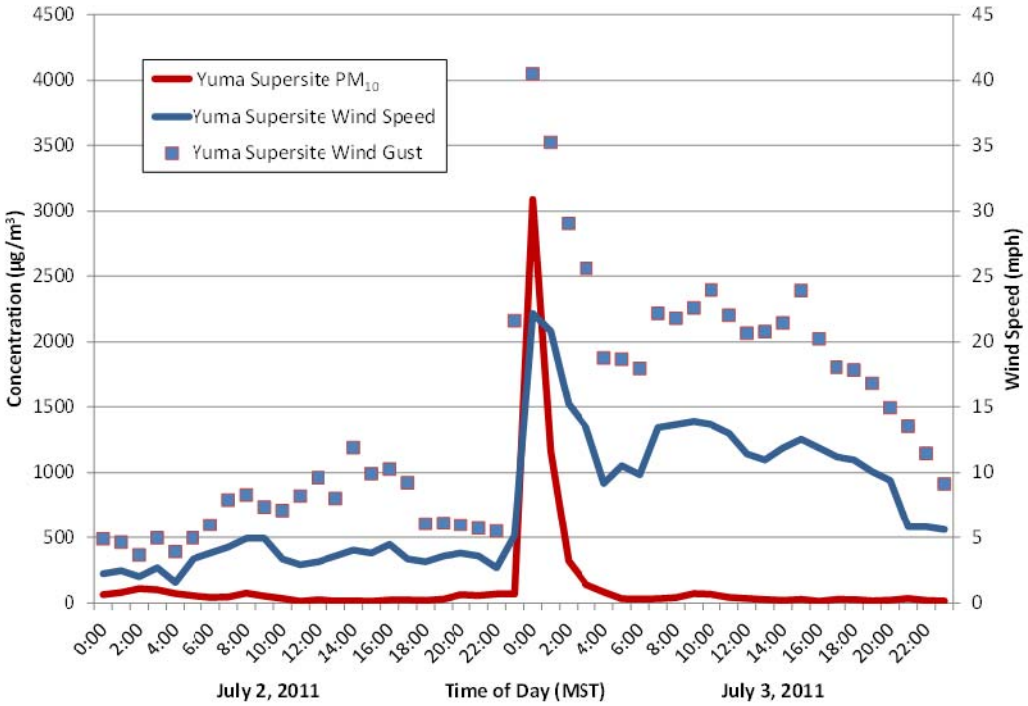
Sonoma Technology, Inc.
Air Quality Research and Innovative Solutions

State of Arizona Exceptional Event Documentation for the Event of July 3, 2011, for the Yuma County PM_{10} Nonattainment Area



Final Report Prepared for

Arizona Department of Environmental Quality
Phoenix, AZ

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State of Arizona Exceptional Event Documentation for the Event of July 3, 2011, for the Yuma County PM_{10} Nonattainment Area

Final Report

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Cover graphic illustrates hourly wind speeds and $PM_{2.5}$ concentrations in Yuma, AZ, during the July 3, 2011, event. See Section 3 for more information.

Acknowledgments

The authors would like to acknowledge the Arizona Department of Environmental Quality and the Environmental Protection Agency – Region 9 for helpful discussion and feedback during the preparation of this document.

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1. Introduction

On July 3, 2011, the Yuma Supersite monitor recorded a 24-hr average PM_{10} concentration of 225 µg/m^3. This value is in exceedance of the National Ambient Air Quality Standard (NAAQS) for 24-hr PM_{10} of 150 µg/m^3. The purpose of this report is to demonstrate that this exceedance was due to naturally occurring windblown dust, was not reasonably controllable or preventable, was historically unusual, and would not have occurred "but-for" the windblown dust and, therefore, is an exceptional event.

1.1 Exceptional Event Rule Requirements

In addition to the technical requirements that are contained within the Exceptional Event Rule (EER), procedural requirements must also be met in order for the U.S. Environmental Protection Agency (EPA) to concur with the flagged air quality monitoring data. This section of the report contains the requirements of the EER and associated guidance, and discusses how Arizona Department of Environmental Quality (ADEQ) addressed those requirements.

1.1.1 Public Notification That the Event Was Occurring (40 CFR 50.14(c)(1)(i))

ADEQ issued Dust Control Action Forecasts for the Greater Yuma area advising citizens of the potential for high wind dust events during the July 2-3, 2011, time frame. More information on ADEQ's forecasting program can be found in Section 6 of this report. The forecast products that were issued during the period July 2-3, 2011, are included in Appendix B.

1.1.2 Place Informal Flag on Data in AQS (40 CFR 50.14(c)(2)(ii))

ADEQ and other operating air quality agencies in Arizona submit data into EPA's Air Quality System (AQS), the official repository of ambient air quality data. This data submittal to AQS includes PM data from both filter-based and continuous monitors operated in Arizona.

When ADEQ and/or another agency operating monitors in Arizona suspect that data may be influenced by an exceptional event, ADEQ and/or the other operating agency expedites analysis of the filters collected from the potentially-affected filter-based air monitoring instruments, quality-assures the results, and submits the data into AQS. ADEQ and/or other operating agencies also submit data from continuous monitors into AQS after quality assurance is complete.

If ADEQ and/or other operating air quality agencies have determined that a potential exists that a monitor's reading(s) have been influenced by an exceptional event, a preliminary flag is submitted for the measurement in AQS. The data are not official until they undergo more thorough quality assurance and quality control, leading to certification by May 1st of the year following the calendar year in which the data were collected (40 CFR 58.15(a)(2)). The presence of the flag can be confirmed in AQS.

1.1.3 Notify EPA of Intent to Flag Through Submission of Initial Event Description by July 1 of Calendar Year Following Event (40 CFR 50.14(c)(2)(iii))

ADEQ submitted notice to EPA on August 29, 2012, listing all days from calendar year 2011 that ADEQ intends to analyze under the Exceptional Events Rule. The PM_{10} exceedance that occurred at one monitor on July 3, 2011, in the Yuma PM_{10} nonattainment area was included on this list. This assessment report serves as demonstration supporting the flagging of these data.

1.1.4 Document That the Public Comment Process Was Followed for Event Documentation (40 CFR 50.14(c)(3)(iv))

ADEQ posted this assessment report on the ADEQ webpage and placed a hardcopy of the report in the ADEQ Records Management Center for public review. ADEQ opened a 30-day public comment period on December 3, 2012. A copy of the public notice certification, along with any comments received, will be submitted to EPA, consistent with the requirements of 40 CFR 50.14(c)(3)(iv). See Appendix D for a copy of the affidavit of public notice.

1.1.5 Submit Demonstration Supporting Exceptional Event Flag (40 CFR 50.14(a)(1-2))

At the close of the public comment period, and after ADEQ has had the opportunity to consider any comments submitted on this document, ADEQ will submit this document, the comments received, and ADEQ's responses to those comments to EPA Region IX headquarters in San Francisco, California. The deadline for the submittal of this package is September 30, 2014.

1.1.6 Documentation Requirements (40 CFR 50.14(c)(3)(iii))

The EER states that in order to justify the exclusion of air quality monitoring data, evidence must be provided for the following elements:

1. The event satisfies the criteria set forth in 40 CFR 501 (j) that:
    a. the event affected air quality,
    b. the event was not reasonably controllable or preventable, and
    c. the event was caused by human activity unlikely to recur in a particular location or was a natural event;
2. There is a clear causal relationship between the measurement(s) under consideration and the event;
3. The event is associated with a measured concentration(s) in excess of normal historical fluctuations; and
4. There would have been no exceedance or violation but for the event.

1.2 Report Contents

Section 2 of this assessment contains a conceptual model of the wind-blown dust event that transpired on July 3, 2011, providing a background narrative of the exceptional event and an overall explanation that the event affected air quality. Section 2 also provides evidence that the event was a natural event.

Section 3 of this assessment establishes a clear causal connection between the natural event on July 3, 2011, and the exceedance of the 24-hr PM_{10} standard at the monitoring station. The evidence in this section also confirms that the event in question both affected air quality and was the result of natural events.

Section 4 of this assessment contains data summaries and time-series graphs which help illustrate that the event of July 3, 2011, produced PM_{10} concentrations in excess of historical normal fluctuations.

Section 5 of this assessment details the existing dust control measures and demonstrates that despite the presence and enforcement of these controls, the event of July 3, 2011, was not reasonably controllable or preventable.

Section 6 of this assessment builds upon the demonstration, showing a clear causal connection between the natural event and the exceedance, and concludes that the exceedance of the 24-hr PM_{10} standard on July 3, 2011, would not have occurred but for the event.

2. Conceptual Model

This section provides a narrative background and summarizes the meteorological and air quality conditions in place on July 3, 2011, in Yuma. Elements described in this section include:

- A description and map of geographic setting of the air quality and meteorological monitors.
- A description of Yuma's climate.
- An overall description of meteorological and air quality conditions on the event day.

2.1 Geographic Setting

Yuma is located in the Sonoran Desert and Lower Colorado River Valley in extreme southwestern Arizona at an elevation of 138 feet above sea level. The Yuma Metropolitan Statistical Area is defined as Yuma County, which had a population of 195,751 as of the 2010 census. Yuma County is bordered by Imperial County, California, to the north and northwest and by Mexican state of Baja California to the west and south (**Figure 2-1**). Yuma lies just west of the confluence of the Colorado and Gila Rivers. Most of Yuma is located in the Colorado River Floodplain, commonly known as the Yuma Valley. The Yuma Valley follows the course of the Colorado River southward to the Sea of Cortez. Part of Yuma is built on the Yuma Mesa, a prominent land feature extending to the east of Yuma. The Gila Mountains, located roughly 15 to 20 miles east and southeast of Yuma, are a range of mountains with a peak elevation of 3,156 feet.

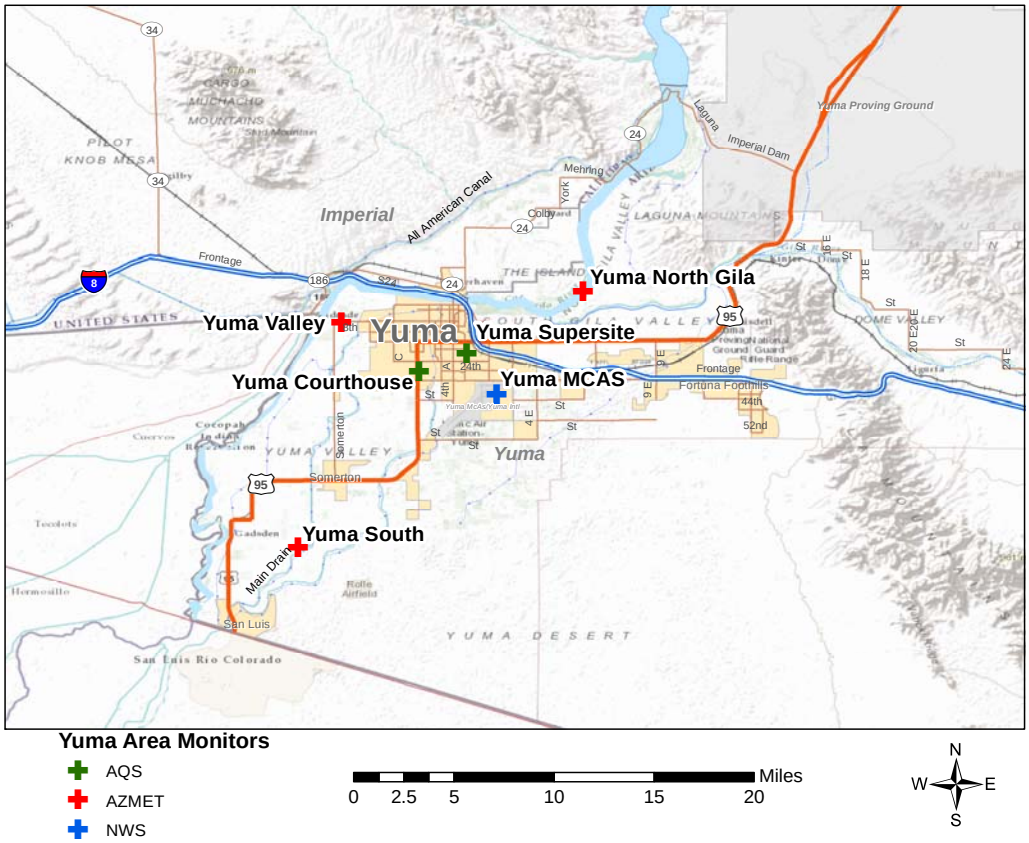

Figure 2-1. Location of air quality and meteorological monitors and relevant geographical features in the Yuma area. AQS monitors measure air quality and meteorological data; AZMET and NWS monitors measure only meteorological data.

The PM_{10} exceedance on July 3, 2011, was recorded at the Yuma Supersite monitor, which is located in central Yuma and has been operational since January 1, 2010. The Yuma Courthouse monitor shown in Figure 2-1 is inactive but measured PM_{10} prior to January 1, 2010. Data from the Yuma Courthouse monitor was used to supplement the Yuma Supersite data record for the Historical Norm section of this demonstration. Three Arizona Meteorological Network (AZMET) sites are in operation in the Yuma area, located northeast, west, and southwest of the city. A National Weather Service monitor is located at the Yuma Marine Corps Air Station (MCAS). All of the above sites measure wind speed and direction.

2.2 Climate, Monsoon, and Thunderstorms

Yuma is one of the hottest cities of any size in the United States, with average high temperatures around 107°F in July and around 70°F in January (**Figure 2-2**). Yuma receives roughly 90% of possible sunshine each year. Yuma is one of the driest cities in the United States, with an average annual rainfall of just over 3 inches. The bulk of this rain usually falls during the December through March and July through August time periods. During the December through March period, winter storms originating from the Pacific Ocean can produce significant rains in southwestern Arizona. During the July and August time period, monsoonal

moisture originating from the Gulf of California, Gulf of Mexico, and large thunderstorm complexes over the Sierra Madre Occidental Mountains in Mexico move northward into Arizona.

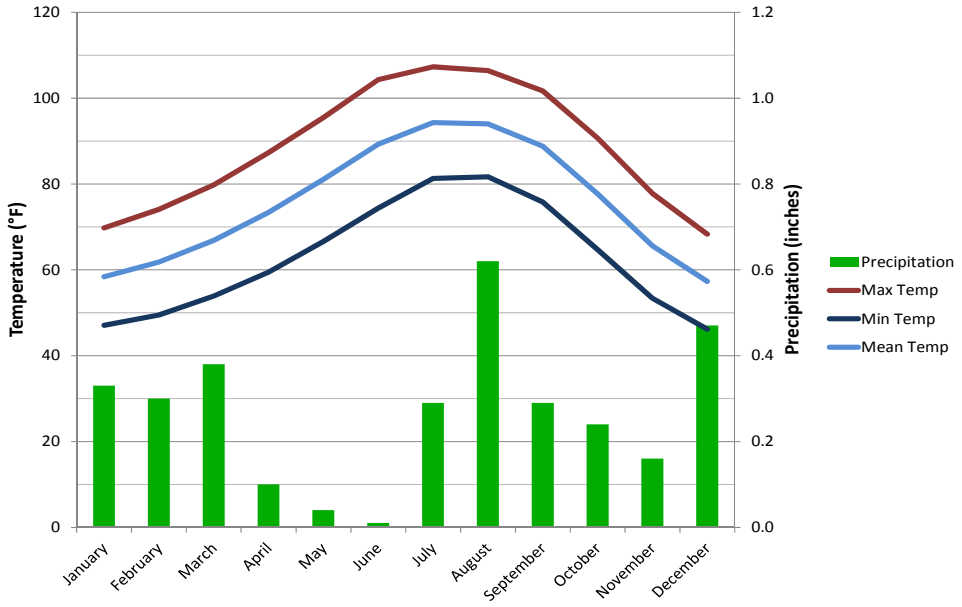

Figure 2-2. Average monthly temperatures and precipitation at KNYL,1981-2010.

The influx of moisture associated with the monsoon, combined with strong solar heating, can result in unstable atmospheric conditions that are favorable for the development of thunderstorms. Heavy precipitation associated with thunderstorms, and the eventual collapse or dissipation of thunderstorms, can generate what are known as downbursts (**Figure 2-3**). Downbursts are the rapid descent of rain-cooled air in a thunderstorm. Upon reaching the surface, this air rapidly disperses horizontally away from the storm as outflow boundaries (also called gust fronts). The high winds associated with outflow boundaries can efficiently loft dust into the air and transport the dust over long distances, resulting in dust storms (also called haboobs) with high PM_{10} concentrations and low visibilities.

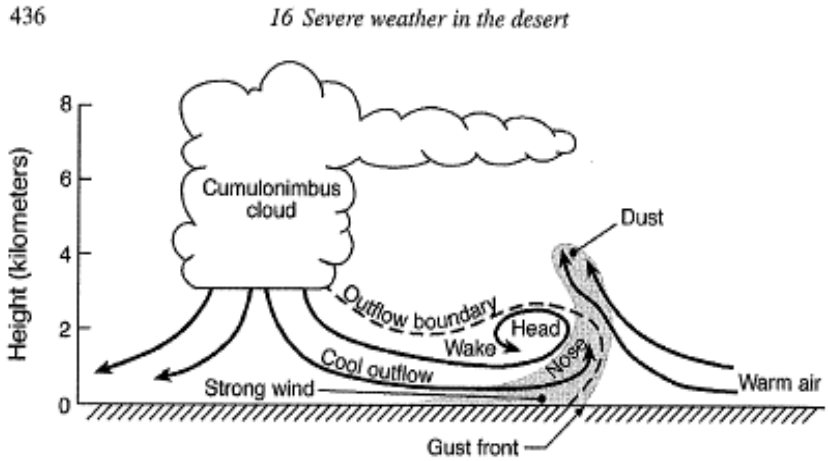

Fig. 16.10 Cross-section schematic of a haboob caused by the cool outflow from a thunderstorm, with the leading edge that is propagating ahead of the storm called an outflow boundary. The strong, gusty winds that prevail at the boundary are defined as a gust front. The leading edge of the cool air is called the nose, and the upward-protruding part of the feature is referred to as the head. Behind the roll in the windfield at the leading edge is a turbulent wake. The rapidly moving cool air and the gustiness at the gust front raise dust (shaded) high into the atmosphere.

Figure 2-3. Cross-section of a thunderstorm creating an outflow boundary and haboob (Source: Desert Meteorology. Thomas T. Warner. 2004.)

Dust storms associated with these thunderstorms typically occur in the early part of the monsoon season (July) before subsequent rains moisten the soil and limit potential lofting of soil into the air. However, depending on the amount and frequency of precipitation received during the monsoon season, extremely hot temperatures act to dry the surface soils very quickly; thus, dust storms can occur at any time during the year. Specific PM_{10} source regions are difficult to determine during thunderstorm-driven dust storms because the thunderstorm outflow can carry dust over long distances that encompass many possible sources of dust. Instead, we consider general PM_{10} source regions, which are typically identified based on the locations of the thunderstorms that are believed to have generated the dust-laden outflow winds.

2.3 Event Day Summary

On the evening of July 2, 2011, strong winds generated by thunderstorms over northwestern Mexico transported dust northwestward into southern Arizona and southeastern California, impacting the Yuma area (**Figure 2-4**). The windblown dust resulted in a 24-hr average PM_{10} concentration of 225 µg/m^3 at the Yuma Supersite monitor (**Table 2-1**); this value is in exceedance of the NAAQS. The hourly and 24-hr average PM_{10} concentrations measured at the Yuma Supersite monitor were in excess of normal historical fluctuations. The dust was naturally occurring and likely originated over undeveloped lands of northwestern Mexico and southeastern Arizona outside the city of Yuma, and wind gusts in excess of 40 mph would have likely overwhelmed reasonable dust control measures. PM_{10} monitors in southeastern

California also recorded high PM_{10} concentrations as the dust storm moved through that region, illustrating the regional nature of this event.

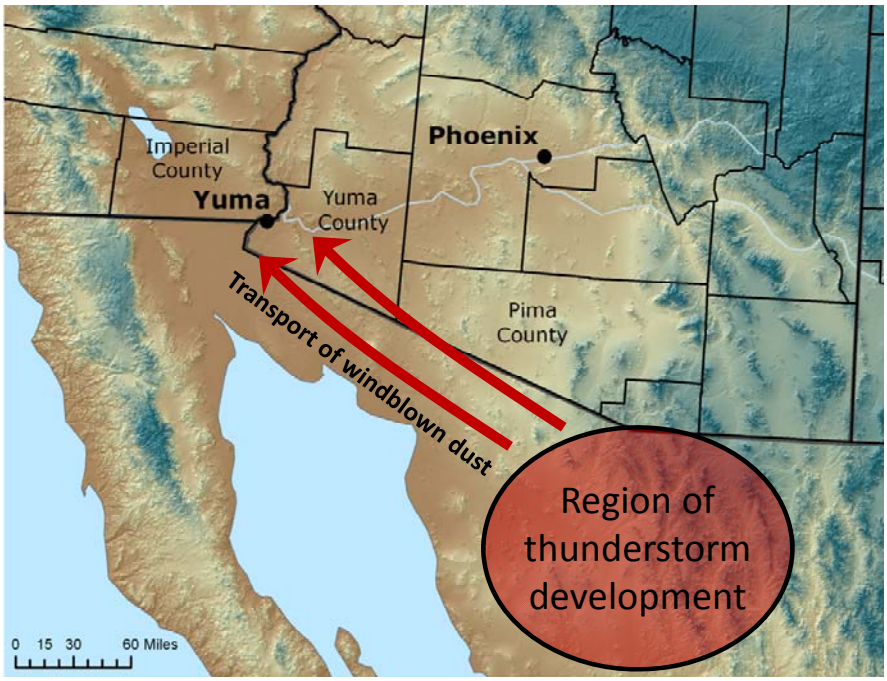

Figure 2-4. Outflow boundaries from thunderstorms over northwest Mexico moved northwestward and transported dust to the Yuma area.

Table 2-1. Yuma Supersite monitor information and PM_{10} measurements on July 3, 2011.

Monitor	Monitor Type	Operator	AQS Monitor ID	24-hr Avg PM_{10} ($\mu g/m^3$)	1-hr Max PM_{10} $\mu g/m^3$)	Time of Max 1-hr PM_{10}	AQS Qualifier Flag
Yuma Supersite	TEOM[1]	ADEQ	04-027-8011-81102-3	225	3089	00:00	RJ[2]

[1] Tapered element oscillating microbalance monitor.
[2] RJ is the qualifier flag for High Winds.

3. Causal Relationship

Meteorological and air quality observations indicate that dust carried by thunderstorm outflow was directly responsible for the high PM_{10} concentrations observed in Yuma on July 3, 2011. On the evening of July 2, intense thunderstorms developed over the higher terrain of northwestern Mexico, just south of the Arizona border (**Figure 3-1**). These thunderstorms expanded northwestward and weakened as they moved into south-central Arizona, but the thunderstorms generated dust-carrying outflow boundaries that propagated northwestward toward the Yuma area. As stated in Section 2.2, thunderstorms associated with the summer monsoon season can generate strong winds and blowing dust across Arizona. The likely source regions for PM_{10} during the July 3, 2011, event were the deserts of far northwestern Mexico and along the path of the outflow boundary from far northwestern Mexico northwestward into western Pima County and southern Yuma County. This region largely consists of natural, undisturbed desert. The last time Yuma recorded any measurable rainfall leading up to the July 3, 2011, high wind event was on April 8, 2011, when showers associated with a cold front produced 0.08 inches of rain at the Yuma MCAS. This combination of geography and lack of rainfall preceding the event resulted in a large fetch of soils that were particularly vulnerable to particulate suspension.

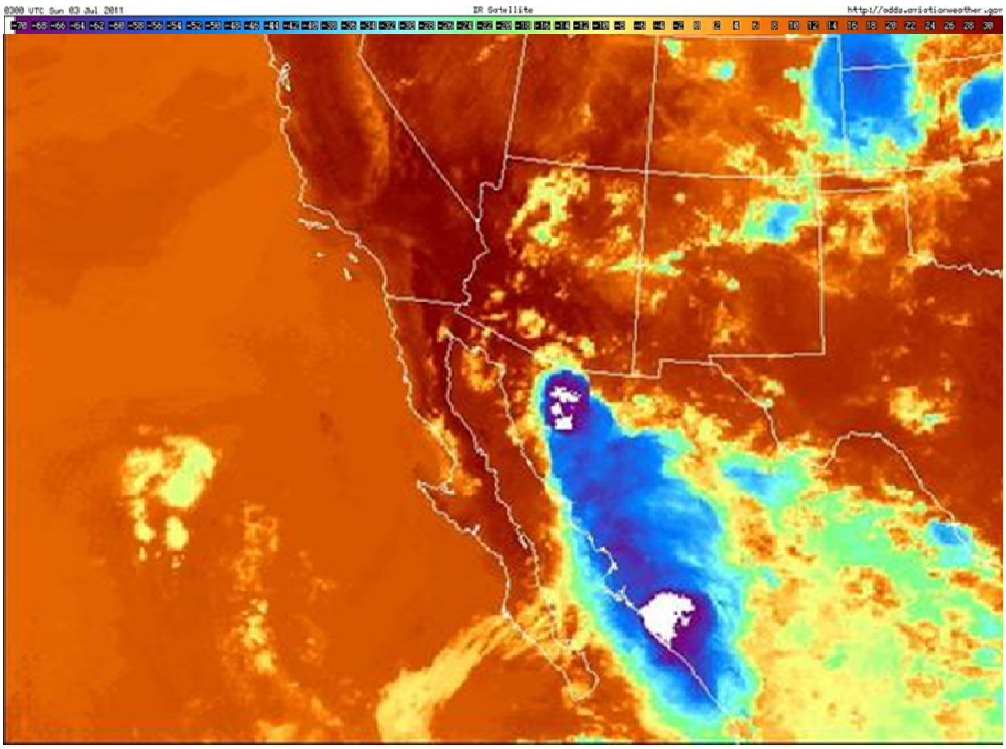

Figure 3-1. Infrared satellite image from 8:00 p.m. MST on July 2, 2011 (GOES-West). Colder temperatures (blues, purples, and white) are indicative of tall, convective (thunderstorm) clouds. Thunderstorms over northwestern Mexico collapsed and generated outflow boundaries that carried dust northwestward into Arizona.

Figure 3-2 and **Table 3-1** summarize the progression of the thunderstorm outflow and windblown dust as it moved through southwestern Arizona. The dust-laden outflow first arrived in the Yuma area around midnight on July 3. PM_{10} concentrations at the Yuma Supersite monitor increased sharply over this time period, with a 1-hr concentration of 3,089 µg/m^3 recorded at midnight on July 3 (**Figure 3-3**). Meteorological monitors in the Yuma area measured sustained winds of over 20 mph and wind gusts in excess of 40 mph coincident with the sharp increase in PM_{10} concentrations (Figure 3-3 and **Appendix A**). The strong southeasterly winds and dust were evident on the National Weather Service Doppler radar in Yuma (**Figure 3-4**). Visibility at the Yuma MCAS also decreased significantly with the arrival of the dust (**Figure 3-5**), prompting the National Weather Service office in Phoenix, AZ, to issue a Dust Storm Warning for Yuma County (see **Appendix B**). It is also important to note that before the abrupt increase in PM_{10} in Yuma, winds were light (at or less than 5 mph) and PM_{10} concentrations were much lower, illustrating the relationship between the high winds and the dust.

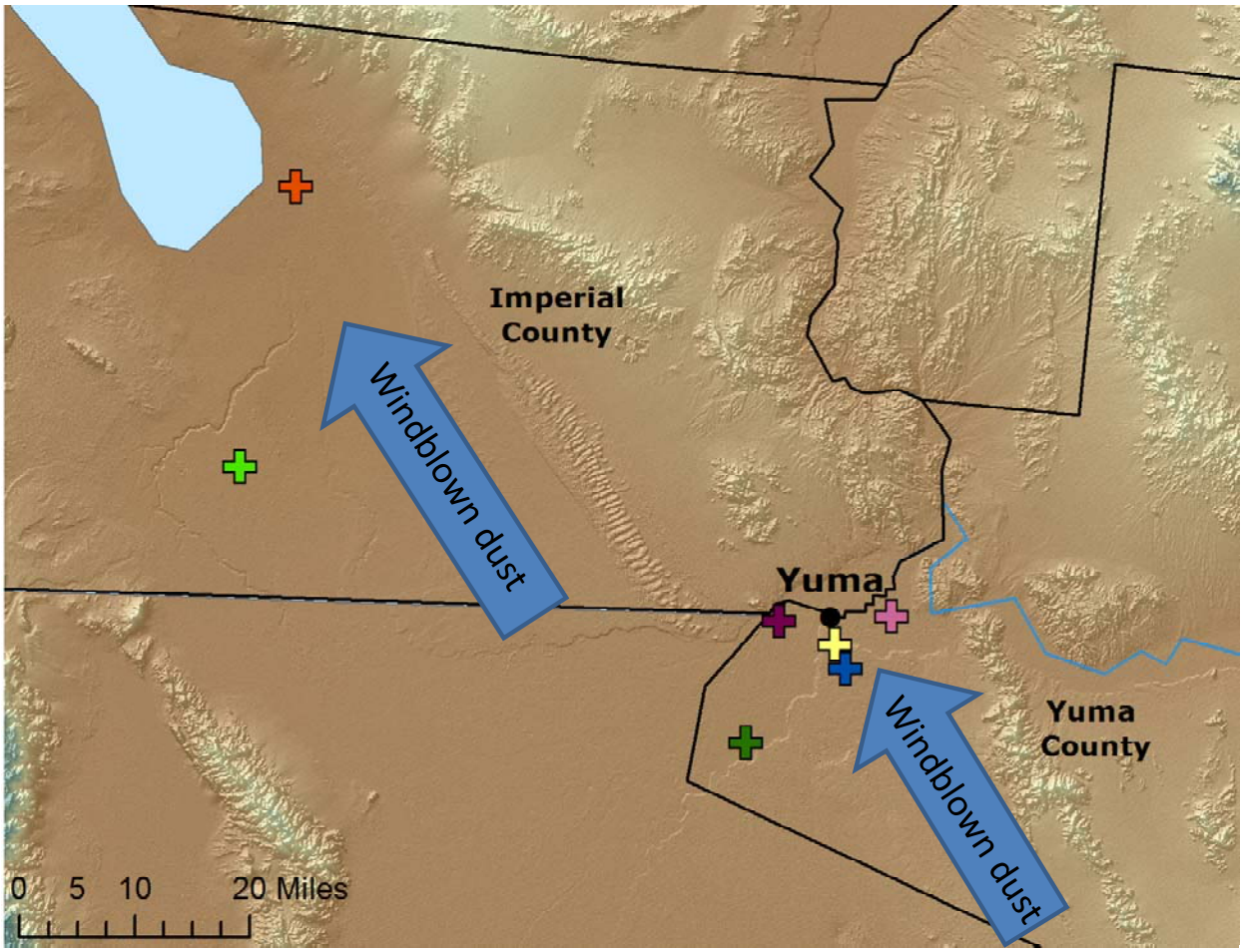

Figure 3-2. Yuma and Imperial County meteorological monitors and wind direction data. Wind speed and wind gust data for each monitor are shown in Table 3-1. Gusty southeasterly to south-southeasterly winds transported dust across Yuma and Imperial Counties on early July 3, 2011.

Table 3-1. Observed wind speeds and wind gusts at Yuma and Imperial County monitors on July 3, 2011. The Yuma Supersite monitor reported a PM_{10} concentration of 3089 µg/m^3 at 00:00 on July 3, 2011, coincident with the peak wind speed and wind gust reported at that monitor.

	Monitor	Maximum Wind Speed (mph)	Wind Direction (degrees)	Date/Time	Maximum Wind Gust (mph)	Date/Time
	Yuma Supersite	22	155	7/3/2011 00:00	41	7/3/2011 00:00
	Yuma North Gila	28	166	7/3/2011 00:00	42	7/3/2011 00:00
	Yuma South	25	162	7/3/2011 01:00	39	7/3/2011 02:00
	Yuma MCAS	30	170	7/3/2011 01:00	48	7/3/2011 00:00
	Yuma Valley	20	177	7/3/2011 01:00	31	7/3/2011 00:00
	Niland	24	150	7/3/2011 01:00	-	-
	Imperial County Airport	29	140	7/3/2011 02:00	37	7/3/2011 01:00

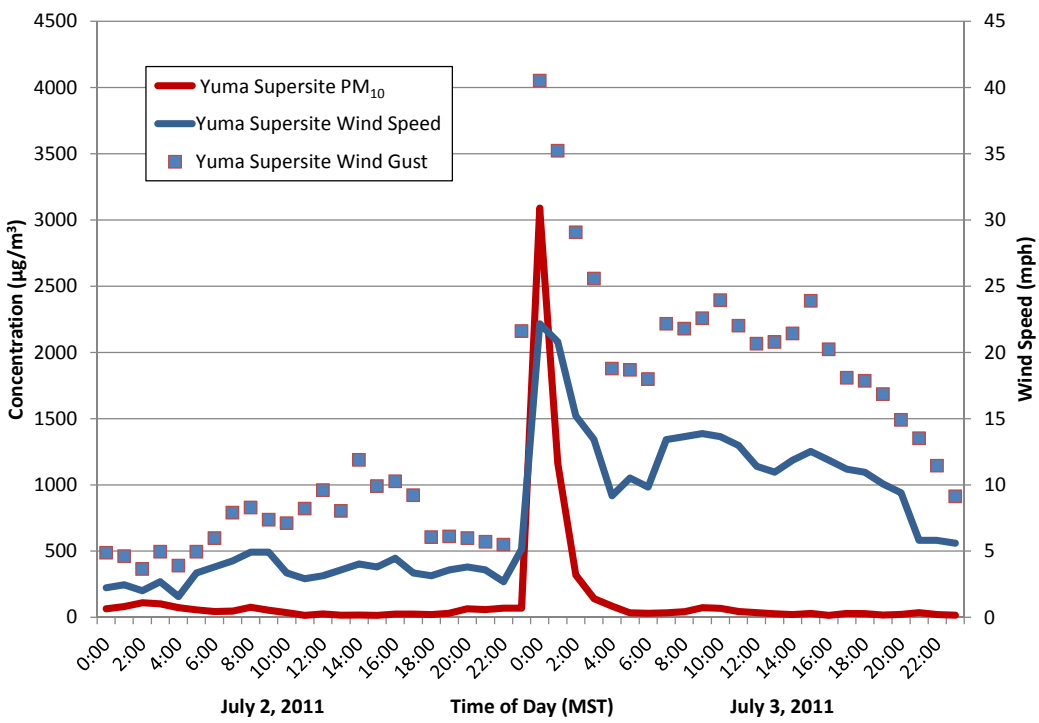

Figure 3-3. Hourly PM_{10} concentrations and wind speeds at the Yuma Supersite monitor on July 2 and 3, 2011. PM_{10} concentrations and wind speeds sharply increased at midnight on July 3, 2011, indicating the arrival of windblown dust.

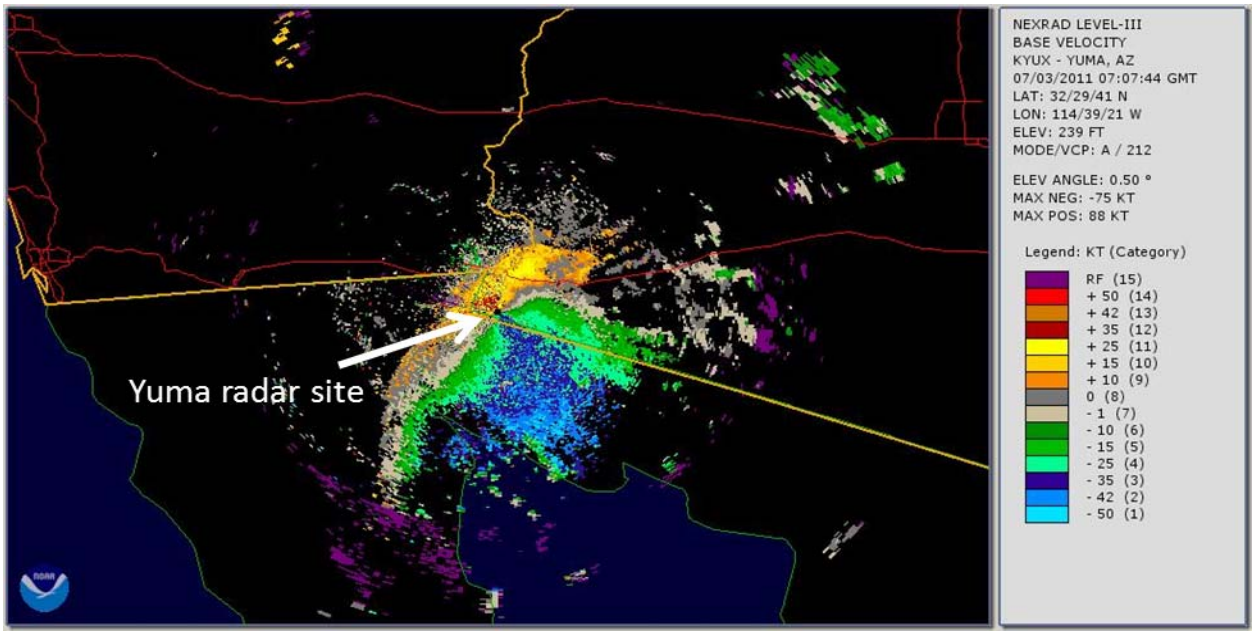

Figure 3-4. Base radial velocity at 12:07 a.m. on July 3, 2011, from NWS Doppler radar in Yuma, AZ. Blue and green indicate flow toward the radar; red and yellow indicate flow away from the radar. Strong southeasterly winds associated with thunderstorm outflow carried dust into the Yuma area.

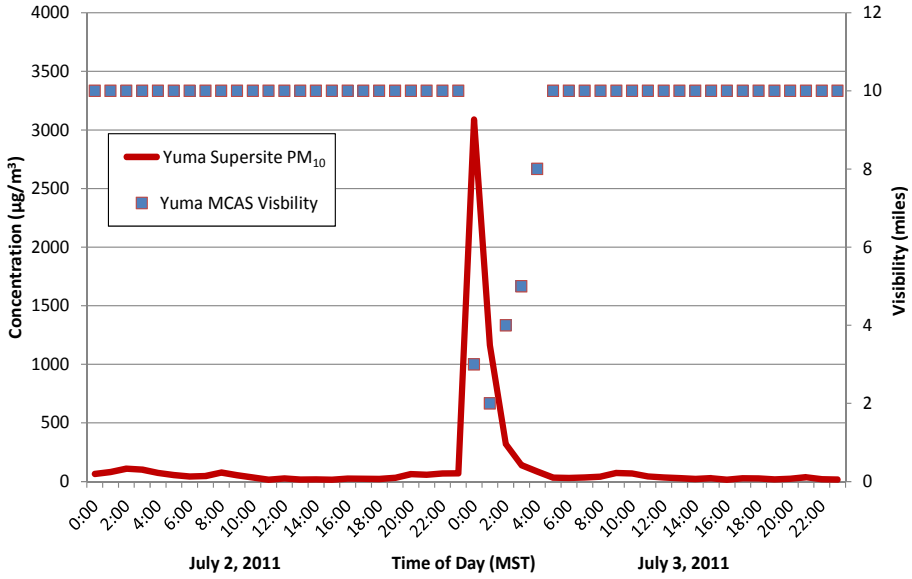

Figure 3-5. Hourly PM_{10} concentrations at the Yuma Supersite monitor and visibility at Yuma MCAS. Visibility was greatly reduced starting at 12:00 a.m. MST on July 3, coincident with the sharp increase in PM_{10} concentrations at the Yuma Supersite monitor, indicating the arrival of windblown dust.

PM_{10} concentrations decreased after 2:00 a.m. MST as the dust storm propagated northwestward out of Arizona and into southeastern California. Air quality monitors in neighboring Imperial County, CA, also reported gusty southeasterly winds and sharp increases

in PM_{10} concentrations, illustrating the widespread nature of this dust storm event (**Figure 3-6**). No rainfall was reported across southwestern Arizona and southeastern California with the passage of this outflow boundary and the associated dust.

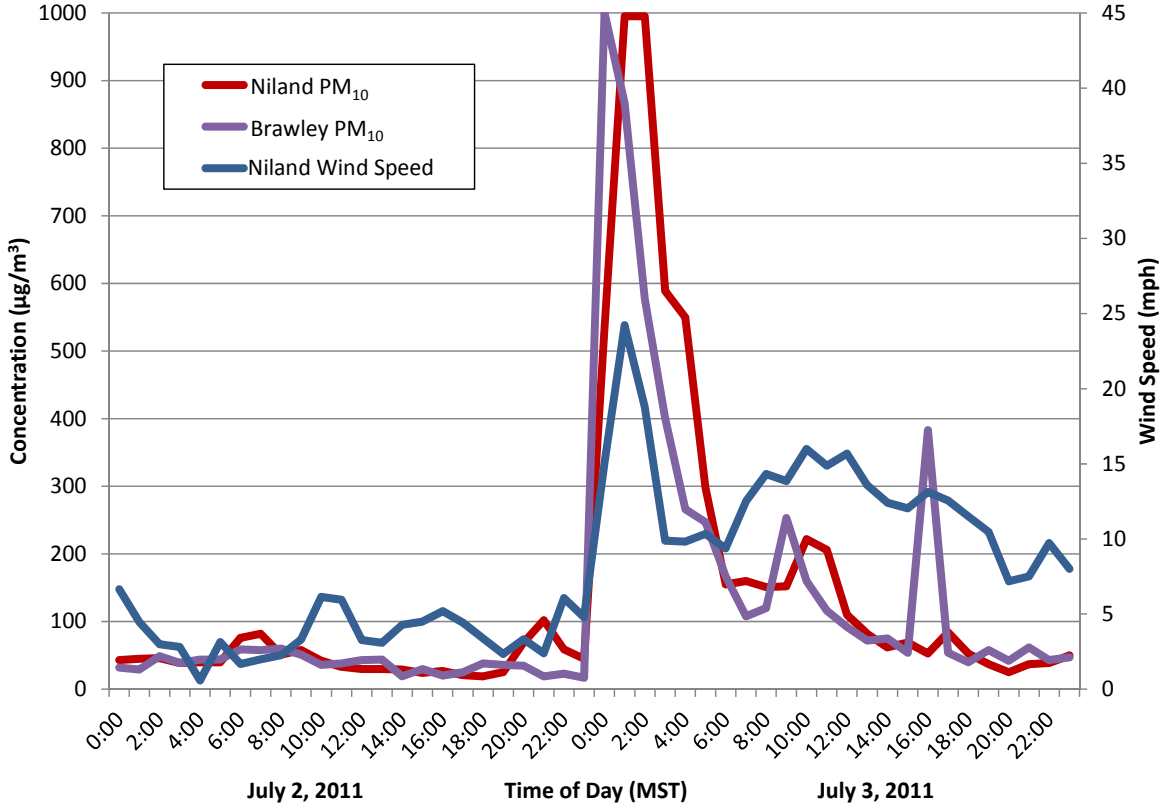

Figure 3-6. Hourly PM_{10} concentrations and wind speeds at the Brawley and Niland AQS monitors in Imperial County, CA, on July 2 and 3, 2011. PM_{10} concentrations and wind speeds sharply increased at midnight on July 3, 2011, indicating the arrival of windblown dust.

4. Historical Norm

PM_{10} concentrations measured at the Yuma Supersite monitor on July 3, 2011, were unusual and in excess of normal historical fluctuations. The PM_{10} concentrations measured on July 3, 2011, were some of the highest hourly and 24-hr averages measured over the last five years, with hourly concentrations exceeding 3,000 µg/m^3. To establish the severity of this event, PM_{10} concentrations measured on July 3, 2011, were compared to a historical 2006-2011 5-year annual data set. Time-series plots of the 24-hr average PM_{10} concentrations for the period January 1, 2006, through December 31, 2011, provide a historical perspective of PM_{10} concentrations (**Figures 4-1** and **4-2**). The 24-hr average PM_{10} concentration on July 3, 2011, is the 6th highest daily average in the last 5 years and the highest daily average in 2011. Additionally, time-series plots of the daily maximum 1-hr PM_{10} concentrations were created to provide a deeper understanding of the frequency with which short-term particulate concentrations affect the Yuma area. The daily maximum 1-hr PM_{10} concentration on July 3, 2011, is the second highest observation in the last 5 years.

Historical daily cumulative distributions of the daily maximum 1-hr and 24-hr average PM_{10} concentrations were created for the Yuma county monitor for the 2006-2011 period to provide additional evidence in establishing the severity of this event. **Figures 4-3** and **4-4** show histograms of daily maximum 1-hr PM_{10} concentrations and 24-hr average PM_{10} concentrations at the Yuma county monitor and the corresponding 95th percentile. The daily maximum 1-hr PM_{10} concentrations and the 24-hr average PM_{10} concentration on July 3, 2011, were above the 95th percentile at the Yuma Supersite monitor. Concentrations in excess of the 95th percentile are considered to be unusual.[3] Given the recorded values and using similar methodology to the one accepted by EPA, it is clear that the PM_{10} levels on July 3, 2011, were outside of normal historical fluctuations. This analysis provides evidence that the event affected air quality on a historic scale.

[3] Excluding days on which concentrations caused by exceptional events exceed the 95th percentile threshold employs a general test of statistical significance and has the effect of ensuring that such concentrations would clearly fall beyond the range of normal expectations for air quality during a particular time of year. Source: "The treatment of Data Influenced by Exceptional Events," 71 FR 12598.

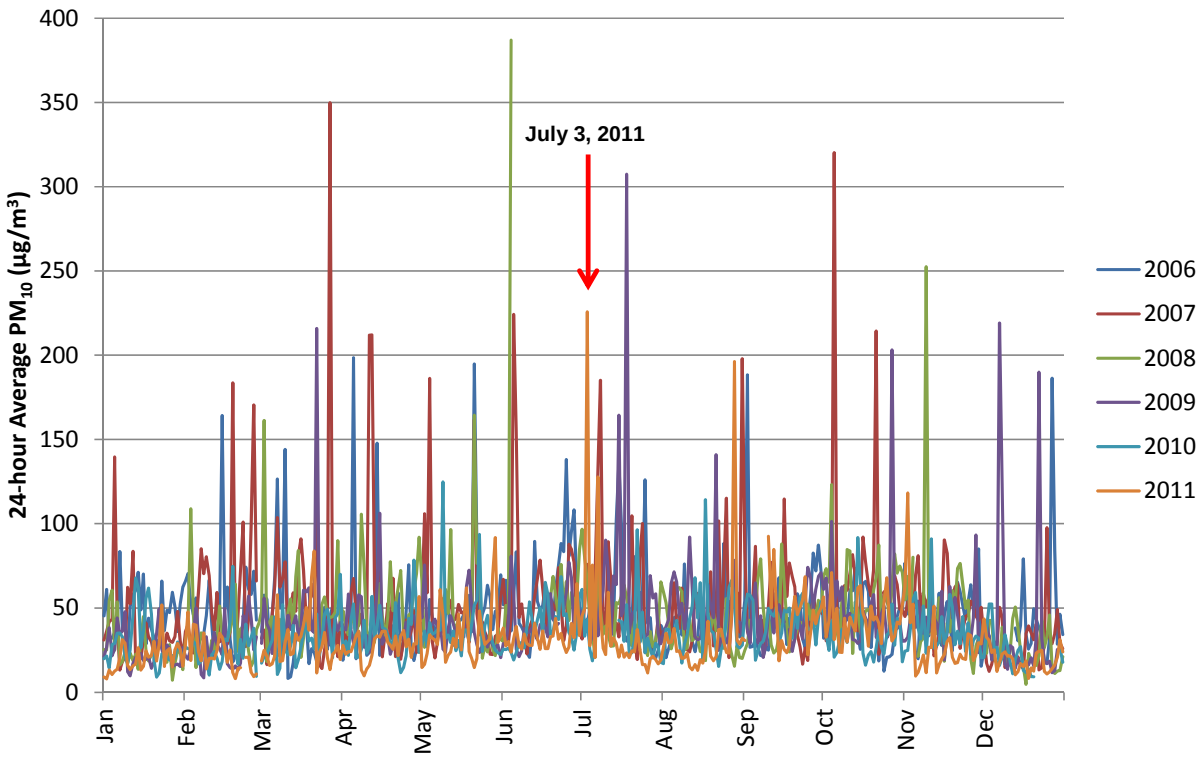

Figure 4-1. 24-hr average PM_{10} concentrations at the Yuma Supersite monitor (2006-2011). The 24-hr average PM_{10} concentration on July 3, 2011, is highlighted by the red arrow.

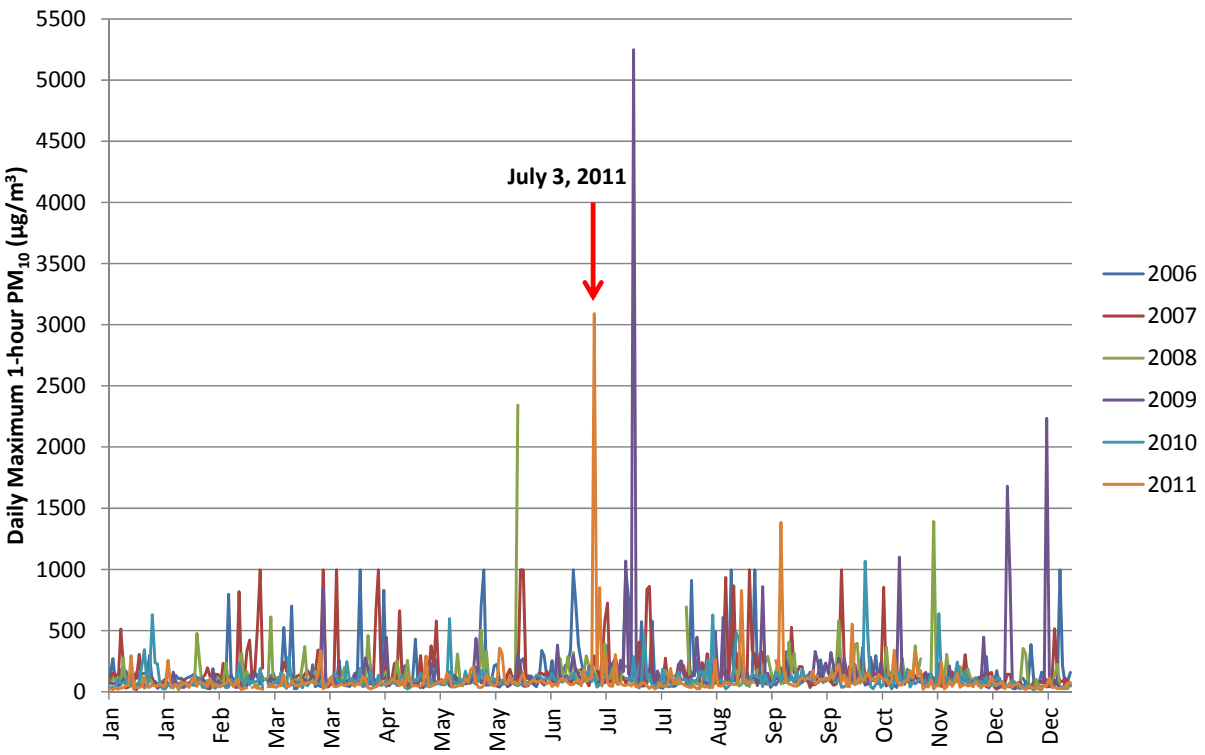

Figure 4-2. Daily maximum 1-hr PM_{10} concentrations at the Yuma Supersite monitor (2006-2011). The daily maximum 1-hr PM_{10} concentration on July 3, 2011, is highlighted by the red arrow.

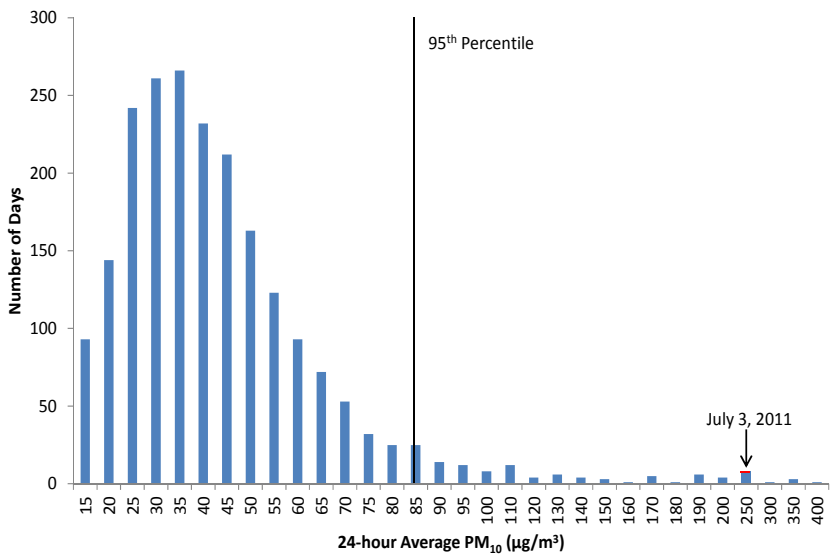

Figure 4-3. 24-hr average PM_{10} concentrations at the Yuma Supersite monitor for 2006-2011. The 24-hr average PM_{10} concentration on July 3, 2011, was in excess of the 95th percentile.

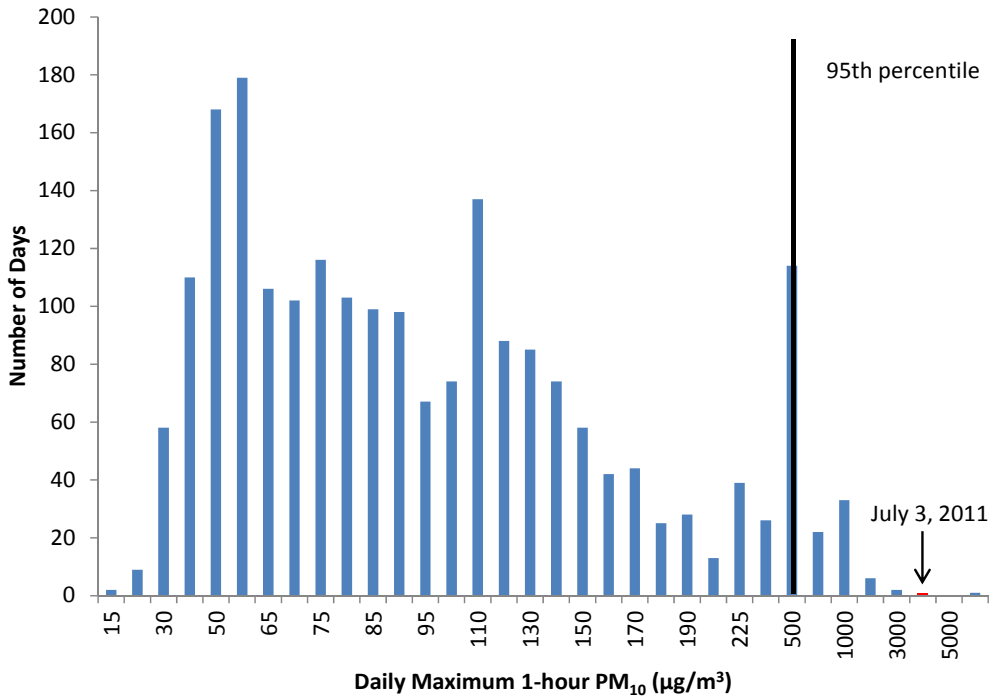

Figure 4-4. Daily maximum 1-hr PM_{10} concentrations at the Yuma Supersite monitor for 2006-2011. The daily maximum 1-hr PM_{10} concentration on July 3, 2011, was in excess of the 95th percentile.

5. Not Reasonably Controllable or Preventable

5.1 Background

Yuma was designated as a moderate PM_{10} nonattainment area by operation of the 1990 Clean Air Act. The nonattainment area is defined in 40 CFR §481.303. ADEQ completed a state implementation plan (SIP) for the area in 1991; however, the plan was found incomplete and in 1994 ADEQ updated the plan, identifying additional reasonably available control measures (RACM). In 2001, due to several years of "clean data" and the existence of permanent and enforceable measures, ADEQ began the development of a maintenance plan and request for redesignation of the area to attainment. The maintenance plan was submitted to EPA in August 2006.

5.1.1 Control Measures

Details of the control measures implemented from 1994-2001 are in Appendix G of the 2006 Yuma PM_{10} Maintenance Plan. A list of the measures is contained in **Table 5-1**.

Table 5-1. Control measures implemented in Yuma nonattainment area 1994-2001.

Implementing Agency	Reasonably Available Control Measure
City of Yuma	Paving unpaved roads
	Closing unpaved roads
	Chemically stabilizing unpaved roads
	Paving or stabilizing parking lots
	Re-routing traffic or rapid cleanup of temporary sources of dust and spills
	Covering haul trucks
	Dust control plans for land clearing, construction projects
	Stabilizing soil; controlling dust on open lands
	Amending building codes
Town of Somerton	Re-routing traffic or rapid cleanup of temporary sources of dust and spills
	Covering haul trucks
	Dust control plans for land clearing, construction projects
	Stabilizing soil
Yuma County	Paving unpaved roads
	Stabilizing unpaved roads
	Re-routing traffic or rapid cleanup of temporary sources of dust and spills
	Covering haul trucks
	Open Burn Permit Program (Rural Metro)
Irrigation Districts	Reducing traffic on unpaved roads
AZ Dept. of Transportation	Requiring contractors to adhere to local dust control plans

RACM for 2000 through 2004 can be found in Table 6.3 of the 2006 Yuma PM_{10} Maintenance Plan and is reproduced in part in **Table 5-2**. Chapter 7 of the Maintenance Plan also contains a list of contingency measures that could be implemented promptly should any violation of the National Ambient Air Quality Standard (NAAQS) for PM_{10} occur.

Table 5-2. Yuma-area-implemented control measures, 2000-2004.

Page 1 of 2

Implementing Agency	Reasonably Available Control Measure
City of Yuma	Pave unpaved roads
	Pave unpaved alleys
	Paving unpaved vacant land
	Chemically stabilize unpaved roads
	Watering shoulders
	Street sweeping paved roads
	Install curbs and sidewalks
	Landscaping median
	Magnesium chloride on alleys
	Magnesium chloride on City property
Town of Somerton	Water unpaved roads
	Water unpaved shoulders
	Pave unpaved roads
	Weekly cleanup of paved roads, mud, trackout, spills
	Pave unpaved lots
	Landscape shoulders
	Install curbs
	Pave/stabilize unpaved roads
	Chip/seal
	Magnesium chloride on unpaved roads
	Street sweeping
Yuma County	Pave unpaved roads
	Developers add new paved roads
	Chip/seal unpaved roads
	Magnesium chloride unpaved roads
	Street sweeping

Table 5-2. Yuma-area-implemented control measures, 2000-2004.

Page 2 of 2

Implementing Agency	Reasonably Available Control Measure
Immigration & Naturalization	Water drag roads
	Pipelined
	Maintain 350 “No Trespassing” signs and 50 barricades
	Patrol and water unpaved canal roads
	3 mi posted/barricaded
	Paved 2.5 mi
	2.5 mi fenced off
	Abandoned 3/8 mi
	Lined 8 mi of canal
N. Gila Irrigation District	20 miles posted
Unit B Irrigation District	3 mi posted/barricaded
Bureau of Reclamation	Water 960 miles of canal banks
Marine Corps Air Station	Remove 26 gas vehicles
	Remove 25 gas scooters
	Pave 240,329 ft roadway
	Pave 102,112 ft parking
	Sweeping 717,221 yd runway
	Sweeping 388,952 yd taxiway
	Sweeping 401,090 yd aprons and 121,380 yd other
	Stabilize desert

In 2010, the Yuma Metropolitan Planning Organization (YMPO) updated the Transportation Improvement Plan (TIP) as required to comply with the requirements for transportation conformity under Section 176(c)(2) of the Clean Air Act. The update required a review of control measures included in the 2006 Yuma PM_{10} Maintenance Plan to assure that emissions were within the limits found in both plans for the current review years through the 2016 projected maintenance period. Yuma’s plans related to transportation improvements can be found under “Plans and Reports” at http://www.ympo.org/.

5.1.2 Additional Measures

On August 18, 2002, Yuma recorded a 24-hr average PM_{10} concentration of 170 µg/m^3, which is in exceedance of the NAAQS. A Natural Events Action Plan (NEAP) was created to address any measures that could be implemented to prevent future violations of the NAAQS. The option to develop a NEAP is no longer available; however, Yuma reviewed existing and developed additional measures that were later incorporated into the 2006 PM_{10} Maintenance Plan. These included: (1) a public notification and education program still in place today and augmented recently by a pilot flag program for public schools and facilities based on the Yuma Dust Control Action Forecast [Appendices D, E and F]; (2) an analysis of best available control

measures (BACM) normally reserved for serious nonattainment areas; and (3) a review of existing control measures for construction sources, street sweepers, paved roads, covered trucks, off-highway vehicles, stationary source opacity limits, other stationary source control measures, and agricultural best management practices [Appendix H]. In 2002, ADEQ met with Yuma stakeholders and began work on the development of a Yuma Agricultural Best Management Practices (AgBMP) rule. The rule became effective July 18, 2005, as R18-2-613 of the Arizona Administrative Code, and was submitted to EPA on August 16, 2006.

5.1.3 Review of Source-Permitted Inspections and Public Complaints

ADEQ's Arizona Unified Repository for Information Tracking of the Environment (AZURITE) database was queried to compile a list of inspections for the permitted sources in the Yuma area around the time of the July 3, 2011, PM_{10} exceedance. Using a date range that includes the date of the exceedance, three days prior, and three days following the event, it was determined that no inspections occurred and no public complaints were submitted during this time period.

5.2 Forecasts and Warnings

Dust forecasts were released prior to the event by both ADEQ and the National Weather Service (NWS) office in Phoenix (Appendix B). The ADEQ Yuma and Vicinity Dust Control Action Forecast issued on Friday, July 1, 2011, stated that conditions would be "possibly gusty late due to thunderstorm outflow winds" and included a "Moderate" windblown dust risk. The NWS issued a Special Weather Statement on Saturday, July 2, 2011, at 1:08 p.m. MST, warning of the potential for strong gusty outflow winds from thunderstorms with gusts over 40 miles per hour, expected to cause windblown dust and possibly a dust storm in open desert areas late that afternoon or evening across southwestern Arizona, including the Yuma area.

At 12:17 a.m. MST on July 3, 2011, the NWS in Phoenix issued a Dust Storm Warning for Yuma and other communities due to large areas of blowing dust and sand, causing "substantially reduced visibilities… to 1/3 mile or less." The time this dust storm warning was issued coincides with the peak PM_{10} concentration of 3,089 $\mu g/m^3$ recorded at the Yuma Supersite monitor.

5.3 Wind Observations

Wind data during the event were available at five Yuma-area sites (Figure 3-3 and Appendix A). Sustained wind speeds of over 20 mph were reported at the Yuma Supersite monitor during the event. The Yuma South, North Gila, and Yuma MCAS sites reported sustained wind speeds of over 25 mph. A peak wind gust of 48 mph was reported at the Yuma MCAS site. Sustained wind speeds of over 25 mph are normally sufficient to overcome most PM_{10} control measures.

5.4 Summary

The weather and air quality forecasts and warnings outlined in this section demonstrate that unpreventable outflow winds from thunderstorms resulted in strong wind gusts that caused the dust storm that significantly impacted Yuma. The surface wind measurements in the Yuma area during the event were high enough (at or above 25 mph) that most reasonable PM_{10} control measures would have been overwhelmed.

6. But-For Analysis

Section 50.14(c)(3)(iv)(D) in 40 CFR part 50 requires that an exceptional event demonstration satisfies that "[t]here would have been no exceedance or violation but for the event." The prior sections of this submittal have provided detailed information that the PM_{10} exceedance at the Yuma Supersite monitor on July 3, 2011:

- Was not reasonably controllable or preventable, and
- That there was a clear causal relationship between PM_{10} transported from thunderstorm outflow originating in desert areas outside the Yuma PM_{10} nonattainment area and the measured PM_{10} exceedance in Yuma.

The weight of evidence in these sections demonstrates that, but for the existence of dust emissions generated by thunderstorm outflow and the associated transport of PM_{10}, there would have been no exceedance of the NAAQS for 24-hr average PM_{10}.

As shown in Section 3, radar velocity data and time-series plots of PM_{10} and wind speeds establish a clear causal relationship between the arrival of dust-laden thunderstorm outflow and elevated PM_{10} concentrations at the Yuma Supersite monitor. Multiple independent measurements of wind speed, wind direction, and visibility all point to the presence of thunderstorm outflow as the mechanism for transport of PM_{10} into the Yuma nonattainment area. High PM_{10} concentrations and gusty winds were also reported in other parts of Arizona and southeastern California, illustrating the widespread, regional nature of this event. In addition, PM_{10} concentrations were well below the NAAQS on days immediately before and after the windblown dust event. The source regions for the thunderstorm outflow and PM_{10} are clearly identified as desert areas southeast of the Yuma PM_{10} nonattainment area. The weight of evidence presented in this submittal provides no alternative that could tie the exceedance of July 3, 2011, to any causal source except PM_{10} transported by thunderstorm outflow, confirming that there would have been no exceedance but for the presence of these uncontrollable natural events.

As detailed in Section 5, all reasonable control measures were in place and/or implemented on a continual basis. Air quality-related inspection and compliance data revealed no violations or complaints within three days before and after the time of the event. Local regulatory agencies, industry, and the general public were alerted to the possibility of dust storms due to thunderstorm activity via daily forecasts and media reports. The weight of evidence presented in this submittal provides no alternative that could tie the exceedance of July 3, 2011, to any causal source except PM_{10} transported by thunderstorm outflow, confirming that there would have been no exceedance but for the presence of these uncontrollable natural events.

7. Conclusions

The PM_{10} exceedance that occurred on July 3, 2011, satisfies the criteria of 40 CFR 50.1(j) and meets the definition of an exceptional event. These criteria are:

- The event affects air quality.
- The event is not reasonably controllable or preventable.
- The event is unlikely to reoccur at a particular location or [is] a natural event.

7.1 Affects Air Quality

As stated in the preamble to the Exceptional Events Rule, the event in question is considered to have affected air quality if it can be shown that there is a clear causal relationship between the monitored exceedance and the event, and that the event is associated with a measured concentration in excess of normal historical fluctuations. Given the information presented in Sections 2, 3, 4, and 5, we can reasonably conclude that the event in question affected air quality.

7.2 Not Reasonably Controllable or Preventable

Section 50.1(j) of Title 40 CFR Part 50 requires that an event must be “not reasonably controllable or preventable” in order to be defined as an exceptional event. This requirement is met by demonstrating that despite reasonable control measures in place within Yuma County, high winds overwhelmed all reasonably available controls. The PM_{10} exceedance discussed in this report was caused by naturally-occurring thunderstorm outflow that transported dust into Yuma County from areas largely outside the Yuma PM_{10} nonattainment area. These facts provide strong evidence that the PM_{10} exceedance on July 3, 2011, was not reasonably controllable or preventable.

7.3 Natural Event

As discussed above, the PM_{10} exceedance in Yuma on July 3, 2011, was shown to be caused by transport of PM_{10} into Yuma from thunderstorm outflow. The event therefore qualifies as a natural event.

7.4 Summary

The exceedance of the federal 24-hr PM_{10} standard on July 3, 2011, at the Yuma Supersite monitor would not have occurred but for the thunderstorm-driven high winds and transport of dust from areas largely outside the Yuma PM_{10} nonattainment area, based on the following weight of evidence:

- Time-series of PM_{10} concentrations show that the timing of high PM_{10} at the Yuma Supersite was consistent with gusty winds and low visibilities at Yuma-area meteorological stations (Section 3).

- High PM_{10} concentrations and gusty winds were reported in Yuma County, Arizona, and Imperial County, California, illustrating the widespread, regional, and uncontrollable nature of this event (Section 3).
- PM_{10} concentrations were well below the NAAQS on days immediately before and after the windblown dust event.
- Dry conditions preceding the event resulted in soils that were particularly susceptible to particulate suspension by high winds (Section 3).
- The 24-hr average and daily 1-hr maximum PM_{10} values measured at the Yuma Supersite monitor were historically unusual compared to a multi-year data set (Section 4).
- PM_{10} control and prevention measures were in place in the Yuma PM_{10} nonattainment area at the time of the event. Measured wind speeds and wind gusts were of sufficient strength to overcome reasonable control measures (Section 5).

Appendix A: Historical Fluctuation Graphs for Yuma County

This section contains time-series of wind data for Yuma-area meteorological monitors on July 2 and 3, 2011. The data show a region-wide increase in wind speeds and wind gusts coincident with the arrival of dust and high PM_{10} concentrations in Yuma.

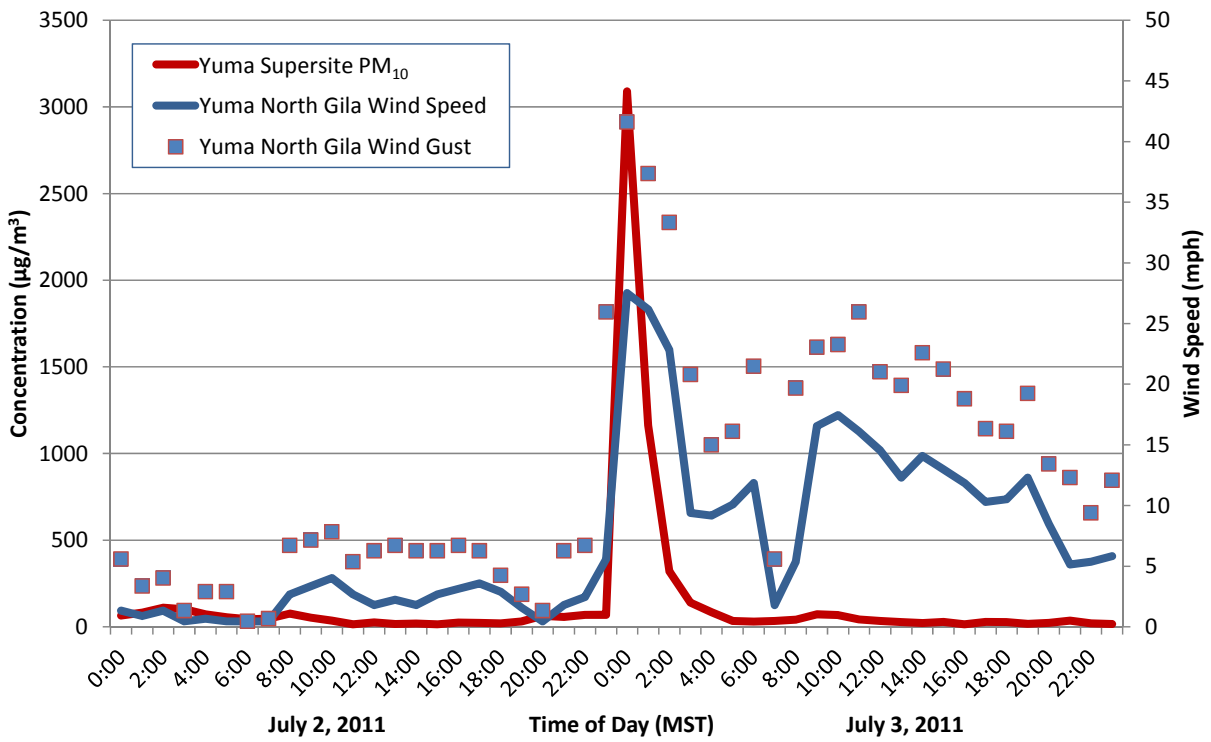

Figure A-1. Hourly PM_{10} concentrations at the Yuma Supersite monitor and wind speeds at the Yuma North Gila monitor on July 2 and 3, 2011. PM_{10} concentrations and wind speeds sharply increased at midnight on July 3, 2011, indicating the arrival of windblown dust.

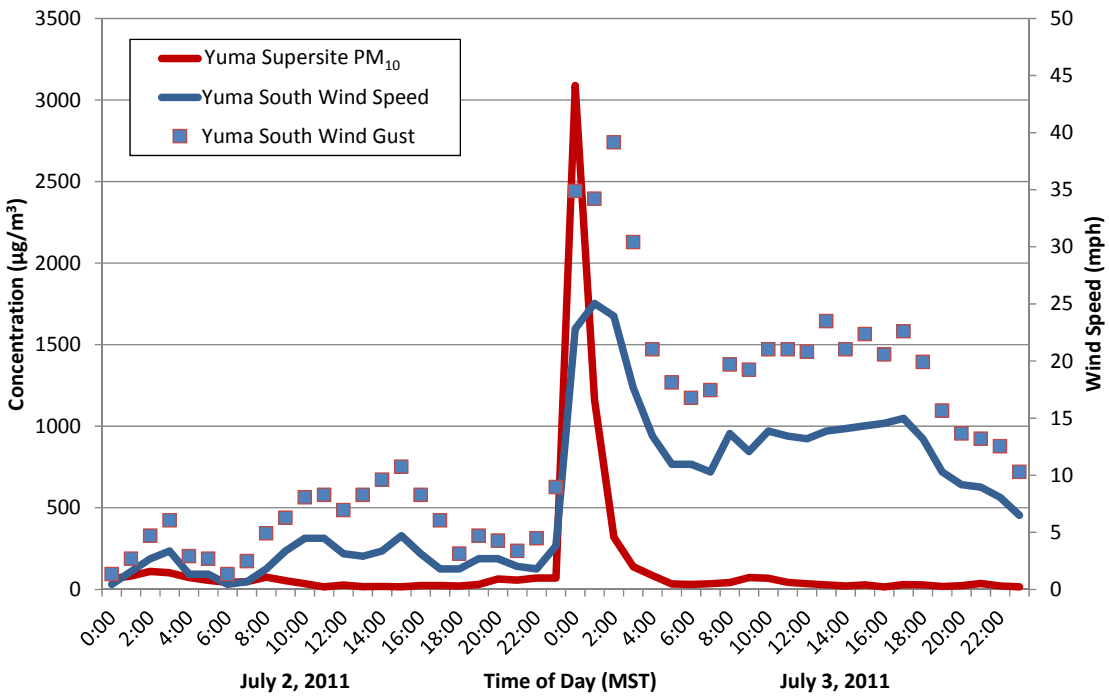

Figure A-2. Hourly PM_{10} concentrations at the Yuma Supersite monitor and wind speeds at the Yuma South monitor on July 2 and 3, 2011. PM_{10} concentrations and wind speeds sharply increased at midnight on July 3, 2011, indicating the arrival of windblown dust.

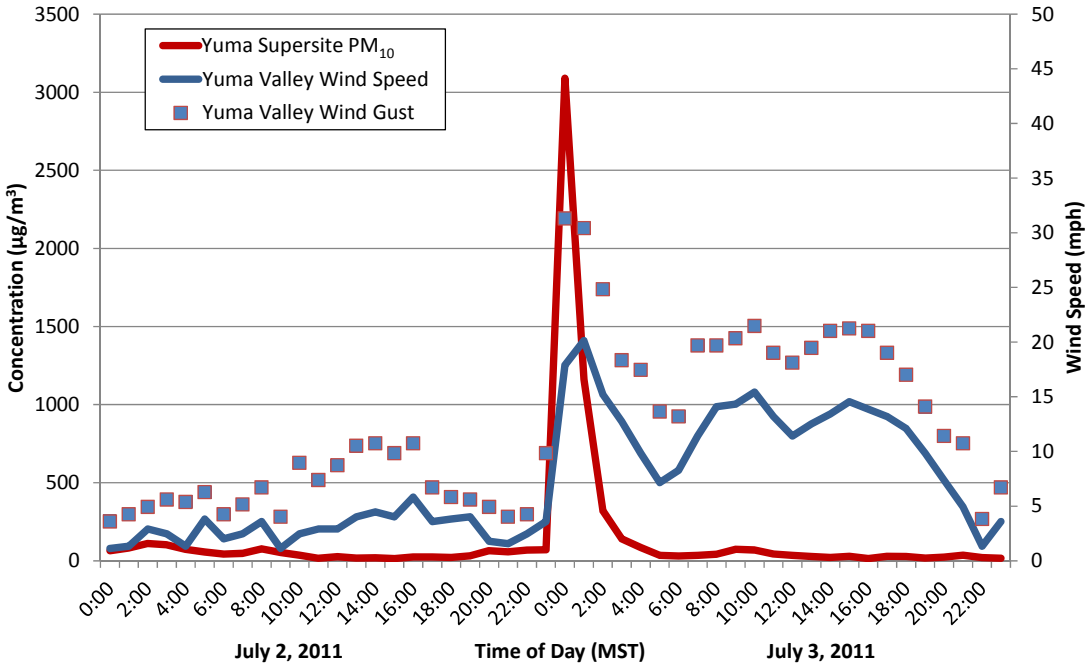

Figure A-3. Hourly PM_{10} concentrations at the Yuma Supersite monitor and wind speeds at the Yuma Valley monitor on July 2 and 3, 2011. PM_{10} concentrations and wind speeds sharply increased at midnight on July 3, 2011, indicating the arrival of windblown dust.

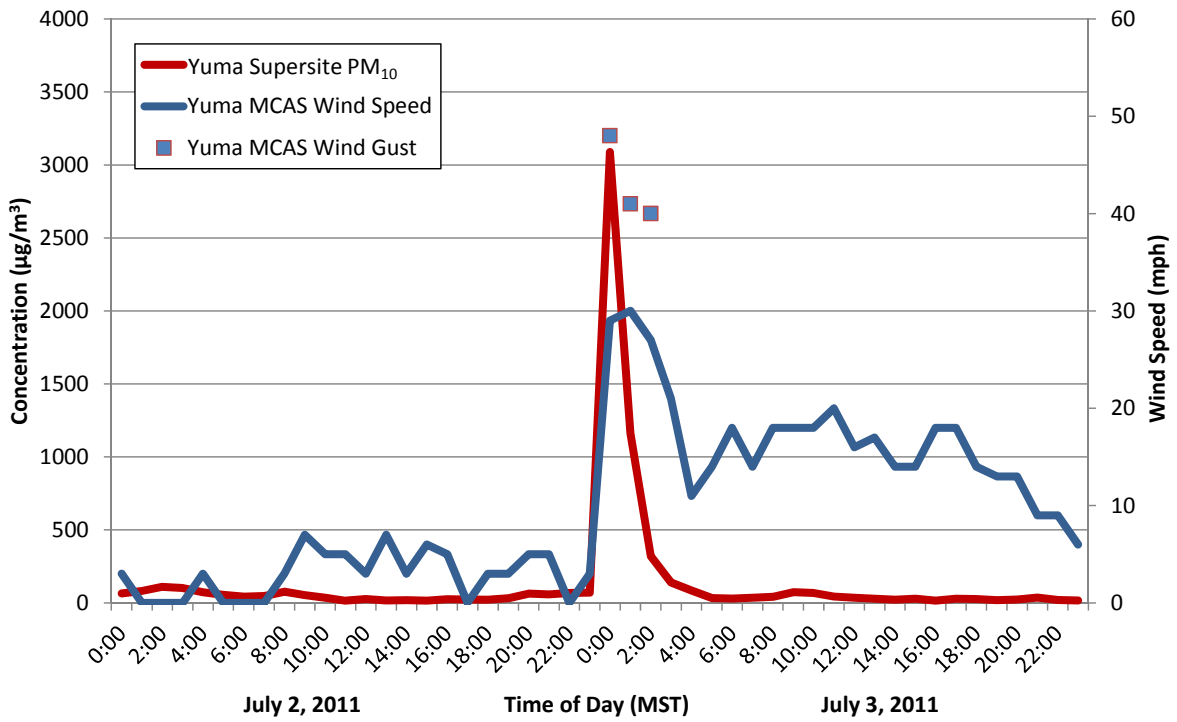

Figure A-4. Hourly PM_{10} concentrations at the Yuma Supersite monitor and wind speeds at the Yuma MCAS monitor on July 2 and 3, 2011. PM_{10} concentrations and wind speeds sharply increased at midnight on July 3, 2011, indicating the arrival of windblown dust.

Appendix B: ADEQ and NWS Forecast Products

YUMA AND VICINITY

DUST CONTROL ACTION FORECAST

ISSUED FRIDAY, JULY 1, 2011

Three-day weather outlook:

High pressure will be near the Four Corners later Friday afternoon through early next week. This will increase moisture levels across Arizona. Thunderstorm activity will ramp up considerably across the mountains as well as the deserts Saturday through Monday. Outflow winds may generate desert dust storms. Thus, the risk of wind-blown dust in Yuma will be MODERATE as a result.

	WINDS	**WIND BLOWN DUST RISK**
Day 1: Sat 07/02/2011	No significant winds are expected early, possibly gusty late due to thunderstorm outflow winds.	**MODERATE**
Day 2: Sun 07/03/2011	No significant winds are expected early, possibly gusty late due to thunderstorm outflow winds.	**MODERATE**
Day 3: Mon 07/04/2011	No significant winds are expected early, possibly gusty late due to thunderstorm outflow winds.	**MODERATE**

PM-10 & PM-2.5 (PARTICLES)

Description – The term “particulate matter” (PM) includes both solid particles and liquid droplets found in air. Many manmade and natural sources emit PM directly or emit other pollutants that react in the atmosphere to form PM. Particles less than 10 micrometers in diameter tend to pose the greatest health concern because they can be inhaled into and accumulate in the respiratory system. Particles less than 2.5 micrometers in diameter are referred to as “fine” particles and are responsible for many visibility degradations (brown cloud). Particles with diameters between 2.5 and 10 micrometers are referred to as “coarse”.

Sources – Fine = All types of combustion (motor vehicles, power plants, wood burning, etc.) and some industrial processes. Coarse = crushing or grinding operations and dust from paved or unpaved roads.

Potential health impacts – PM can increase susceptibility to respiratory infections and can aggravate existing respiratory diseases, such as asthma and chronic bronchitis.

Units of measurement – Micrograms per cubic meter (ug/m3)

Averaging interval – 24 hours (midnight to midnight).

Reduction tips – Stabilize loose soils, minimize travel on dirt roads, utilize tarps on haul trucks, limit use of leaf-blowers, and on high-wind days reduce outdoor activities.

NWS Special Weather Statement

WWUS85 KPSR 022008

SPSPSR

SPECIAL WEATHER STATEMENT

NATIONAL WEATHER SERVICE PHOENIX AZ

108 PM MST SAT JUL 2 2011

AZZ021>023-026>028-030100-
WEST CENTRAL DESERTS-NORTHWEST MARICOPA COUNTY-GREATER PHOENIX AREA-SOUTHWEST DESERTS-SOUTHWEST MARICOPA COUNTY-NORTHWEST AND NORTH CENTRAL PINAL COUNTY-
INCLUDING THE CITIES OF...BOUSE...QUARTZSITE...SALOME...BUCKEYE...LAKE PLEASANT...MORRISTOWN...NEW RIVER...TONOPAH...WICKENBURG... CAREFREE...CAVE CREEK...CHANDLER...FOUNTAIN HILLS...GILBERT... GLENDALE...MESA...PEORIA...PHOENIX...SCOTTSDALE...SUN CITY...TEMPE... DATELAND...TACNA...WELLTON...GILA BEND...APACHE JUNCTION...CASA GRANDE...COOLIDGE...AND FLORENCE
108 PM MST SAT JUL 2 2011
...STRONG GUSTY WINDS LATE THIS AFTERNOON OR THIS EVENING WITH BLOWING DUST POSSIBLE IN THE DESERT AREAS...
SCATTERED THUNDERSTORMS OVER THE HIGHER TERRAIN TO THE EAST OF THE GREATER PHOENIX AREA ARE EXPECTED TO MOVE WEST ACROSS SOUTHERN GILA COUNTY AND THE TONTO NATIONAL FOREST FOOTHILLS THIS AFTERNOON. MOST OF THESE THUNDERSTORMS ARE EXPECTED TO DISSIPATE AS THEY MOVE INTO THE DESERT AREAS. HOWEVER...STRONG GUSTY OUTFLOW WINDS FROM THE THUNDERSTORMS ARE EXPECTED TO SPREAD FROM EAST TO WEST ACROSS THE DESERT INCLUDING THE GREATER PHOENIX AREA LATE THIS AFTERNOON OR THIS EVENING. SOME OF THE WINDS COULD GUST TO OVER 40 MPH. THESE WINDS ARE EXPECTED TO RESULT IN SOME BLOWING DUST ESPECIALLY IN THE OPEN DESERT AREAS WHERE A DUST STORM IS POSSIBLE LATE THIS AFTERNOON OR THIS EVENING. THIS INCLUDES MARICOPA COUNTY...NORTHWEST AND NORTH-CENTRAL PINAL COUNTY...AND POSSIBLY EVEN LA PAZ AND YUMA COUNTIES.
IF YOU SEE A DUST STORM APPROACHING OR GET CAUGHT IN ONE...PULL OFF TO THE SIDE OF THE ROAD AS FAR AS SAFELY POSSIBLE...PUT YOUR VEHICLE IN PARK...TAKE YOUR FOOT OFF THE BRAKE PEDAL...AND TURN YOUR LIGHTS ALL THE WAY OFF.
IT WOULD BE WISE TO SECURE LOOSE OBJECTS TO PROTECT THEM FROM THE WIND. THE WIND COULD ALSO MAKE DRIVING DIFFICULT ESPECIALLY FOR HIGH PROFILE VEHICLES. STAY UP-TO-DATE ON THE LATEST FORECASTS BY LISTENING TO WEATHER RADIO ON THE PUBLIC SERVICE BAND. MORE DETAILED INFORMATION

IS AVAILABLE FROM THE NATIONAL WEATHER SERVICE IN PHOENIX ON THE INTERNET AT WEATHER.GOV/PHOENIX

NWS Dust Storm Warning

WWUS85 KPSR 030717

SPSPSR

SPECIAL WEATHER STATEMENT

NATIONAL WEATHER SERVICE PHOENIX AZ

1217 AM MST SUN JUL 3 2011

AZZ020-025-026-CAZ031-033-030815-
LA PAZ AZ-YUMA AZ-IMPERIAL CA-
1217 AM MST SUN JUL 3 2011
THE NATIONAL WEATHER SERVICE IN PHOENIX HAS ISSUED A
LOCAL DUST STORM WARNING FOR...
EASTERN IMPERIAL COUNTY IN SOUTHEAST CALIFORNIA
WEST CENTRAL YUMA COUNTY IN SOUTHWEST ARIZONA
SOUTHWESTERN LA PAZ COUNTY IN WEST CENTRAL ARIZONA
* COMMUNITIES IMPACTED: GORDON'S WELL...HOLTVILLE...WINTERHAVEN...
CIBOLA...GADSDEN...MARTINEZ LAKE...SOMERTON...YUMA...ANDRADE...KINTER
AND ARABY
* UNTIL 115 AM MST
* MAJOR HIGHWAYS IMPACTED INCLUDE:
I-8...
US 95...
* A LOCAL DUST STORM WARNING IS ISSUED WHEN WINDS HAVE GENERATED
LARGE AREAS OF BLOWING DUST OR BLOWING SAND THAT HAVE SUBSTANTIALLY
REDUCED VISIBILITIES...TO 1/4 MILE OR LESS...RESULTING IN VERY HAZARDOUS
DRIVING CONDITIONS IN SOME AREAS. BE READY FOR A SUDDEN DROP IN VISIBILITY
TO NEAR ZERO. IF YOU ENCOUNTER BLOWING DUST OR BLOWING SAND ON THE
ROADWAY OR SEE IT APPROACHING...PULL OFF THE ROAD AS FAR AS POSSIBLE AND
PUT YOUR VEHICLE IN PARK. TURN THE LIGHTS ALL THE WAY OFF AND KEEP YOUR
FOOT OFF THE BRAKE PEDAL