

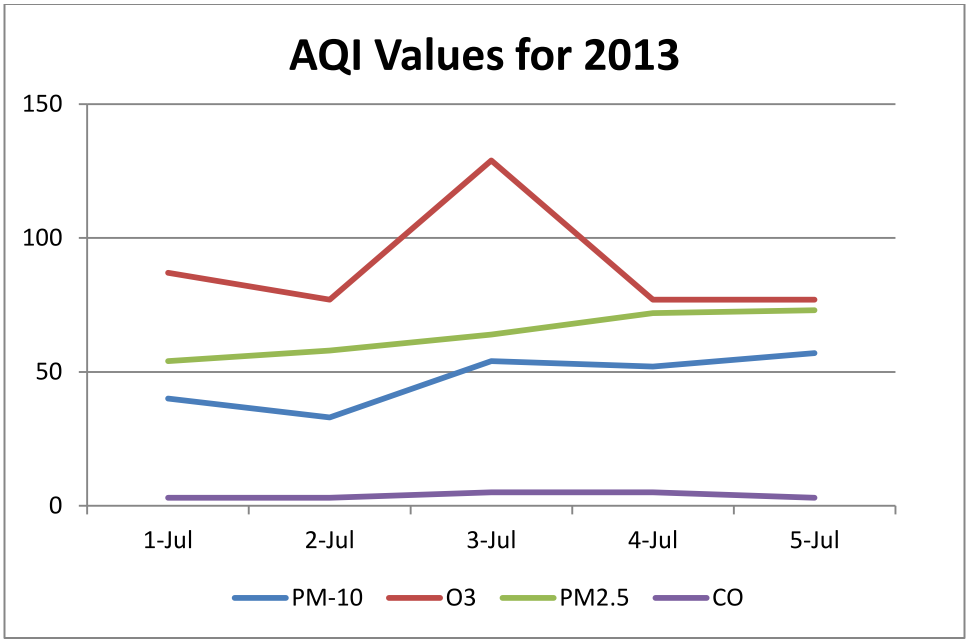


Figure 3-18. O_3, CO, and $PM_{2.5}$ Concentrations in 2013.

4.0 THE "BUT FOR" ARGUMENT

4.1 METEOROLOGICAL PARAMETERS AND VISIBILITY CAMERAS

Meteorology is an important variable affecting air quality. Weather data in Figure 4-1 show a remarkably consistent weather pattern before and after the exceptional event, when wind patterns maintained smoke plume impacts in southern Nevada during the wildfire episode. Local anthropogenic emissions of ozone precursor pollutants did not exceed normal weekday or weekend levels. The difference during this period is the accumulation of the wildfire smoke plume, exacerbating ozone concentrations in Clark County.

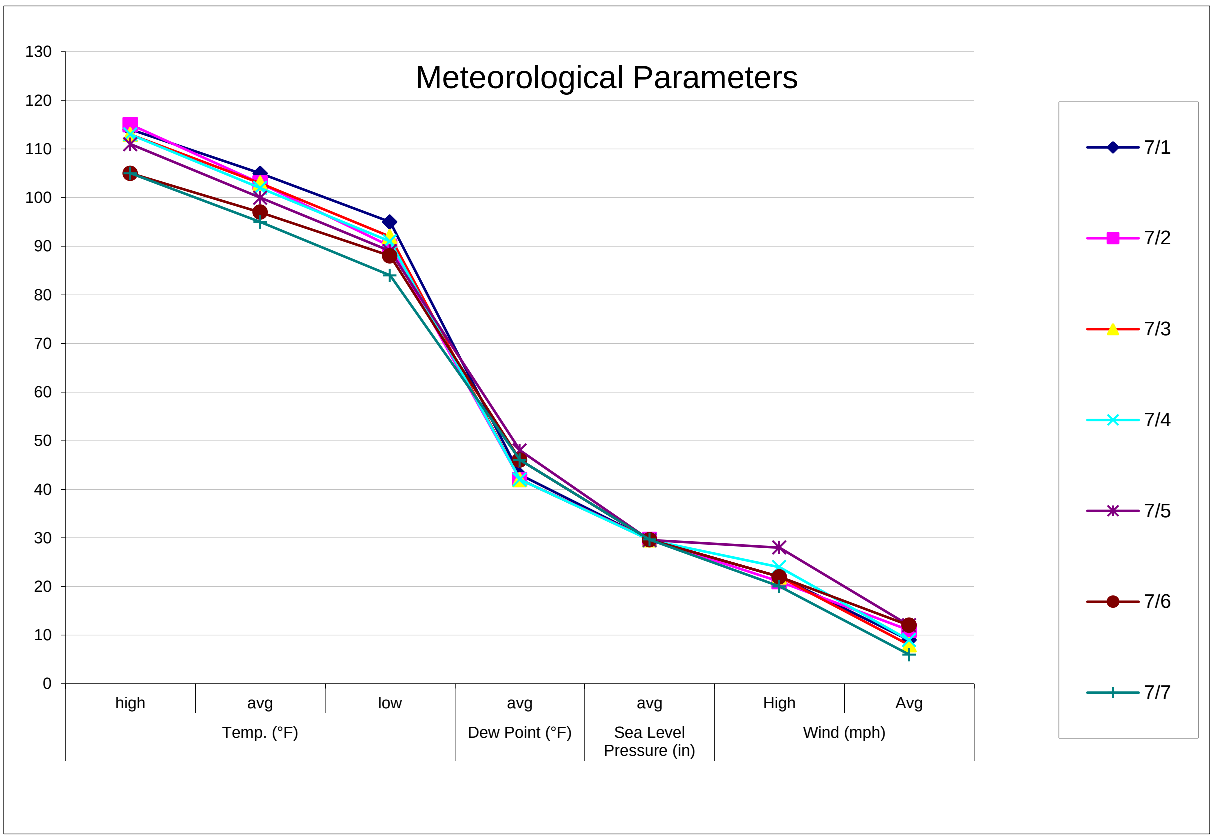


Figure 4-1. Weather Data for July 1–7, 2013.

Documentation in previous sections shows that the ozone exceedances on July 3, 2013, would not have occurred but for the Carpenter 1 Fire in Clark County. The 24-hour backward trajectory in Figure 4-2 shows air mass on July 3 crossed paths with the smoke plume from the fire.

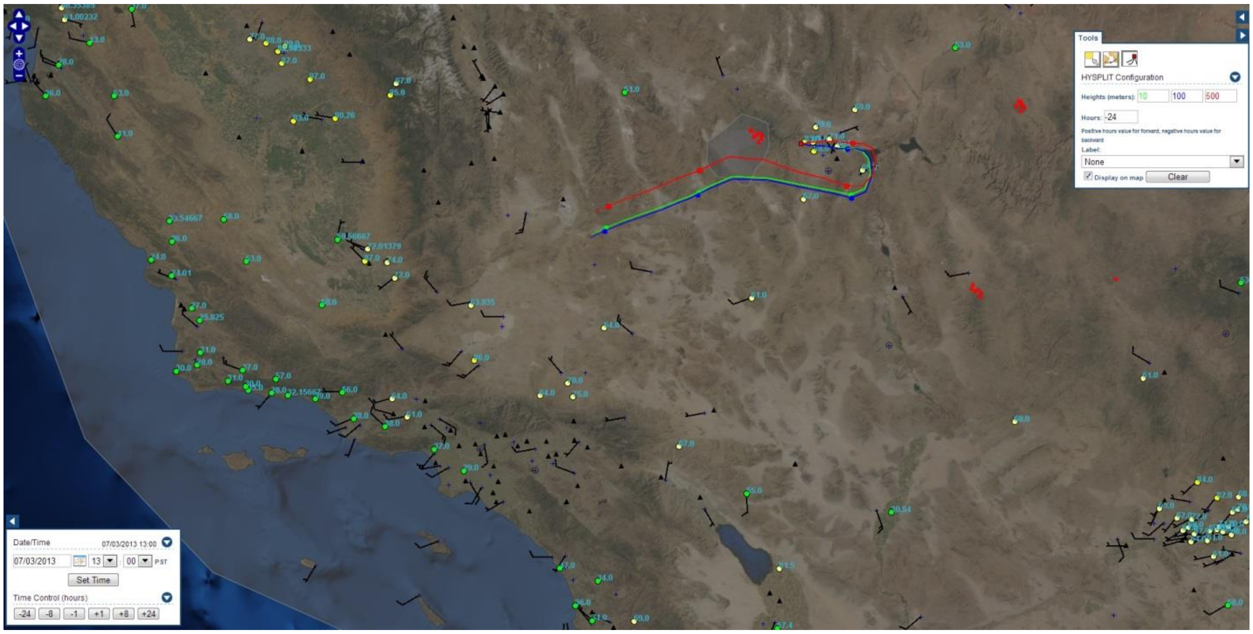


Figure 4-2. Forward Trajectory from Carpenter 1 Fire area.

Visibility cameras at the North Las Vegas Airport capture pictures of the downtown area every 15 minutes. Figure 4-3 shows a picture taken on a no-fire day (May 14) at 1800 in which landmarks like Desert Hills and Potosi Mountain are clearly visible. In Figures 4-4 and 4-5, taken on the afternoon of July 3 looking south, the landmarks are not nearly as visible. These pictures show the impact of the wildfire smoke plume.

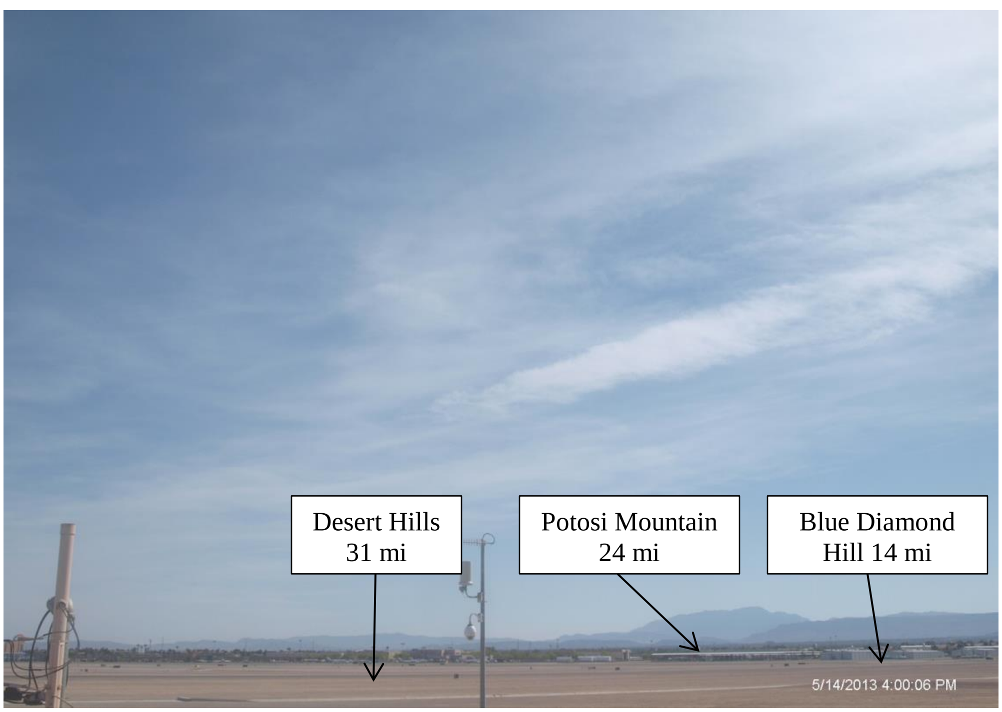


Figure 4-3. Visibility on a "No Fire" Day.

Figure 4-4. Visibility on July 3, at 1600.

Figure 4-5. Visibility on July 3, at 1700.

4.2 OZONE CONCENTRATION CALCULATIONS

Two methods were used to estimate ozone concentrations on July 3. Average concentrations were estimated using prior and next-day concentrations; interpolation is a numerical analysis that creates new data points in a set of data.

4.2.1 Average Concentrations

In this method, the average daily ozone concentration is calculated for each monitoring site from July 1–5, excluding July 3. This average is then applied as a reasonable surrogate for what would have occurred on July 3 given consistent weather patterns and normal local anthropogenic emissions, but no smoke impacts. Table 4-1 provides the average calculated concentration for July 3. Under this approach, average ozone concentrations for the exceptional event day vary from 51–67 ppb throughout the monitoring network.

Table 4-1. Calculated Average for July 3, 2013

Date	AP	MS	PM	WJ	PV	JO	WW	JM	BC	JN	JD
1-Jul	56	50	66	71	71	69	53		51	58	64
2-Jul	62	52	59	60	60	70	60		56	60	64
3-Jul	58	51	63	64	65	67	55	54	53	60	61
4-Jul	62	53	64	64	65	68	59	59	59	59	63
5-Jul	52	52	64	64	66	63	49	49	49	66	55

4.2.2 Interpolation

Interpolation is a method of constructing new data points within the range of a set of known data points. In this application, the data points for July 3 were assumed to be missing and linear interpolation was used to estimate their values. Table 4-2 shows this method yields a minimum concentration of 53 ppb and a maximum concentration of 69 ppb.

Table 4-2. Interpolated Values for July 3, 2013

Date	AP	MS	PM	WJ	PV	JO	WW	JM	BC	JN	JD
2-Jul	62	52	59	60	60	70	60		56	60	64
3-Jul	62	53	62	62	63	69	60		58	60	64
4-Jul	62	53	64	64	65	68	59	59	59	59	63

4.3 SATELLITE IMAGERY

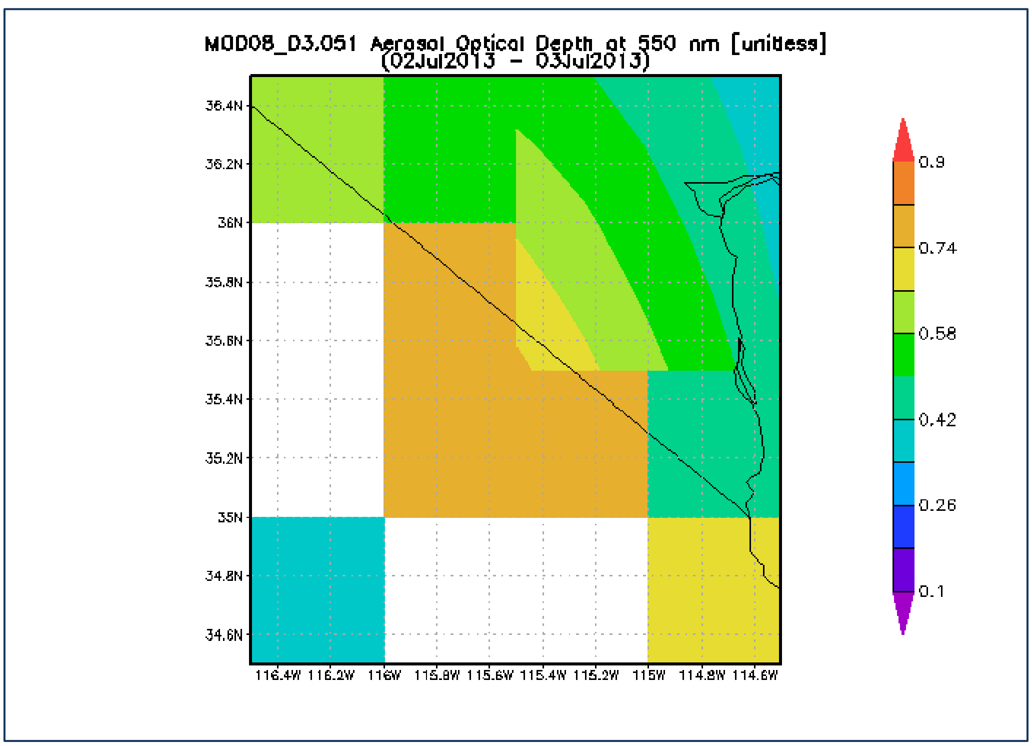
4.3.1 Aerosol Optical Depth and Aerosol Optical Thickness[3]

Optical measurements of light extinction can be used to represent aerosol content in the entire column of the atmosphere. This aerosol optical depth (AOD) expresses the quantity of light removed from a beam by scattering or absorption during its path through a medium (AOD is a unitless quantity). Aerosol Optical Thickness (AOT) is the degree to which aerosols prevent the transmission of light by absorption or scattering of light.

Table 4-3. AOD Values

Sample AOD Values		Equivalent $PM_{2.5}$ Values
0.02	Very clean isolated area	~ 1 μm^{-3}
0.2	Fairly clean urban area	~ 12 μm^{-3}
0.4	Somewhat polluted urban area	~ 24 μm^{-3}
0.6	Fairly polluted area	~ 36 μm^{-3}
1.5	Heavy biomass burning or dust event	~ 90 μm^{-3}

The higher the AOD value, the more polluted the area is. Figures 4-6 and 4-7 demonstrate that the Las Vegas area AOD for July 3 was between 0.58 and 0.74, which means it was a fairly polluted area. This agrees with Figure 1-3, which showe $PM_{2.5}$ concentrations over a three-day period.



[3] http://disc.sci.gsfc.nasa.gov/giovanni/

Figure 4-6. AOD for July 3.

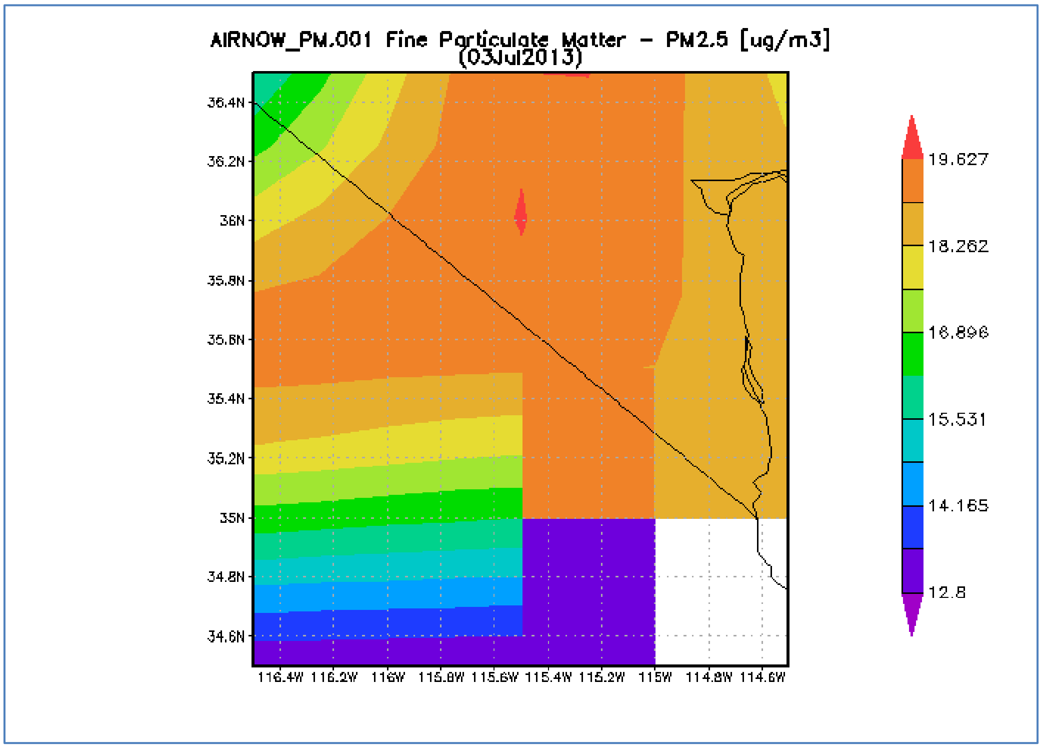


Figure 4-7. $PM_{2.5}$ AOD for July 3.

4.3.2 AERONET Data

The AErosol RObotic NETwork (AERONET) program is a federation of ground-based remote sensing aerosol networks established by the National Aeronautics and Space Administration and other institutions. AERONET data show the AOT for a daily or monthly time frame. The AERONET site in Southern NV (see Figure 4-8) was severely impacted by the smoke plumes from the Carpenter 1 Fire. The $PM_{2.5}$ readings for this station were some of the highest for the month of July.

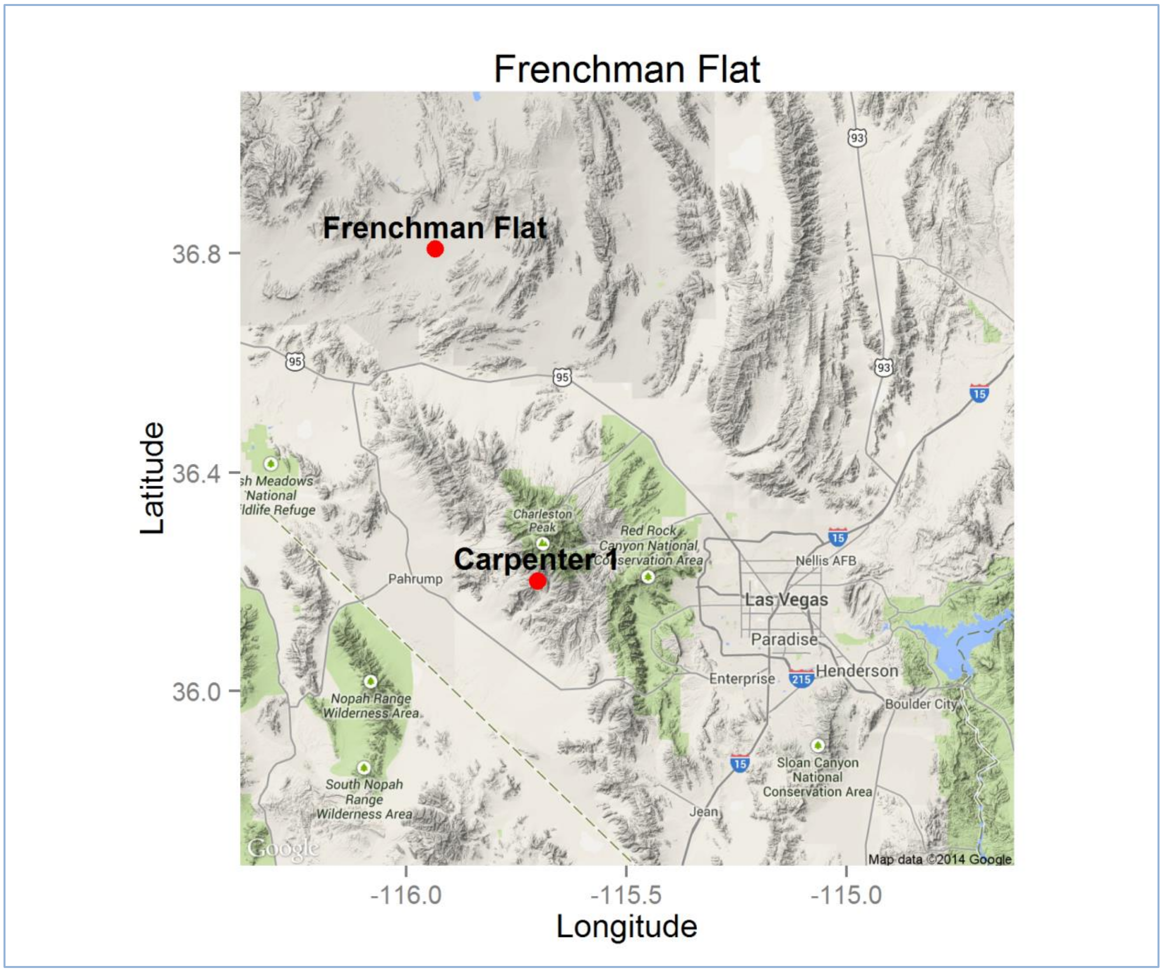


Figure 4-8. Location of Frenchman Flat Station.

Source: http://aeronet.gsfc.nasa.gov/

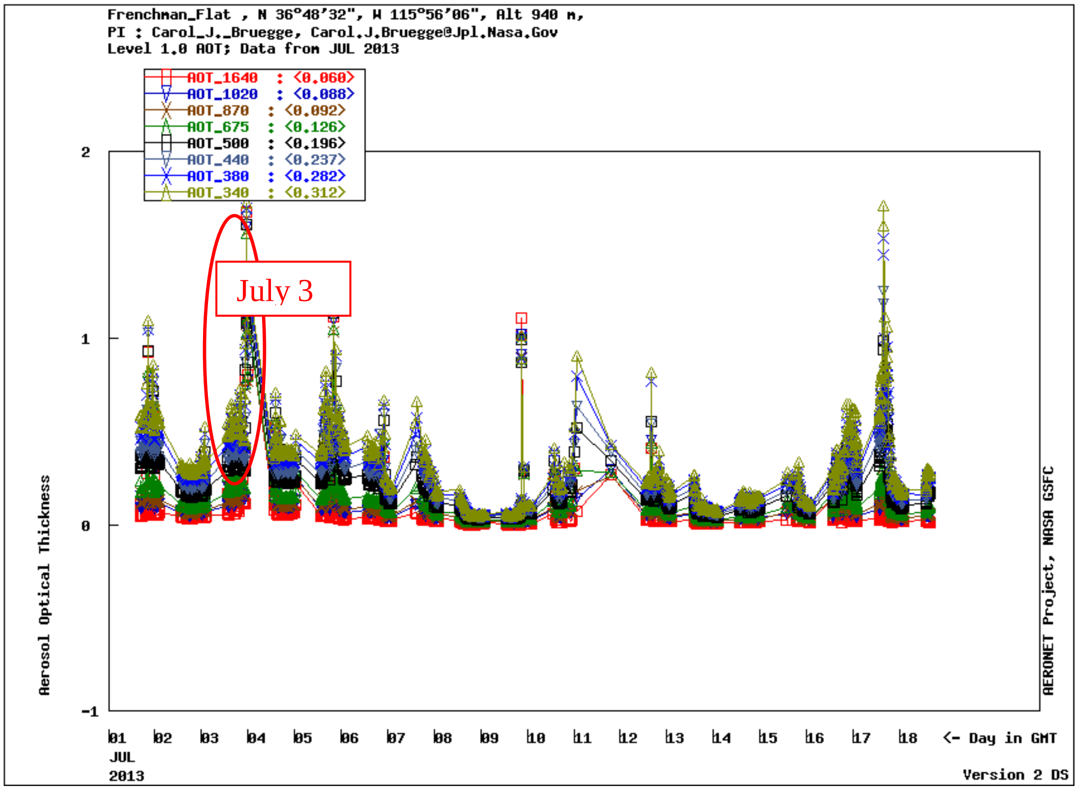


Figure 4-9. AOT for Frenchman Flat.

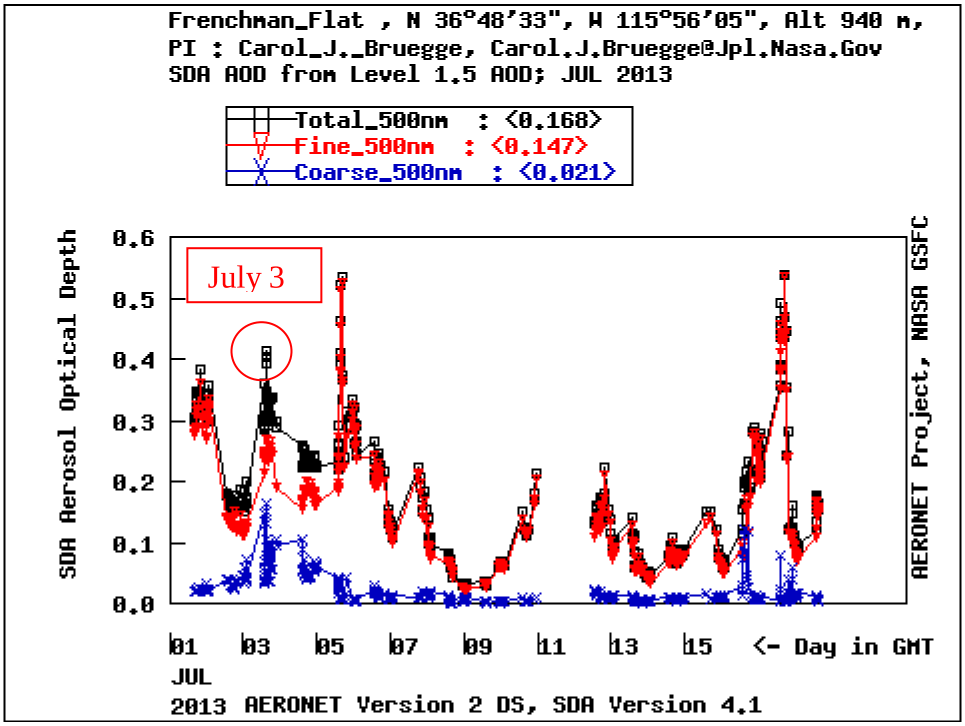


Figure 4-10. AOT for Railroad Valley.

Note: Spectral Deconvolution Algorithm (SDA) effectively computes the Fine mode AOD in mixed cloud-smoke observations.

4.3.3 Site-Specific Time-Series and Correlations of AOD and Surface $PM_{2.5}$

The graph in Figure 4-11 shows AOD and $PM_{2.5}$ data from the J.D. Smith monitoring site. The AOD/ $PM_{2.5}$ mass concentration plot of site-specific Moderate Resolution Imaging Spectroradiometer (MODIS) and Geostationary Operational Environmental Satellite (GOES) Aerosol/Smoke Product (GASP) data details the temporal behavior of the measurements made at a specific monitoring site location. Correlations between the MODIS/GASP AOD observations and $PM_{2.5}$ measurements can also be seen. The left vertical axis shows the mass concentration of $PM_{2.5}$ on a scale of 0–100; the right vertical axis shows the MODIS/GASP AOD on a scale of 0.0–1.6). The graph shows a high concentration of $PM_{2.5}$ and a high AOD on July 3, proving that smoke was affecting the monitoring sites.

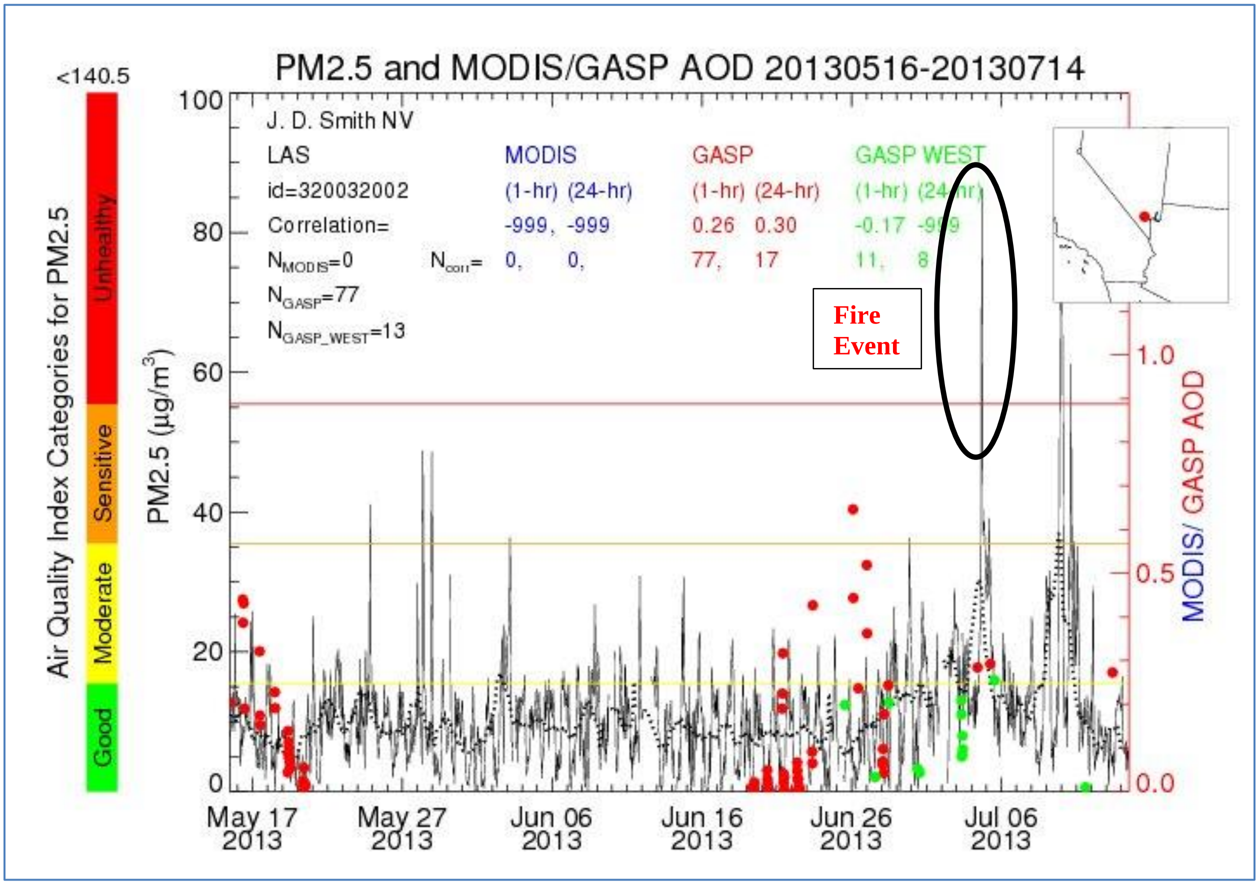


Figure 4-11. Data for J.D. Smith.

Source: http://www.star.nesdis.noaa.gov/smcd/spb/aq/

5.0 PUBLIC OUTREACH AND EDUCATION IN RESPONSE TO THE EXCEPTIONAL EVENT

DAQ has in place an education program to protect the public from adverse health problems associated with elevated pollutant levels. Its goals are to inform and educate the public on topics that include:

- How they can avoid exposure and minimize health impacts.
- How they can reduce their contributions to concentrations of the pollutant.
- What types of exceptional events may affect the area's air quality.
- When an exceptional event is imminent or occurring.

To meet these goals, DAQ conducts a comprehensive program that engages in local outreach events to provide information to the public. These include:

- Media press releases issued to the community as needed.
- School and youth outreach programs with classroom and youth group presentations, teacher training, and air quality information packets.
- Participation in community events (e.g., local fairs).
- Training in air quality reporting for local weather anchors.
- Activities with city, county, and local environmental/health professionals to improve methods for reaching and educating the community.

DAQ has also developed a notification system to contact at-risk populations. Avenues include:

- The Clark County School District.
- The Southern Nevada Health District.
- The Clark County Parks and Recreation Department.
- Local municipalities, comprising the cities of Henderson, Mesquite, Las Vegas, North Las Vegas, and Boulder City.
- Local media (i.e., newspapers, radio and television stations).
- Sensitive individuals (through a notification service).

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6.0 CONCLUSIONS AND RECOMMENDATION

This demonstration makes a clear and compelling case, by weight of evidence, that the ozone exceedance on July 3, 2013, was due to the influence of the Carpenter 1 Fire on Mount Charleston. It meets the EER requirements, allowing EPA to exclude that day's ozone data for regulatory purposes.

The tables and figures in this report depict the relationships between O_3, $PM_{2.5}$, and CO on July 3, as well as on days before and after the event. Figure 4-1 demonstrated that temperature, humidity, and wind speeds had little influence on the ambient levels of O_3, $PM_{2.5}$, and CO during the subject period. Figures 3-3 through 3-6 show the variation in diurnal patterns between the non-fire days and the fire day. Section 3.3 describes historical fluctuations in ozone levels over four previous years, pointing out that O_3 concentrations were never as high as during this episode in 2013. Although Clark County experienced high O_3 concentrations that May, several high-concentration days are contribute to regional or international transport. Since transport is not considered an exceptional event, the May 2013 days are not addressed in this report.

Figure 3-7 depicts a clear causal relationship between the ambient levels of O_3, $PM_{2.5}$, and CO during the event. A strong correlation between O_3, $PM_{2.5}$, and levoglucosan proves that the smoke plume reached ground level and significantly affected ozone concentrations.
In addition, this demonstration analyzed the hourly AQI values for O_3**,** $PM_{2.5}$, and CO (Figure 3-8). The high AQI values for all three pollutants tracked nearly identically, and were elevated proportionately on the wildfire smoke intrusion days. Back trajectories and wind data show that the smoke plume impacted Clark County. Satellite imagery also shows that high levels of smoke and dust impacted Clark County on July 3.

Section 5 outlines the steps Clark County took to protect public health through release of a public advisory and cooperation with the local media.

Based on the information contained within this demonstration, EPA should exclude the ozone data for July 3, 2013 as being caused by an exceptional event in accordance with the EER.

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APPENDIX A: ADVISORIES AND NEWS ARTICLES

Department of Air Quality air quality advisory for ozone:

News Release

Office of Public Communications • (702) 455-3546 • FAX (702) 455-3558 • www.accessclarkcounty.com

Contact: Stacey Welling
Sr. Public Information Officer

Phone: (702) 455-3201
Cell: (702) 249-3823
E-mail: stac@co.clark.nv.us

For Immediate Release **Monday April 1, 2013**

Air Quality Advisory Issued for Ozone from April 1 through Sept. 30

Clark County Department of Air Quality officials are advising residents that weather conditions and levels of pollutants may trigger a build-up of ground-level ozone in Southern Nevada from April through September.

At this time, unhealthy levels of ozone pollution are not occurring. Air Quality officials will continue to monitor conditions and will post an alert on the forecast page of the department's website if unhealthy levels actually occur. A link to the forecast page is located at http://redrock.clarkcountynv.gov/forecast/.

Ozone is a gas that occurs naturally in the upper atmosphere and protects the earth from the sun's harmful ultraviolet rays. At ground level, ozone is a key ingredient of urban smog during the hottest months of the year in Clark County. Ground-level ozone can build up during the afternoon hours due to a combination of several factors, including strong sunlight, hot temperatures, and pollutants from automobiles and other sources such as transport and wildfires from Southern California and other areas. Unhealthy doses of ground-level ozone can reduce lung function and worsen respiratory illnesses such as asthma or bronchitis. Exposure to ozone also can induce coughing, wheezing and shortness of breath even in healthy people. When ozone levels are elevated, everyone should limit strenuous outdoor activity, especially people with respiratory diseases. Officials suggest these tips to help reduce the formation of ground-level ozone:

- Fill up your gas tank after sunset.
- Plan errands so they can be done in one trip
- Try not to spill gasoline when filling up, and don't top off your gas tank.
- Keep your car well maintained.
- Use mass transit or carpool.
- Don't idle your car engine unnecessarily.
- Walk or ride your bike whenever practical and safe.
- Drive an electric or hybrid vehicle, or low-emission scooter or motorcycle.
- Consider low-maintenance landscaping that uses less water and doesn't require the use of gas-powered lawn tools to maintain.
- Turn off lights and electronics when not in use. Less fuel burned at power plants means cleaner air.

Detailed air quality conditions are posted in the monitoring section of the Department of Air Quality's website. You can receive free text and e-mail advisories and air quality forecasts through the U.S. Environmental Protection Agency's EnviroFlash service at www.enviroflash.org.

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Pictures taken by DAQ staff and from media releases:

7-3


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