Technical Support Document For the February 28, 2012, Lamar Exceptional Event

Prepared by the
Air Pollution Control Division
Colorado Department of Public Health and Environment

March 10, 2015

Executive Summary

In 2005, Congress identified a need to account for events that result in exceedances of the National Ambient Air Quality Standards (NAAQS) that are exceptional in nature[1] (e.g., not expected to reoccur or caused by acts of nature beyond man-made controls). In response, EPA promulgated the Exceptional Events Rule (EER) to address exceptional events in 40 CFR Parts 50 and 51 on March 22, 2007 (72 FR 13560). On May 2, 2011, in an attempt to clarify this rule, EPA released draft guidance documents on the implementation of the EER to State, tribal and local air agencies for review. The EER allows for states and tribes to "flag" air quality monitoring data as an exceptional event and exclude those data from use in determinations with respect to exceedances or violations of the NAAQS, if EPA concurs with the demonstration submitted by the flagging agency.

Due to the semi-arid nature of large parts of the state, Colorado is highly susceptible to windblown dust events. These events are often captured by various air quality monitoring equipment throughout the state, sometimes resulting in exceedances or violations of the 24-hour PM_{10} NAAQS. This document contains detailed information about the large regional windblown dust event that occurred on February 28, 2012. The Colorado Department of Public Health and Environment (CDPHE) Air Pollution Control Division (APCD) has prepared this report for the U.S. Environmental Protection Agency (EPA) to demonstrate that the elevated PM_{10} concentrations were caused by a natural event.

EPA's June 2012, Draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule states, "the EPA will accept a threshold of a sustained wind of 25 mph for areas in the west provided the agencies support this as the level at which they expect stable surfaces (i.e., controlled anthropogenic and undisturbed natural surfaces) to be overwhelmed…". In addition, in Colorado it has been shown that sustained wind speeds of 30 mph or greater and gusts of 40 mph or greater can cause blowing dust (see Blowing Dust Climatologies available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2). For this blowing dust event, it has been assumed that sustained winds of 30 mph and higher or wind gusts of 40 mph and higher can cause blowing dust on the plains of southeast Colorado.

On February 28, 2012, an intense low pressure system and associated upper level trough moved across Colorado. The strong west to southwest winds associated with this system transported blowing dust from southeast Colorado and northeast New Mexico into the Lamar area, affecting PM_{10} samples in Lamar. During this event a sample in excess of 150 µg/m^3 was recorded at the Lamar Power Plant monitoring site (Lamar Power, 167 µg/m^3). An elevated sample was recorded at the Lamar Municipal monitoring site (Lamar Muni, 109 µg/m^3). No other samples were affected by this event. The elevated PM_{10} readings in Lamar resulted from blowing dust associated with strong, gusty winds in lead of the cold front. The winds transported blowing dust into Lamar from southeastern Colorado and northeastern New Mexico.

APCD is requesting concurrence on exclusion of the exceedance PM_{10} value from Lamar Power (08-099-0001) on February 28, 2012.

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[1] Section 319 of the Clear Air Act (CAA), as amended by section 6013 of the Safe Accountable Flexible Efficient-Transportation Equity Act: A Legacy for Users (SAFE-TEA-LU of 2005, required EPA to propose the Federal Exceptional Events Rule (EER) no later than March 1, 2006.

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1.0 Exceptional Events Rule Requirements

In addition to the technical requirements that are contained within the EER, procedural requirements must also be met in order for EPA to concur with the flagged air quality monitoring data. This section of the report lays out the requirements of the EER and discusses how the APCD addressed those requirements.

1.1 Procedural Criteria

This section presents a review of the procedural requirements of the EER as required by 40 CFR 50.14 (Treatment of Air Quality Monitoring Data Influenced by Exceptional Events) and explains how APCD fulfills them.

The Federal EER requirements include public notification that an event was occurring, the placement of informational flags on data in EPA's Air Quality System (AQS), submission of initial event description, the documentation that the public comment process was followed, and the submittal of a demonstration supporting the exceptional events flag. APCD has addressed all of these procedural and documentation requirements.

Public notification that event was occurring (40 CFR 50.14(c)(1)(i))
APCD issued Blowing Dust Advisories for southeastern Colorado advising citizens of the potential for high wind/dust events on February 28, 2012. This area includes: Pueblo, Lamar, La Junta, Kit Carson and Springfield. The advisories that were issued on February 28, 2012 can be viewed at:
http://www.colorado.gov/airquality/forecast_archive.aspx?seeddate=02%2f28%2f2012 and are included in Appendix A.

Place informational flag on data in AQS (40 CFR 50.14(c)(2)(ii))
APCD and other applicable agencies in Colorado submit data into EPA's AQS. Data from both filter-based and continuous monitors operated in Colorado are submitted to AQS.

When APCD and/or another agency operating monitors in Colorado suspects that data may be influenced by an exceptional event, APCD 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. APCD and/or other operating agencies also submit data from continuous monitors into AQS after quality assurance is complete.

If APCD and/or the applicable operating agency have determined a potential exists that the sample value has been influenced by an exceptional event, a preliminary flag is submitted for the measurement when the data is uploaded to AQS. The data are not official until they are certified 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.

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))
In early 2011, APCD and EPA Region 8 staff agreed that the notification of the intent to flag data as an exceptional event would be done by submitting data to AQS with the proper flags and the initial event descriptions. This was deemed acceptable, since Region 8 staff routinely pull the data to review for completeness and other analyses.

On February 28, 2012, one sample value greater than 150 µg/m^3 was taken at the Lamar Power Station monitor (SLAMS) in southern Colorado during the high wind event that occurred that day. This monitor is operated by APCD in partnership with a local operator.

Document that the public comment process was followed for event documentation (40 CFR 50.14(c)(3)(iv))
APCD posted this report on the Air Pollution Control Division's webpage for public review. APCD opened a 30-day public comment period on February 5, 2015 and closed the comment period on March 9, 2015. A copy of comments received will be submitted to EPA, consistent with the requirements of 40 CFR 50.14(c)(3)(iv).

> ***NOTE: No comments were received during the public comment period. Some minor non-substantial grammatical and formatting corrections were made.***

Submit demonstration supporting exceptional event flag (40 CFR 50.14(a)(1-2))
APCD will submit this document, along with any comments received (if applicable), and APCD's responses to those comments to EPA Region VIII headquarters in Denver, Colorado. The deadline for the submittal of this demonstration package is March 31, 2015.

1.2 Documentation Requirements

Section 50.14(c)(3)(iv) of the EER states that in order to justify excluding air quality monitoring data, evidence must be provided for the following elements:

a. The event satisfies the criteria set forth in 40 CFR 501(j) that:
   (1) the event affected air quality,
   (2) the event was not reasonably controllable or preventable, and
   (3) the event was caused by human activity unlikely to recur in a particular location or was a natural event;

b. There is a clear causal relationship between the measurement under consideration and the event;

c. The event is associated with a measured concentration in excess of normal historical fluctuations; and

d. There would have been no exceedance or violation but for the event.

2.0 Meteorological Analysis of the February 28, 2012, Blowing Dust Event and PM_{10} Exceedance – Conceptual Model and Wind Statistics

On February 28 of 2012, a powerful late winter storm system caused an exceedance of the twenty-four hour PM_{10} standard in Lamar, Colorado, at the Power Plant monitor with a concentration of 167 $\mu g/m^3$. This elevated reading and the location of the Power Plant monitor (100 N. 2nd Avenue) along with the nearby Municipal Complex monitor (104 E. Parmenter St.) are plotted on a map of the Greater Lamar area in Figure 1. The exceedance in Lamar was the result of very strong surface winds produced by an intense low pressure system and associated upper level trough. Along the leading edge of this storm system was a warm front that produced winds mainly out of a southwesterly direction which moved over very dry soils in both southeast Colorado and northeast New Mexico. Trailing this warm front was a vigorous cold front which shifted the winds to a more westerly direction upon its passage. These winds moved over drought-stricken soils along the Arkansas River Valley, consequently producing a continuation of significant airborne dust throughout southeast Colorado.

EPA's June 2012, Draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule states, "the EPA will accept a threshold of a sustained wind of 25 mph for areas in the west provided the agencies support this as the level at which they expect stable surfaces (i.e., controlled anthropogenic and undisturbed natural surfaces) to be overwhelmed…". In addition, in Colorado it has been shown that sustained wind speeds of 30 mph or greater and gusts of 40 mph or greater can cause blowing dust (see Blowing Dust Climatologies available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2). For this blowing dust event, it has been assumed that sustained winds of 30 mph and higher or wind gusts of 40 mph and higher can cause blowing dust in southeast Colorado and northeast New Mexico.

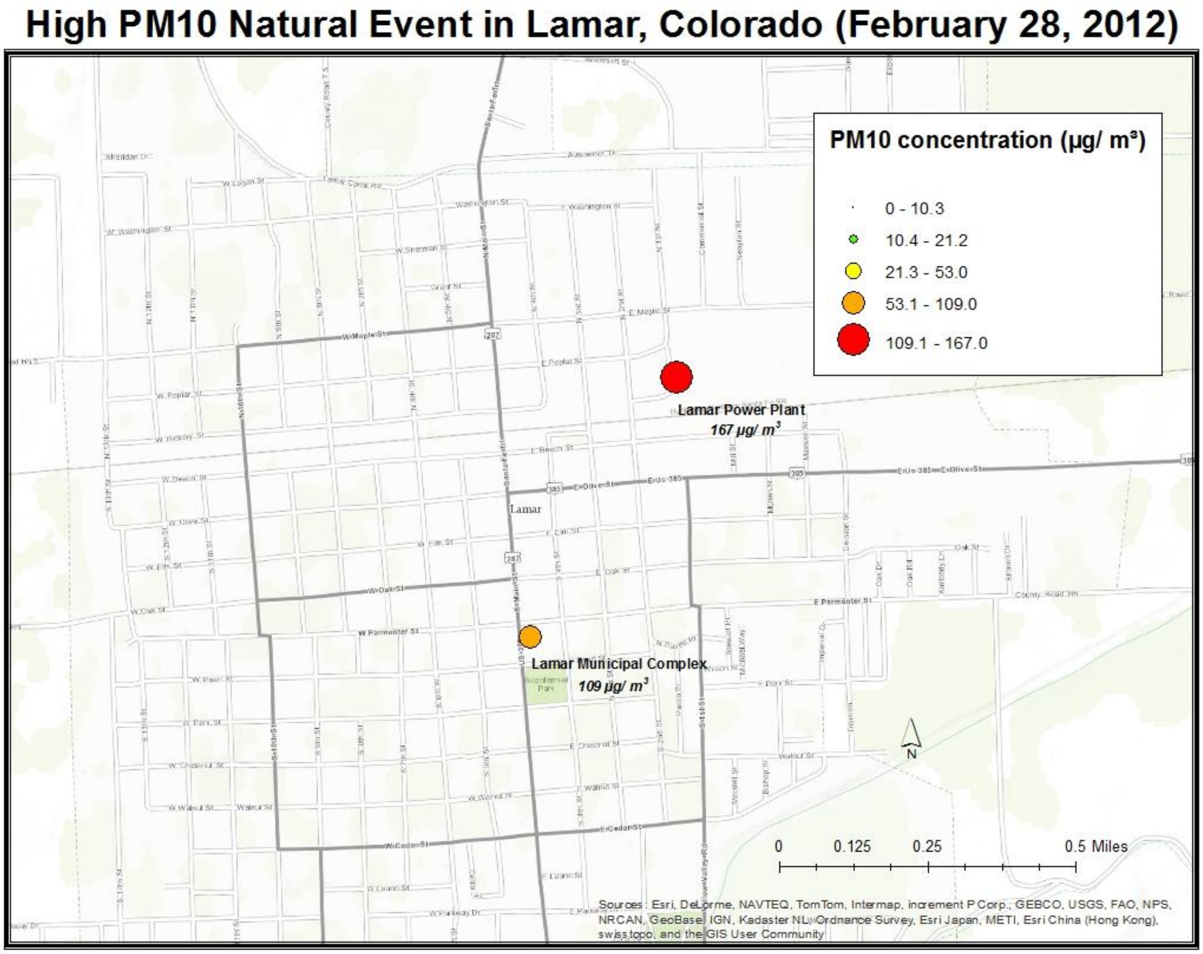


Figure 1: 24-hour PM_{10} concentrations for February 28, 2012.
(Source: http://webapps.datafed.net/datafed.aspx?dataset=AQS_D&parameter=pm10)

The surface weather associated with the storm system of February 28, 2012, is presented in Figure 2, Figure 3 and Figure 4; the surface analyses for 5 AM, 11 AM and 5 PM MST, respectively. Significant surface features in southeast Colorado during this period of time included a departing warm front and a cold front passage. These fronts were associated with surface low pressure that was traversing the region.

The upper level trough associated with this storm system is shown on the 700mb height analysis map at 5 AM and 5 PM in Figure 5 and Figure 6, respectively. The 700mb level is roughly 3 kilometers above mean sea level (MSL). These two charts show that a deep trough of low pressure was present at the 700mb level preceding and during the blowing dust event of February 28, 2012, and that it was moving over the southwestern United States.

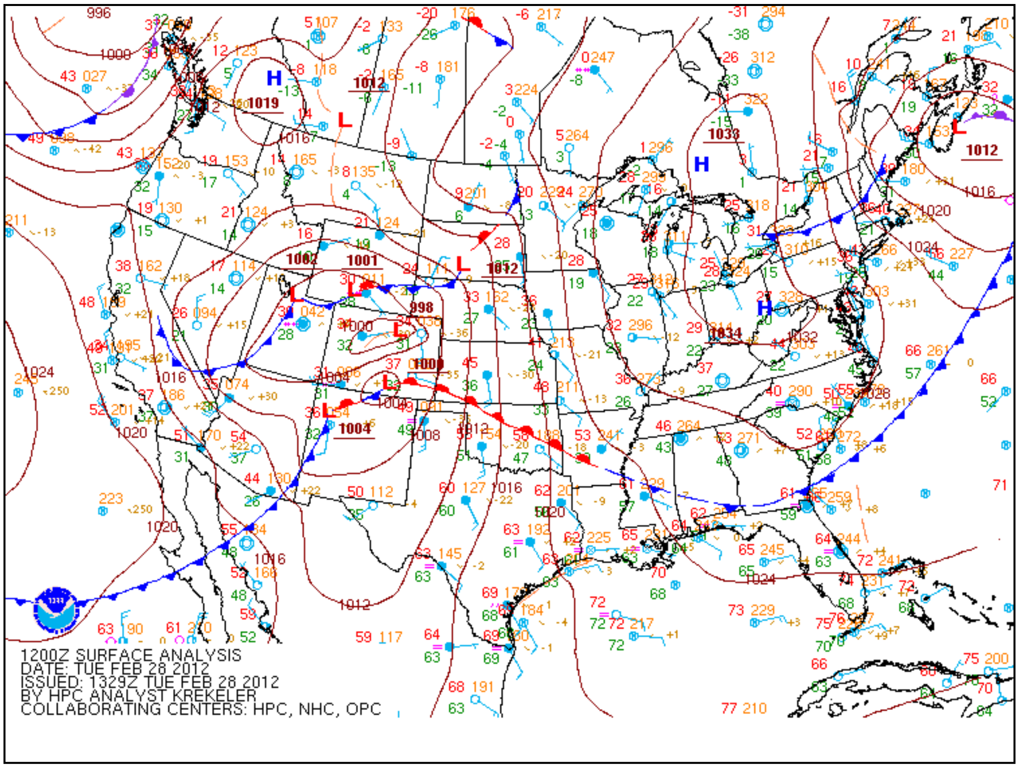


Figure 2: Surface Analysis for 12Z February 28, 2012, or 5 AM MST February 28, 2012. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

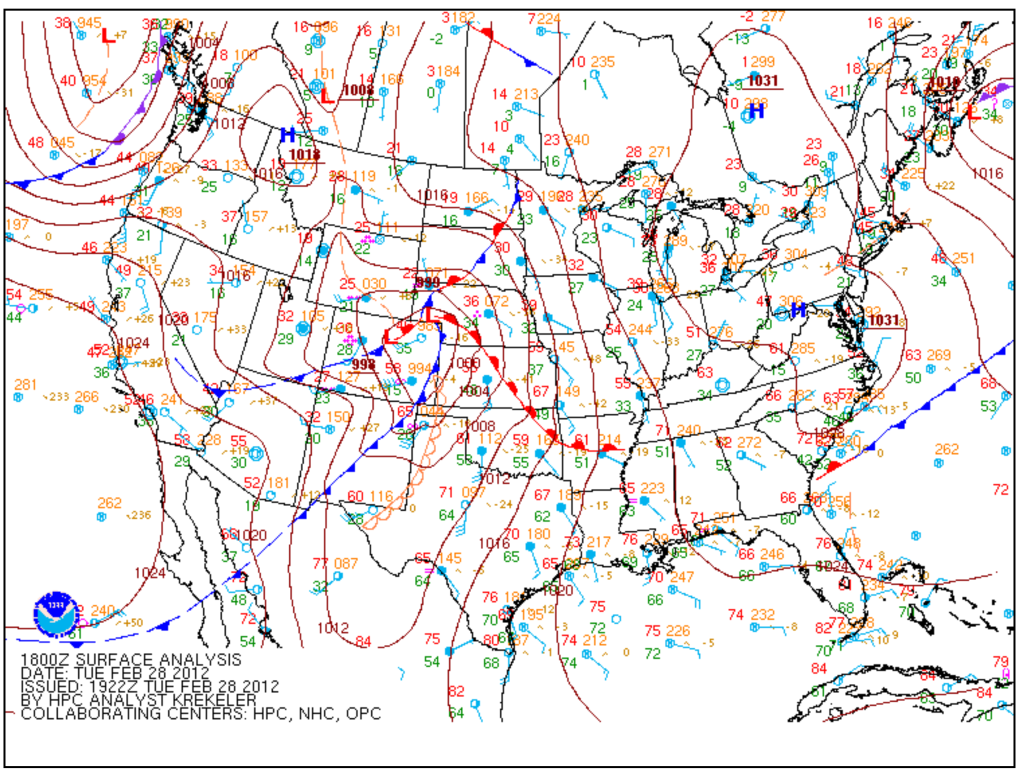


Figure 3: Surface Analysis for 18Z February 28, 2012, or 11 AM MST February 28, 2012. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

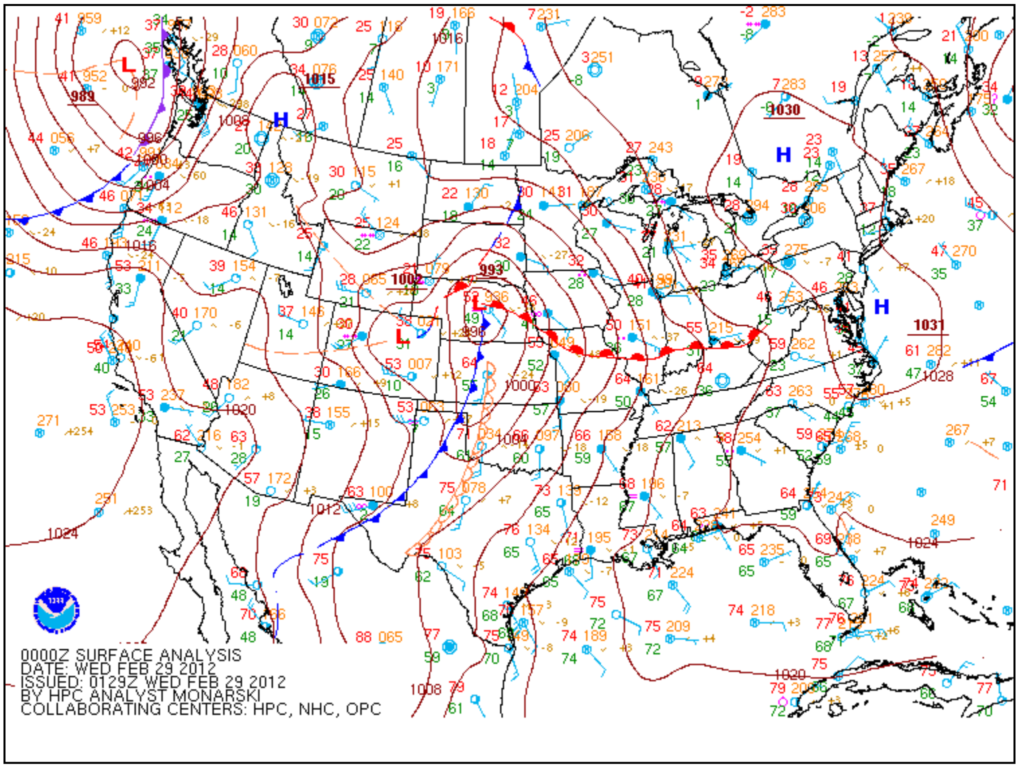


Figure 4: Surface Analysis for 00Z February 29, 2012, or 5 PM MST February 29, 2012. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

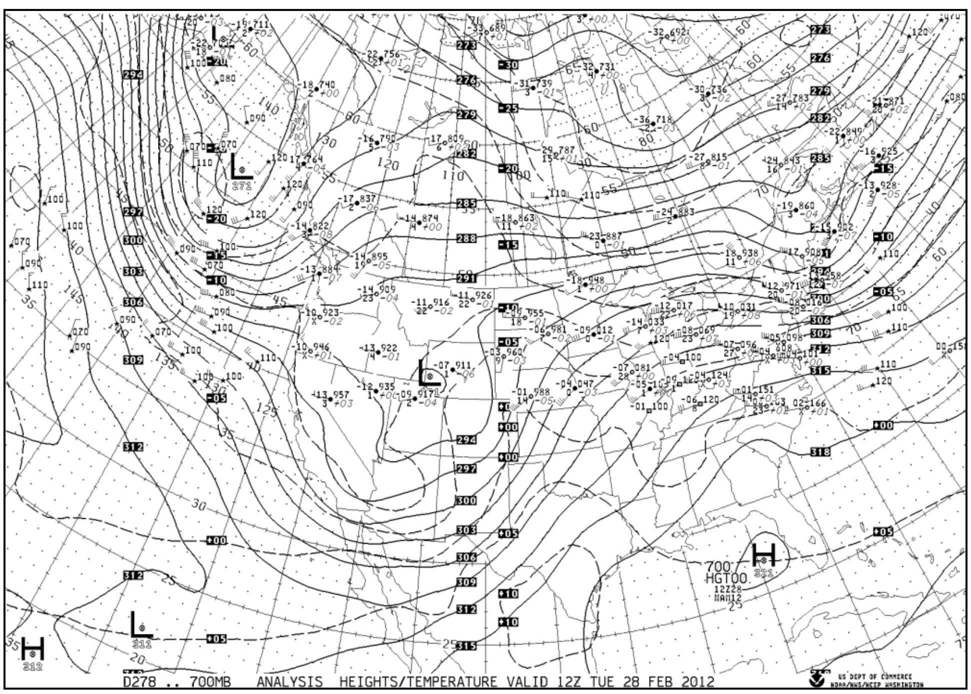


Figure 5: 700 mb (about 3 kilometers above mean sea level) analysis for 12Z February 28, 2012, or 5 AM MST February 28, 2012.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

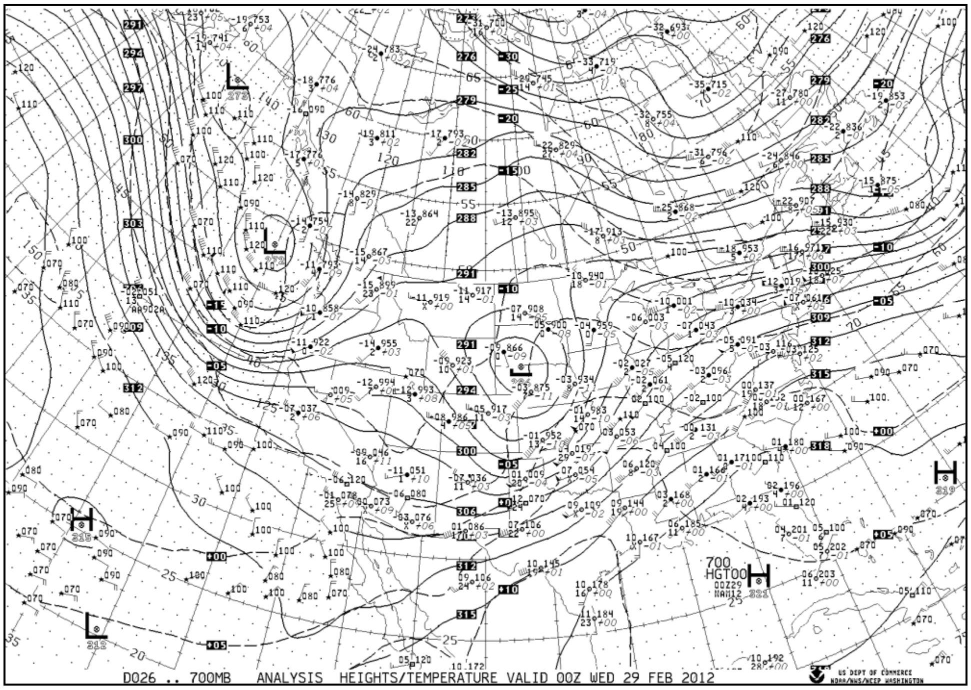


Figure 6: 700 mb (about 3 kilometers above mean sea level) analysis for 00Z February 29, 2012, or 5 PM MST February 28, 2012.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

Figure 7 and Figure 8 show a more detailed view of the 700 mb trough via the NARR (North American Regional Reanalysis) at 11 AM and 2 PM MST February 28, 2012, respectively. Embedded in the trough is a well-defined shortwave that can be observed extending from south-central Colorado to the south-southwest into central New Mexico. Strong winds of 30-50 knots can be found to the east of this shortwave, including around Lamar and areas upwind to the west and southwest.

At the start of this time period a cold front was moving through southeast Colorado (Figure 3). This cold front effectively destabilized the atmosphere and produced deep mixing of the atmosphere. Figure 9 and Figure 10 show the height of the top of the mixed layer in kilometers above MSL at 11 AM MST and 2 PM MST, respectively. In Figure 9 it can be seen that deep mixing of 4-6 km was already taking place over southeast Colorado and northeast New Mexico by 11 AM MST as the cold front was passing. As the atmosphere continued to destabilize during the afternoon hours, mixing increased to 6-7 km by 2 PM MST (Figure 10).

Mixing to this degree would have been more than sufficient to transfer momentum to the surface from the zone of strong winds at 700 mb (about 3 km above MSL) taking place over southeast Colorado and northeast New Mexico during this same time frame (Figure 7 and Figure 8). The deep mixing combined with strong winds aloft correlate well with weather observations in Lamar during the 11 AM to 2 PM time window when sustained wind speeds reached 36-45 mph with gusts of 44-56 mph.

It is also reasonable to believe that with mixing as deep as 5 to 6 km in northeast New Mexico, long range transport of dust may have occurred during the late morning and early afternoon hours of February 28, 2012. Figure 11 shows 500 mb (about 6 km above MSL) wind speeds at 11 AM MST on February 28, 2012. A jet streak containing winds in excess of 100 knots can be seen directly upwind from Lamar over northeast New Mexico. At the same time and in the same area, deep mixing of 5 to 6 km can be observed in Figure 9. Northeast New Mexico is known to be a source region for blowing dust events in Lamar (see Appendix A - Lamar, Colorado, Blowing Dust Climatology). When blowing dust occurs with strong winds at the surface and aloft combined with deep mixing as was observed during the February 28, 2012 event, dust can be suspended for many hours and transported long distances. These conditions are the hallmarks of a regional dust transport event.

The synoptic weather conditions on February 28, 2012 for the area of concern (illustrated in Figure 7 through Figure 11) were conducive for widespread strong gusty winds and the long range transport of blowing dust.

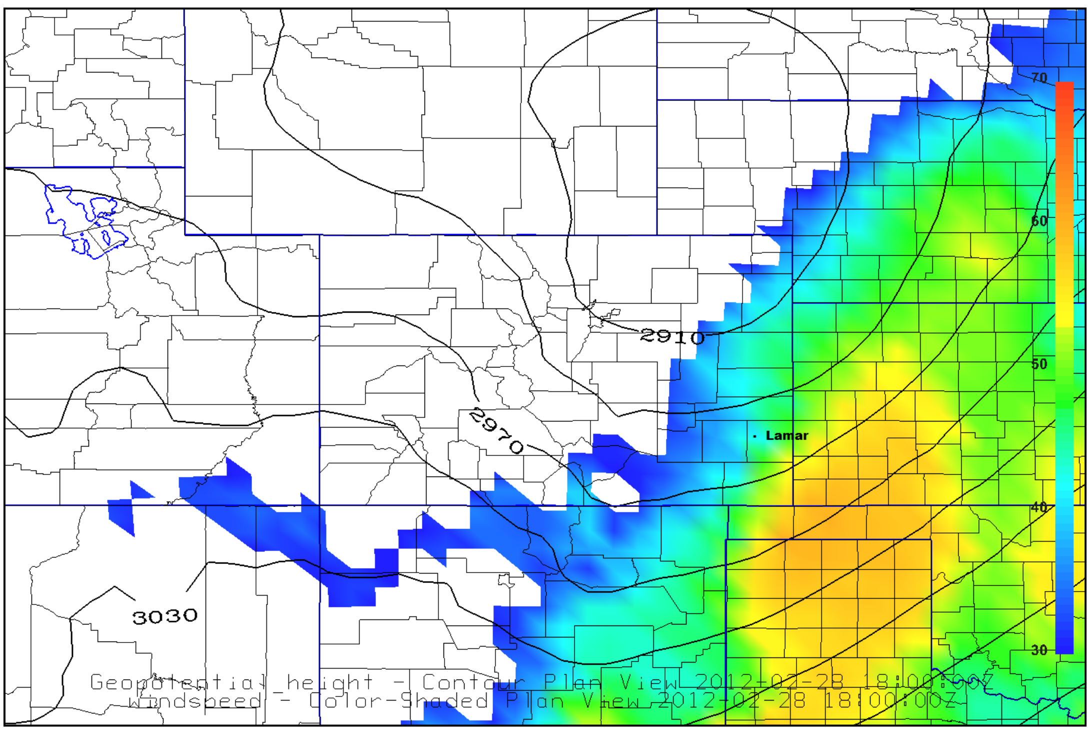


Figure 7: NARR 700 mb analysis for 18Z February 28, 2012, or 11 AM MST February 28, 2012 showing wind speeds in knots. Only speeds above 30 knots are shown. (Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

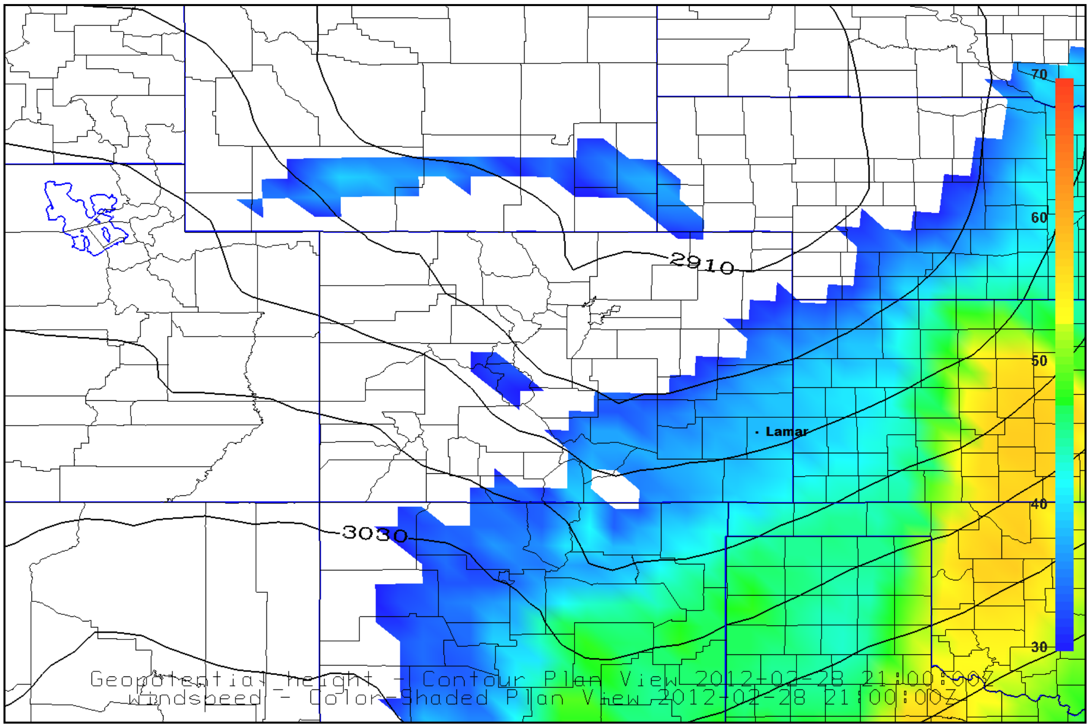


Figure 8: NARR 700 mb analysis for 21Z February 28, 2012, or 2 PM MST February 28, 2012, showing wind speeds in knots. Only speeds above 30 knots are shown.
(Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

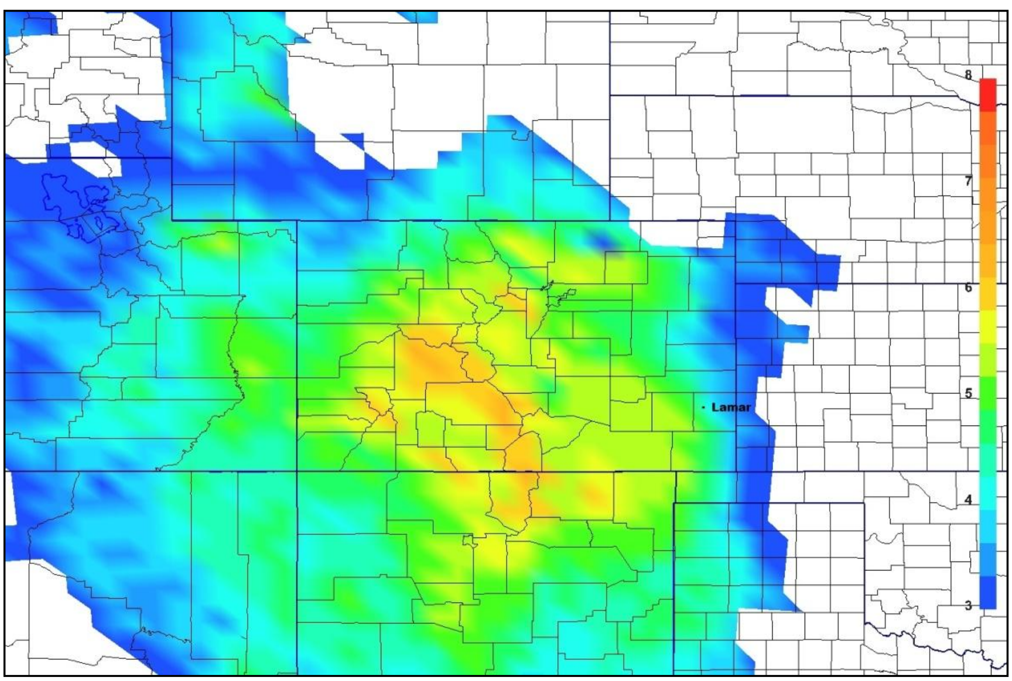


Figure 9: Height of the mixed layer in kilometers above mean sea level from the NARR at 18Z February 28, 2012, or 11 AM MST February 28, 2012. Only mixing heights above 3 kilometers are shown.
(Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

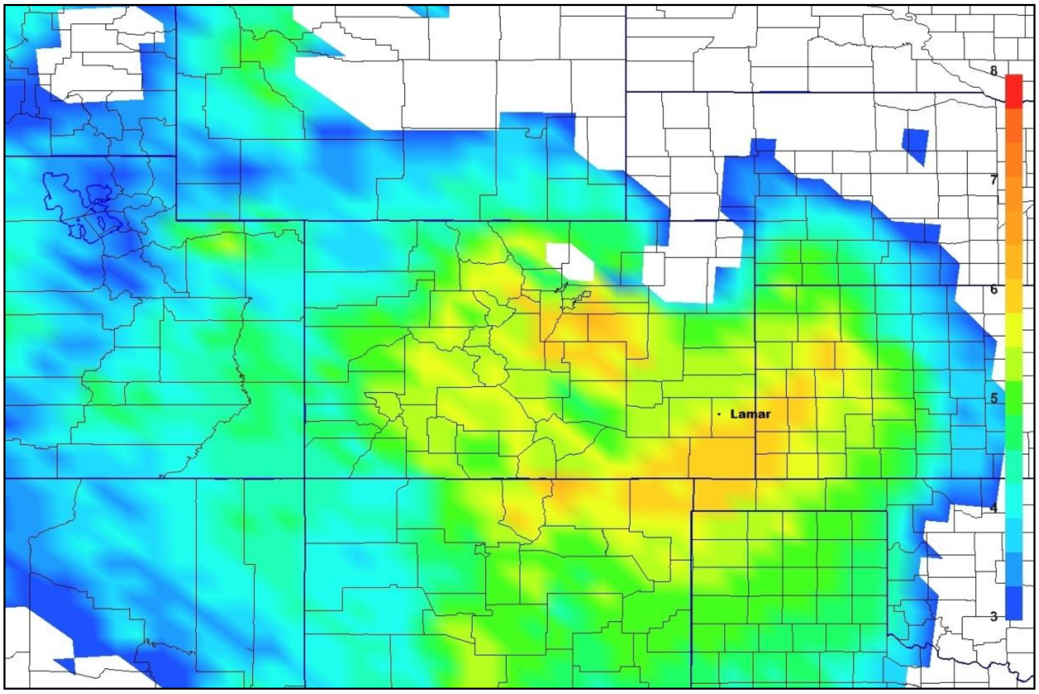


Figure 10: Height of the mixed layer in kilometers above mean sea level from the NARR at 21Z February 28, 2012, or 2 PM MST February 28, 2012. Only mixing heights above 3 kilometers are shown.
(Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

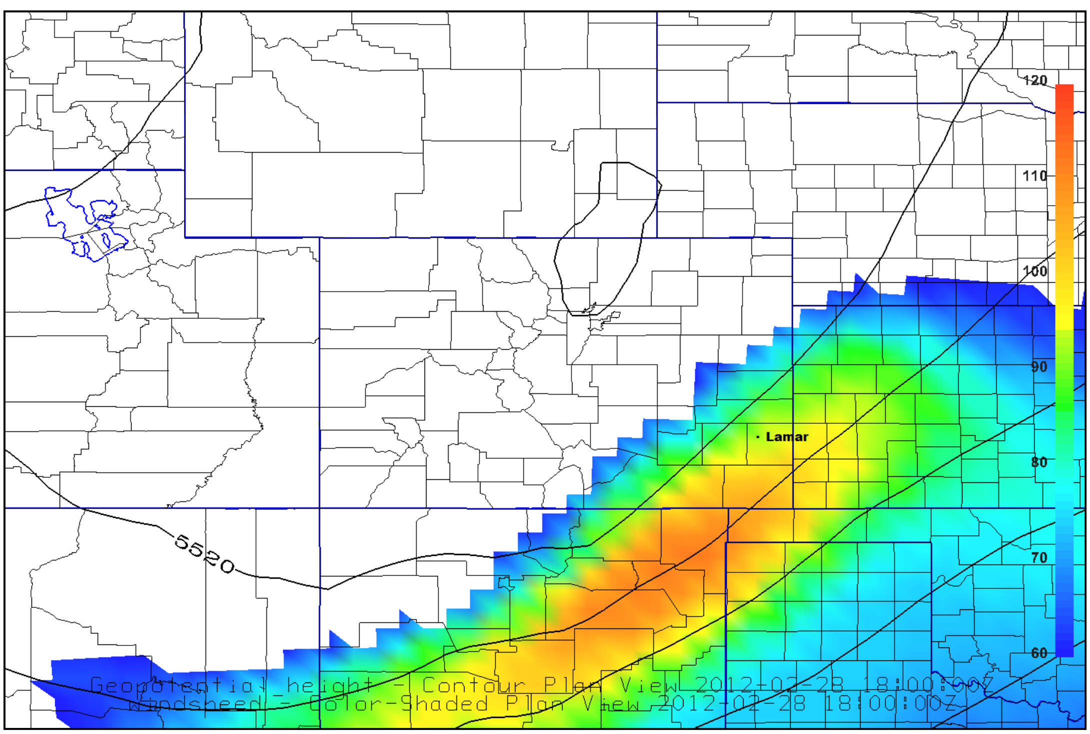


Figure 11: NARR 500 mb analysis for 18Z February 28, 2012, or 11 AM MST February 28, 2012 showing wind speeds in knots. Only speeds above 60 knots are shown.
(Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

In order to fully evaluate the synoptic meteorological scenario of February 28, 2012, regional surface weather maps were derived from station observations during the height of the event in question. Figure 12 provides a reference map containing the location of all the weather stations utilized for this analysis. Lamar is denoted in bold and caps.

Figure 13 through Figure 15 present the surface stations from Figure 12 and the corresponding weather observations for 12:53 PM, 2:53 PM and 4:53 PM MST on February 28, 2012, respectively. The observations include surface wind direction (the direction from which the wind is blowing in degrees; e.g., 225 would represent a southwesterly wind, and 315 would represent a northwesterly wind) and sustained speed and gusts (mph) in blue, visibility (statute miles) in red and observed weather in black (if applicable). These maps cover southeast Colorado and areas of New Mexico, Texas, Oklahoma and Kansas that experienced winds which were intense enough to create blowing dust based on the criteria established earlier in this paper. These surface analyses illustrate that sustained winds above 30 mph with gusts above 40 mph were widespread in the wake of a cold front that passed through the area at around 11:00 AM MST (Figure 3).

On the map in Figure 13 the station observation for La Junta, Colorado, located approximately 56 miles to the west of Lamar, shows winds sustained at 43 mph, gusts to 56 mph, and a reduced visibility of 4 statute miles with the weather symbol of infinity (∞). The infinity sign is the weather symbol for haze. Haze is often reported during dust storms, and in dry and windy conditions haze typically refers to blowing dust (see the following link for the description of haze published by the National Oceanic and Atmospheric Administration (NOAA): http://www.crh.noaa.gov/lmk/?n=general_glossary). At this time Lamar was also reporting high winds, sustained at 40 mph with gusts to 50 mph. Visibility was reduced to 8 statute miles. Concurrently, high winds and poor visibility were being reported across the Texas Panhandle and southwest Kansas.

Two hours later at 2:53 PM MST (Figure 14), visibility in Lamar had improved to 10 statute miles despite the winds remaining strong (sustained at 38 mph with gusts to 50 mph). However other weather stations in southeast Colorado upwind from Lamar were reporting blowing dust and reduced visibility. In Pueblo, the surface observation shows a dollar sign ($). The dollar sign is the weather symbol for dust or sand raised by wind at the time of the observation. Additionally, Trinidad was reporting very windy conditions sustained at 45 mph with gusts to 59 mph. Visibility was also diminished at 8 statute miles. By 4:53 PM MST (Figure 15), visibility had again decreased slightly in La Junta and Lamar (9 statute miles) while widespread haze and blowing dust were being reported nearby in southwest Kansas and throughout the Oklahoma and Texas panhandles.

Surface weather maps show clear evidence of blowing dust and winds well above the threshold speeds for blowing dust on February 28, 2012.

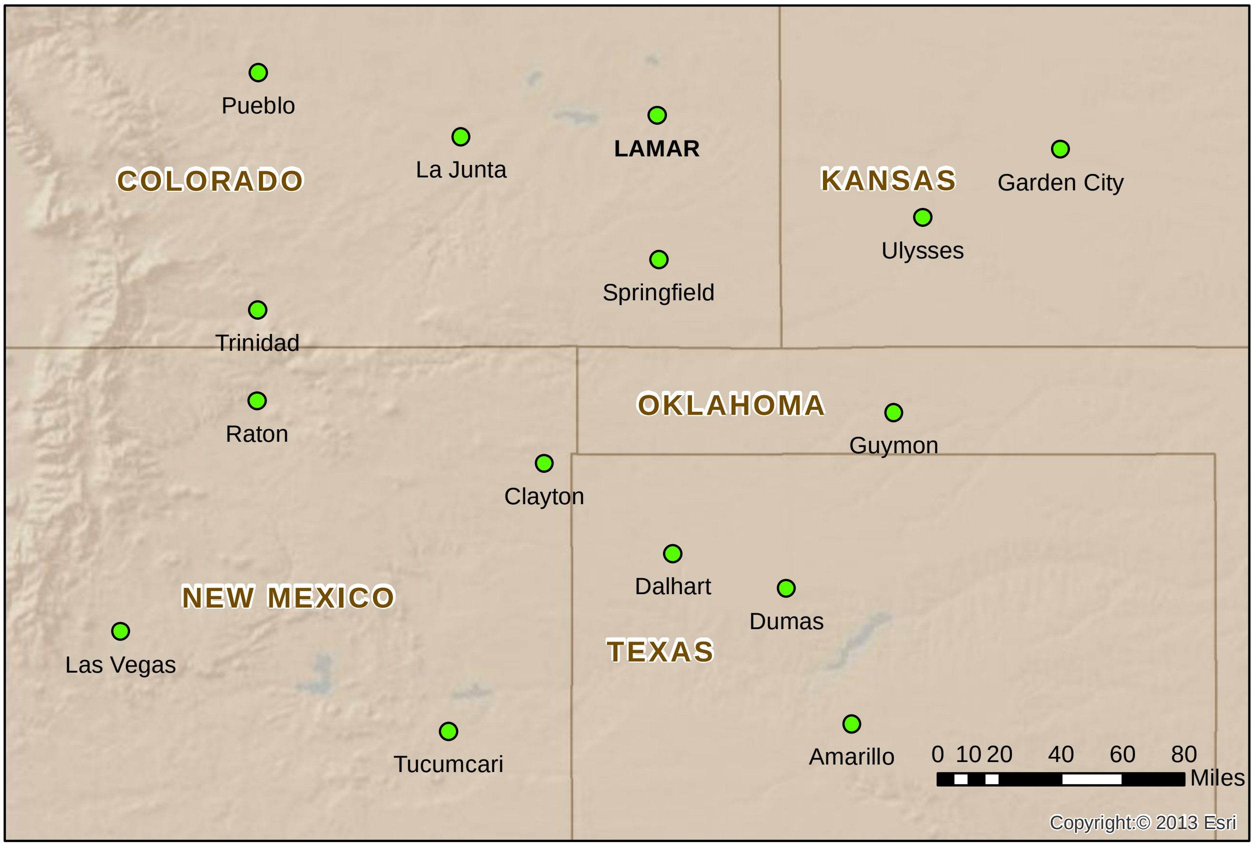


Figure 12: Weather observation stations for February 28, 2012, synoptic meteorological analysis.
(Source: http://mesowest.utah.edu)

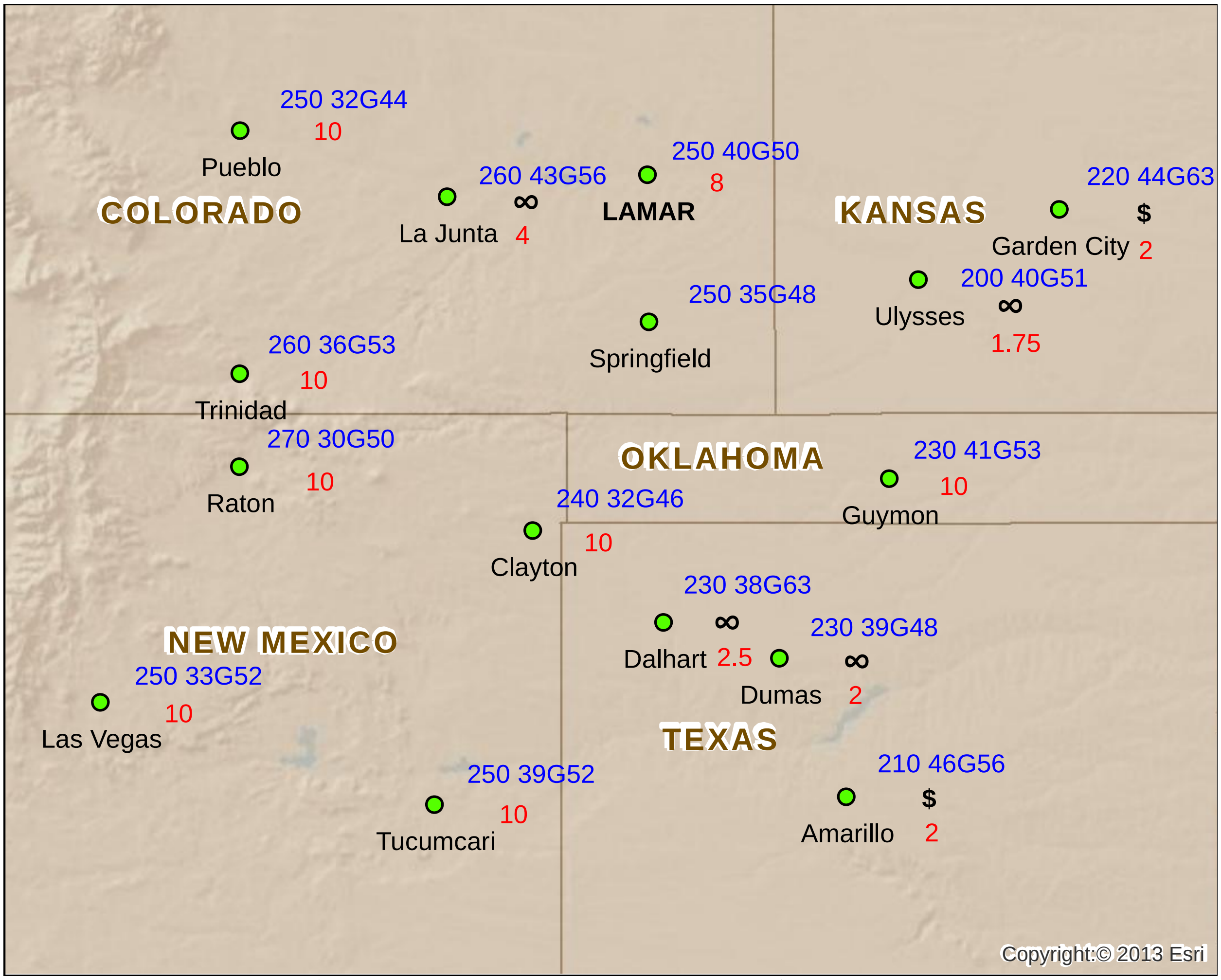


Figure 13: Surface Analysis for 12:53 PM MST (1953Z), February 28, 2012. (Source: http://mesowest.utah.edu)

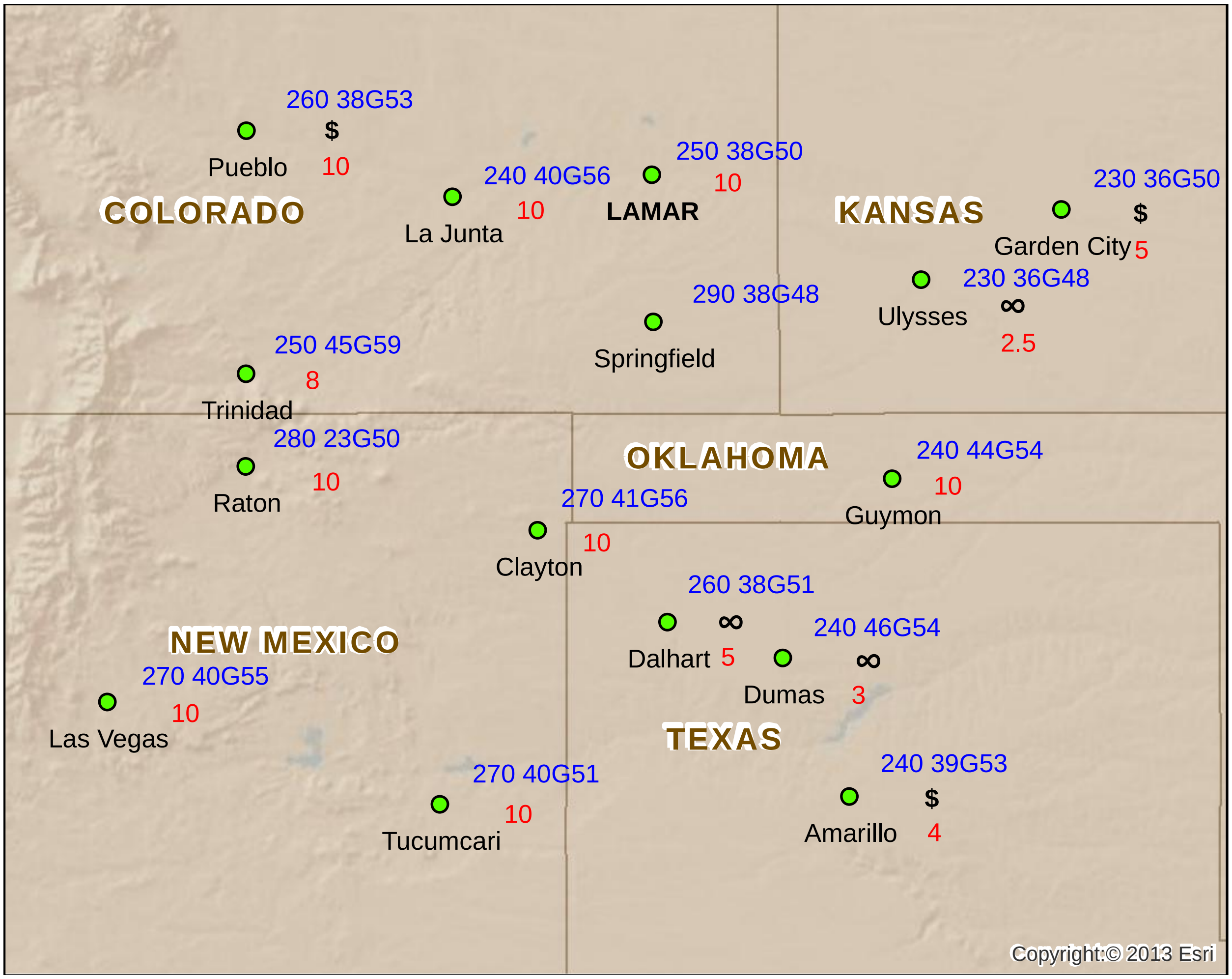


Figure 14: Surface Analysis for 2:53 PM MST (2153Z), February 28, 2012. (Source: http://mesowest.utah.edu)

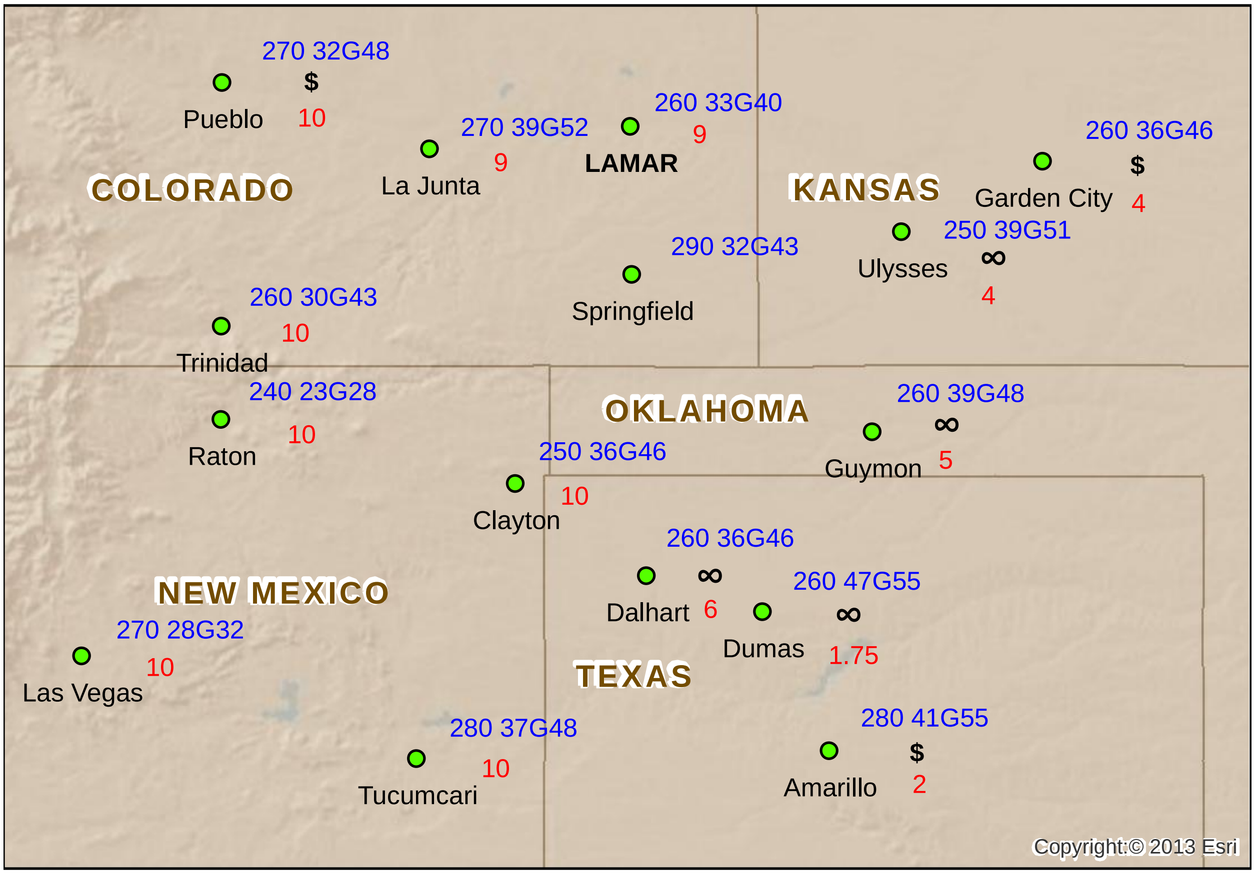


Figure 15: Surface Analysis for 4:53 PM MST (2353Z), February 28, 2012. (Source: http://mesowest.utah.edu)

To expand on the data from these regional weather maps, hourly surface observations were gathered from each of the reporting stations displayed in Figure 12. Table 1 lists observations for the PM_{10} exceedance location of Lamar. Observations that are climatologically consistent with blowing dust conditions are highlighted in yellow. Table 2 through Table 15 contain the surface observations from the remainder of sites illustrated in Figure 12. Collectively these weather observation sites experienced many hours of reduced visibility along with sustained wind speeds and gusts at or above the thresholds for blowing dust.

Observations of sustained wind speeds and gust speeds above the blowing dust thresholds and reduced visibilities on February 28, 2012, at weather stations in southeast Colorado, northeast New Mexico, western Kansas and the Oklahoma and Texas Panhandles show that a regional dust storm event occurred under west-southwesterly flow in the vicinity of a cold front. The observations contribute to the large body of evidence that shows that a regional dust storm caused the PM_{10} exceedance at the monitoring site in question.

Table 1: Weather observations for Lamar, Colorado, on February 28, 2012 (Source: http://mesowest.utah.edu)

Time MST February 28, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:53	42	85	14		180		10
1:53	42	85	5				10
2:53	41	89	7		200		10
3:53	41	89	13		160		10
4:53	42	89	14		150		10
5:53	41	96	13		150		10
6:53	42	92	21	27	150		10
7:53	47	86	25	37	160		10
8:53	54	69	29	37	180		10
9:53	62	34	44	53	210		10
10:53	65	21	38	51	230		10
11:53	63	21	36	44	260		10
12:53	63	15	40	50	250		8
13:53	61	10	45	56	260		8
14:53	59	12	38	50	250		10
15:53	56	12	39	51	250		10
16:53	54	15	33	40	260		9
17:53	52	20	29	39	260		7
18:53	49	19	24	32	250		10
19:53	47	23	29	35	250		10
20:53	45	24	24	31	260		10
21:53	44	27	22	33	250		10
22:53	40	33	16		260		10
23:53	35	40	10		270		10

Table 2: Weather observations for La Junta, Colorado, on February 28, 2012
(Source: http://mesowest.utah.edu)

Time MST February 28, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
8:53	57	40	31	48	200		10
9:53	61	28	33	50	230		10
10:06	57	24	45	54	250	haze	2
10:13	57	23	45	59	250	haze	1.25
10:29	55	21	48	58	250		
10:32	54	22	47	56	250	haze	1
10:39	55	21	45	60	260	haze	1.25
10:44	54	22	41	60	260	haze	2
10:53	58	18	45	56	250	haze	4
11:03	55	19	45	59	250	haze	1.75
11:12	57	17	48	56	250	haze	2
11:35	57	17	47	59	250	haze	3
11:45	57	17	45	58	250	haze	2.5
11:53	58	17	52	61	240	haze	3
11:57	57	17	52	62	240	haze	1.75
12:06	59	13	48	61	230	haze	3
12:15	59	12	43	64	230	haze	4
12:22	59	13	50	60	240	haze	1.75
12:30	57	15	43	61	240	haze	3
12:44	57	18	43	54	250	haze	5
12:53	58	15	43	56	260	haze	4
13:03	57	15	39	54	250		10
13:53	57	13	44	56	230		10
14:53	55	12	40	56	240		10
15:53	54	15	37	53	260		10
16:53	53	17	39	52	270		9
17:08	52	19	36	47	270		10
17:53	50	19	35	46	260		10
18:53	45	24	23		260		10
19:53	44	25	30	33	250		10
20:53	42	29	20		260		10
21:53	42	30	25		260		10
22:53	42	31	22	32	250		10
23:53	41	34	20		230		10

Table 3: Weather observations for Pueblo, Colorado, on February 28, 2012 (Source: http://mesowest.utah.edu)

Time MST February 28, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:53	29	72	4		150		10
1:53	28	75	4		110		10
2:53	23	86	0				10
3:53	22	84	0				10
4:53	21	88	4		20		10
5:53	21	84	0				10
6:53	22	84	0				10
7:53	29	82	5		240		10
8:53	46	53	17	27	230		10
9:53	50	43	12		240		10
10:53	54	23	30	37	260		10
11:53	53	22	37	45	240		10
12:53	53	14	32	44	250		10
13:53	54	11	30	38	280		7
14:53	51	21	38	53	260	blowing dust	10
15:53	50	23	33	45	240	blowing dust	10
16:53	50	18	32	48	270	blowing dust	10
17:53	46	22	17	32	290	blowing dust	10
18:53	45	24	30	44	280	blowing dust	10
19:53	43	27	23	33	280		10
20:53	37	33	8		250		10
21:53	33	41	7		260		10
22:53	28	52	0				10
23:53	32	47	4		80		10

Table 4: Weather observations for Springfield, Colorado, on February 28, 2012 (Source: http://mesowest.utah.edu)

Time MST February 28, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:56	39	96	17		200		
1:56	39	96	15		190		
2:56	39	100	13		180		
3:56	40	100	9		190		
4:56	40	100	13		210		
5:56	41	96	13		200		
7:56	45	97	25	32	210		
8:56	52	80	27	43	230		
9:56	56	51	37	53	230		
10:56	58	40	31	47	230		
11:56	61	26	30	45	240		
12:56	63	18	35	48	250		
13:56	61	19	31	47	260		
14:56	55	18	38	48	290		
15:56	52	14	31	44	260		
16:56	50	17	32	43	290		
17:56	47	22	28	39	290		
18:56	45	22	23	32	290		
19:56	44	23	20	32	280		
20:56	41	28	20	28	290		
21:56	40	30	22	30	290		
22:56	38	34	16	25	280		
23:56	39	34	20		290		

Table 5: Weather observations for Trinidad, Colorado, on February 28, 2012 (Source: http://mesowest.utah.edu)

Time MST February 28, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:54	38	67	0				10
1:54	40	67	22	30	210		10
2:54	40	70	17		210		10
3:54	42	70	22	30	180		10
4:54	41	73	21	33	160		10
5:54	43	68	30	37	180		10
6:54	44	62	25	38	180		10
7:54	47	53	27	33	190		10
8:54	51	38	27	37	200		10
9:54	48	39	25	37	260		10
10:54	50	24	35	45	240		10
11:54	49	23	39	51	280		10
12:54	48	19	36	53	260		10
13:54	45	21	39	58	260		10
14:41	46	18	50	59	250		7
14:54	45	20	45	59	250		8
15:36	45	21	44	62	260	haze	5
15:43	45	21	45	56	260	haze	5
15:54	44	22	48	59	260	haze	6
16:02	45	22	44	56	250		10
16:54	43	23	30	43	260		10
17:54	38	30	14		240		10
18:54	38	28	21		240		10
19:54	37	32	25	37	240		10
20:54	36	34	27	33	250		10
21:54	37	33	27	35	250		10
22:54	38	34	30	41	250		10
23:54	38	30	33	41	250		10

Table 6: Weather observations for Garden City, Kansas, on February 28, 2012 (Source: http://mesowest.utah.edu)

Time CST February 28, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
11:54	59	77	32	43	180		10
12:28	64	60	37	47	190		10
12:54	66	42	37	47	210	blowing dust	6
13:10	68	28	40	54	210	blowing dust	2
13:47	70	21	38	54	220	blowing dust	2
13:54	69	21	44	63	220	blowing dust	2
14:01	70	18	46	55	220	blowing dust	3
14:14	70	20	37	52	220	blowing dust	2.5
14:28	70	18	43	55	230	blowing dust	2.5
14:41	70	20	41	56	230	blowing dust	3
14:51	70	20	36	53	220	blowing dust	2.5
14:54	68	21	38	52	230	blowing dust	3
15:07	68	19	35	50	220	blowing dust	3
15:54	68	17	36	50	230	blowing dust	5
16:46	63	13	29	41	290	blowing dust	5
16:54	61	14	29	38	290	blowing dust	6
17:23	63	14	23	35	280	blowing dust	10
17:54	60	15	36	46	260	haze; blowing dust	4
18:54	54	14	29	37	260	blowing dust	9
19:54	50	18	18		250	blowing dust	10
20:54	49	23	15		290	blowing dust	10
21:54	42	34	10		270	blowing dust	10
22:54	47	25	17		280	blowing dust	10
23:54	40	36	12		260	blowing dust	10

Table 7: Weather observations for Ulysses, Kansas, on February 28, 2012 (Source: http://mesowest.utah.edu)

Time CST February 28, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:54	45	70	7		170		10
1:54	43	87	8		160	fog	2
2:54	45	81	8		160	fog	1.25
3:54	48	93	12		160	fog	1.5
4:54	52	87	15	20	150	fog	1.25
5:54	52	87	17	24	140	mod rain	2
6:54	52	87	20	24	140	fog	0.75
7:54	52	87	21	28	150	lt rain	0.75
8:54	54	94	23		160	fog	4
9:59	55	94	26	31	160		7
10:54	61	77	32	39	180		10
11:54	66	46	40	51	200		10
12:54	70	25	40	54	200	haze	3
13:54	72	22	40	51	200	haze	1.75
14:54	72	17	35	49	220	haze	3
15:54	72	14	36	48	230	haze	2.5
16:54	64	15	37	49	250	haze	3
17:54	59	13	39	51	250	haze	4
18:54	54	17	17		240		10
19:54	52	24	13		230		10
20:54	46	29	15		240		10
21:54	43	33	10		250		10
22:54	45	31	16		250		10
23:54	41	36	12		250		10

Table 8: Weather observations for Clayton, New Mexico, on February 28, 2012 (Source: http://mesowest.utah.edu)

Time MST February 28, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:55	38	100	13		180	fog	0.5
1:55	39	100	14		180	fog	0.75
2:55	39	100	12		170	fog	0.25
3:55	40	97	10		200	lt rain; fog	1
4:55	40	100	9		190	fog	1
5:55	41	100	9		200	fog	0.25
6:55	45	100	21		190		8
7:55	48	93	30	37	190		10
8:55	49	83	30	35	200		10
9:55	54	49	32	50	210		10
10:55	55	34	30	45	210		10
11:55	59	23	30	43	210		10
12:55	60	20	32	46	240		10
13:55	56	16	35	52	230		10
14:55	50	22	41	56	270		10
15:14	48	21	44	59	270		10
15:41	48	21	37	50	260		10
15:55	48	17	39	55	250		10
16:55	47	20	36	46	250		10
17:55	43	26	27	41	250		10
18:55	41	30	27	38	260		10
19:55	40	34	25	36	250		10
20:55	38	37	21	28	250		10
21:55	37	40	17		240		10
22:55	36	42	17	25	250		10
23:55	40	31	21	27	270		10

Table 9: Weather observations for Las Vegas, New Mexico, on February 28, 2012 (Source: http://mesowest.utah.edu)

Time MST February 28, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:53	36	100	15		170	fog	2
1:53	37	96	15		190	fog	5
2:53	37	100	20	28	180	fog	0.5
3:53	38	92	20	29	180		9
4:53	36	89	23		190		10
5:53	36	79	20		190		10
6:53	34	82	22		190		10
7:53	41	42	35	44	220		10
8:53	43	35	47	58	230		10
9:53	45	34	43	58	240		10
10:53	41	53	39	46	250		10
11:53	41	33	40	58	250		10
12:53	41	33	33	52	250		10
13:53	39	34	32	46	260		10
14:53	39	22	40	55	270		10
15:53	39	25	30	38	270		10
16:53	37	31	28	32	270		10
17:53	34	35	20	27	280		10
18:53	33	34	16		240		10
19:53	29	42	10		230		10
20:53	29	49	12		230		10
21:53	30	44	14	18	260		10
22:53	30	47	14	20	260		10
23:53	30	48	21	29	270		10

Table 10: Weather observations for Raton, New Mexico, on February 28, 2012 (Source: http://mesowest.utah.edu)

Time MST February 28, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:53	35	88	16		190	fog	6
1:53	35	92	13		190	lt rain; fog	0.5
2:53	36	92	9		190	fog	1.25
3:53	35	96	13		180	lt rain; fog	2
4:53	38	92	17		180	fog	0.25
5:53	39	96	25	35	180	fog	0.5
6:53	40	93	29	37	180	fog	4
7:53	41	89	30	37	180		7
8:53	46	53	31	40	190		10
9:53	50	36	29	45	250		10
10:53	48	34	32	38	270		10
11:49	50	23	40	51	250		9
11:53	49	22	44	51	240		10
12:53	46	26	30	50	270		10
13:53	44	20	39	63	250		8
14:53	44	21	23	50	280		10
15:53	43	22	31	46	280		10
16:53	43	24	23	28	240		10
17:53	38	30	22	29	250		10
18:53	36	35	21	35	260		10
19:53	36	35	20	28	250		10
20:53	35	38	25	33	270		10
21:53	36	37	30	40	270		10
22:53	36	40	41	54	290		10
23:53	36	37	45	59	290		10

Table 11: Weather observations for Tucumcari, New Mexico, on February 28, 2012 (Source: http://mesowest.utah.edu)

Time MST February 28, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:53	47	86	10		150		10
1:53	48	89	9		170		10
2:53	49	86	5		160		10
3:53	50	87	15		180		10
4:53	50	87	13		190		10
5:53	49	86	10		210		10
6:53	49	83	14		220		10
7:53	52	74	20	25	210		10
8:53	56	60	25	31	210		10
9:53	61	26	33	46	230		10
10:53	64	18	39	51	230		10
11:53	66	13	36	53	240		10
12:53	66	14	39	52	250		10
13:53	63	21	29	38	280		10
14:53	61	18	40	51	270		10
15:45	57	17	45	59	270	haze	6
15:53	56	16	47	58	280		8
16:32	54	12	37	51	280		10
16:53	53	13	37	48	280		10
17:53	49	16	22	36	270		10
18:53	48	19	20	28	270		10
19:53	43	24	8		210		10
20:53	41	26	14		210		10
21:53	43	28	18		240		10
22:53	42	30	14		240		10
23:53	43	30	20		270		10

Table 12: Weather observations for Guymon, Oklahoma, on February 28, 2012 (Source: http://mesowest.utah.edu)

Time CST February 28, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:53	44	96	0			fog	0.75
1:25	45	100	0			lt rain; fog	1
1:53	45	97	0			lt rain; fog	1.5
2:53	48	96	9		170	lt rain; fog	4
3:53	49	97	12		160	fog	1.25
4:53	50	96	14	23	160	fog	1.5
5:53	51	96	17	24	160		7
6:53	51	96	20	28	160		10
7:53	53	93	17	25	170		10
8:53	54	93	17		180		10
9:53	57	83	18	28	190		10
10:53	62	65	32	44	200		10
11:53	68	45	36	44	210		10
12:53	71	29	41	47	210		10
13:53	71	19	41	53	230		10
14:53	72	15	39	58	220		10
15:53	70	16	44	54	240		10
16:15	66	16	43	59	260	haze	1.75
16:47	64	16	32	55	270	haze	3
16:53	63	17	36	47	260	haze	6
17:53	58	18	39	48	260	haze	5
18:53	53	17	30	43	250	haze	6
19:04	54	17	33	41	250		9
19:53	51	21	30	37	240		10
20:53	49	23	24	33	240		10
21:53	47	27	14	20	270		10
22:53	47	30	23	31	260		10
23:53	45	31	23		250		10

Table 13: Weather observations for Amarillo, Texas, on February 28, 2012 (Source: http://mesowest.utah.edu)

Time CST February 28, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
10:53	63	65	29	41	190		10
11:53	69	29	46	55	210	blowing dust	10
12:53	71	24	40	55	210	blowing dust	3
13:14	72	17	44	60	220	blowing dust	2
13:53	72	17	46	56	210	blowing dust	2
14:00	72	17	41	56	210	blowing dust	3
14:31	73	13	41	55	210	blowing dust	2.5
14:53	73	13	41	53	210	blowing dust	2.5
15:00	73	13	39	51	210	blowing dust	5
15:53	73	8	39	53	240	blowing dust	4
16:09	72	10	41	51	250	blowing dust	1.5
16:18	70	11	40	50	240	blowing dust	1
16:33	70	11	43	53	250	blowing dust	0.75
16:53	68	12	38	51	250	blowing dust	1
17:00	68	12	39	50	240	blowing dust	0.75
17:10	68	13	35	51	250	blowing dust	0.75
17:23	66	14	37	47	250	blowing dust	1.5
17:33	63	19	39	52	280	blowing dust	3
17:53	59	20	41	55	280	blowing dust	2
17:55	59	20	38	56	280	blowing dust	9
18:02	57	21	39	56	280	blowing dust	2.5
18:53	54	15	32	47	270	blowing dust	4
19:53	51	16	20	33	270		10
20:53	50	17	24	38	270		10
21:53	49	19	23	39	260		10
22:53	48	21	24	31	260		10

Table 14: Weather observations for Dalhart, Texas, on February 28, 2012 (Source: http://mesowest.utah.edu)

Time MST February 28, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:53	42	96	6		170	lt rain; fog	0.5
1:53	42	100	6		180	fog	0.25
2:53	42	100	5		180	fog	0.25
3:53	43	100	10		140	fog	0.25
4:53	47	97	15		160	fog	0.25
5:53	49	100	20		170	fog	2
6:53	51	96	25	32	180	fog	5
7:53	51	96	21		180	fog	4
8:53	52	97	19		190	fog	4
9:53	56	80	27	36	200		8
10:53	61	52	32	39	210		10
11:53	65	25	40	55	210	haze	3
12:01	64	26	38	50	210	haze	3
12:34	66	21	40	52	230	haze	2
12:45	66	19	40	50	210	haze	3
12:53	66	19	36	51	220	haze	3
13:03	66	19	40	52	220	haze	2.5
13:13	66	19	40	53	220	haze	3
13:27	66	13	40	56	230	haze	2
13:53	68	11	38	63	230	haze	2.5
14:08	68	13	43	63	230	haze	1.75
14:15	66	14	41	54	240	haze	3
14:53	67	15	43	53	240	haze	6
15:11	64	18	36	50	260		8
15:20	64	18	40	53	260	haze	5
15:53	62	18	38	51	260	haze	5
16:33	59	16	41	58	260	haze	1.75
16:41	59	16	48	59	270	haze	2
16:47	57	15	44	59	260	haze	1.75
16:48	58	15	46	59	260	haze	1.75
17:11	57	15	43	60	260	haze	2
17:19	55	18	41	55	260	haze	1.5
17:24	55	16	40	55	250	haze	3
17:51	54	15	38	48	260	haze	6
17:53	53	15	36	46	260	haze	6
18:53	49	17	28	37	250		9
19:53	47	21	25	31	260		10
20:53	44	27	22	29	270		9
21:53	43	30	18		250		10
22:53	41	33	20	29	250		10
23:53	39	35	17		250		10

Table 15: Weather observations for Dumas, Texas, on February 28, 2012 (Source: http://mesowest.utah.edu)

Time MST February 28, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:55	43	100	5		160	lt rain	0.75
1:55	45	100	7		160	fog	0.5
2:55	46	100	13		150	lt drizzle	0.5
3:55	48	93	14		150	fog	0.5
4:55	48	100	13		150	fog	0.25
5:55	50	100	15		160	fog	5
6:55	52	94	25	31	170		10
7:55	52	94	24	31	180	fog	5
8:55	54	94	25	32	180		7
9:55	57	82	28	37	190		10
10:55	61	63	25	39	200		10
11:55	66	28	37	48	220	haze	2.5
12:55	68	24	35	53	230	haze	1.5
13:55	68	18	39	48	230	haze	2
14:55	70	13	36	53	230	haze	1.25
15:55	68	16	46	54	240	haze	3
16:55	63	20	40	52	260	haze	3
17:55	55	19	47	55	260	haze	1.75
18:55	50	20	28	37	260		7
19:55	46	23	18		250		10
20:55	46	23	27	33	250		10
21:55	43	28	22		250		10
22:55	43	31	24		250		10
23:55	41	36	22		250		10

Satellite imagery from February 28, 2012 provides strong supporting evidence that dust caused the PM_{10} exceedance in Lamar. Figure 16 shows the visible satellite image of the southwestern United States at 1:45 PM MST (2045Z). Dust storms were widespread across the Southwest at this time, including a large plume of dust from the White Sands area that is readily visible in south-central New Mexico. Other plumes can be observed in northern parts of Mexico and west Texas along with southeast Colorado (circled in red).

These dust plumes are also visible when analyzing MODIS (Moderate Resolution Imaging Spectroradiometer) satellite imagery (for additional information on MODIS from the National Aeronautics and Space Administration (NASA): https://earthdata.nasa.gov/data/near-real-time-data/data/instrument/modis). Figure 17 shows the MODIS Aqua satellite image at approximately 1:20 PM MST. Several dust plumes can be easily identified throughout the region. When we zoom in closer on southeast Colorado (Figure 18) we can see the extent of blowing dust, particularly to the north of Lamar. According to surface observations for Lamar in the hour before and the hour after this image was generated, sustained winds of 40-45 mph were recorded along with wind gusts of 50-56 mph and visibility reduced to 8 statute miles

(Table 1). Winds of this magnitude are well above the thresholds to produce blowing dust according to local climatology (see Blowing Dust Climatologies available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

Webcam imagery was also able to capture the dust storm occurring during the afternoon of February 28th, 2012. As stated in the previous paragraph, large plumes of dust are evident to the north of Lamar on MODIS satellite imagery at approximately 1:20 PM MST. The web cam image (Figure 19) taken at 1:29 PM MST shows a hazy, dust-filled sky over the town of Eads, which is located approximately 35 miles to the north-northwest of Lamar within the visible dust plumes (Figure 18). For comparison purposes a 2nd web cam image (Figure 20) is included from Eads at approximately the same time of day (1:30 PM MST), but from two days earlier (February 26) when the wind was generally light (sustained at 6-7 mph with gusts to 16 mph) and visibility was considered good (10 statute miles). Also note from the MODIS image in Figure 18 that the sky is relatively cloud-free over Eads, so the darkness of the sky from the web cam image in Figure 19 should not be mistaken for cloud cover.

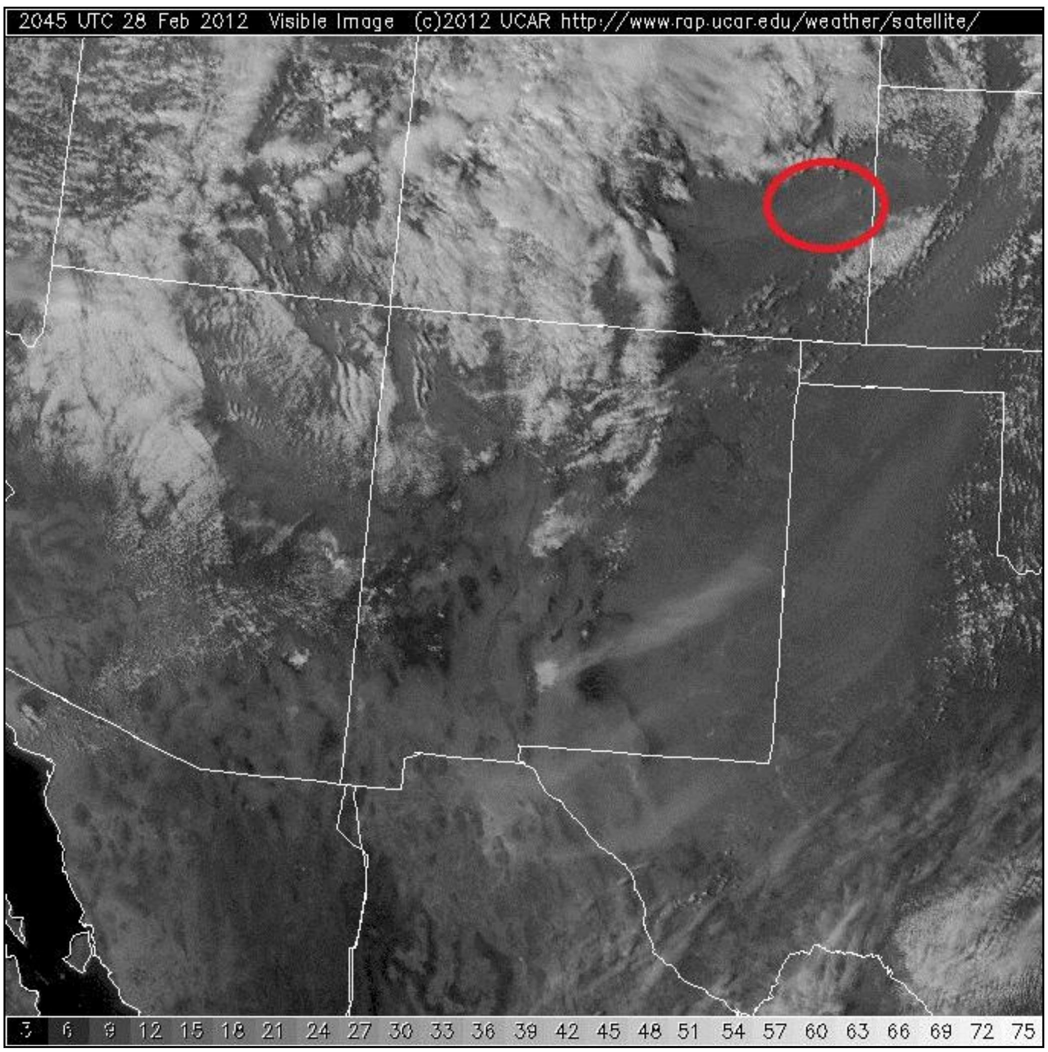


Figure 16: GOES 15 visible satellite image at 1:45 PM MST (2045Z) February 28, 2012. (Source: http://weather.rap.ucar.edu/satellite/)

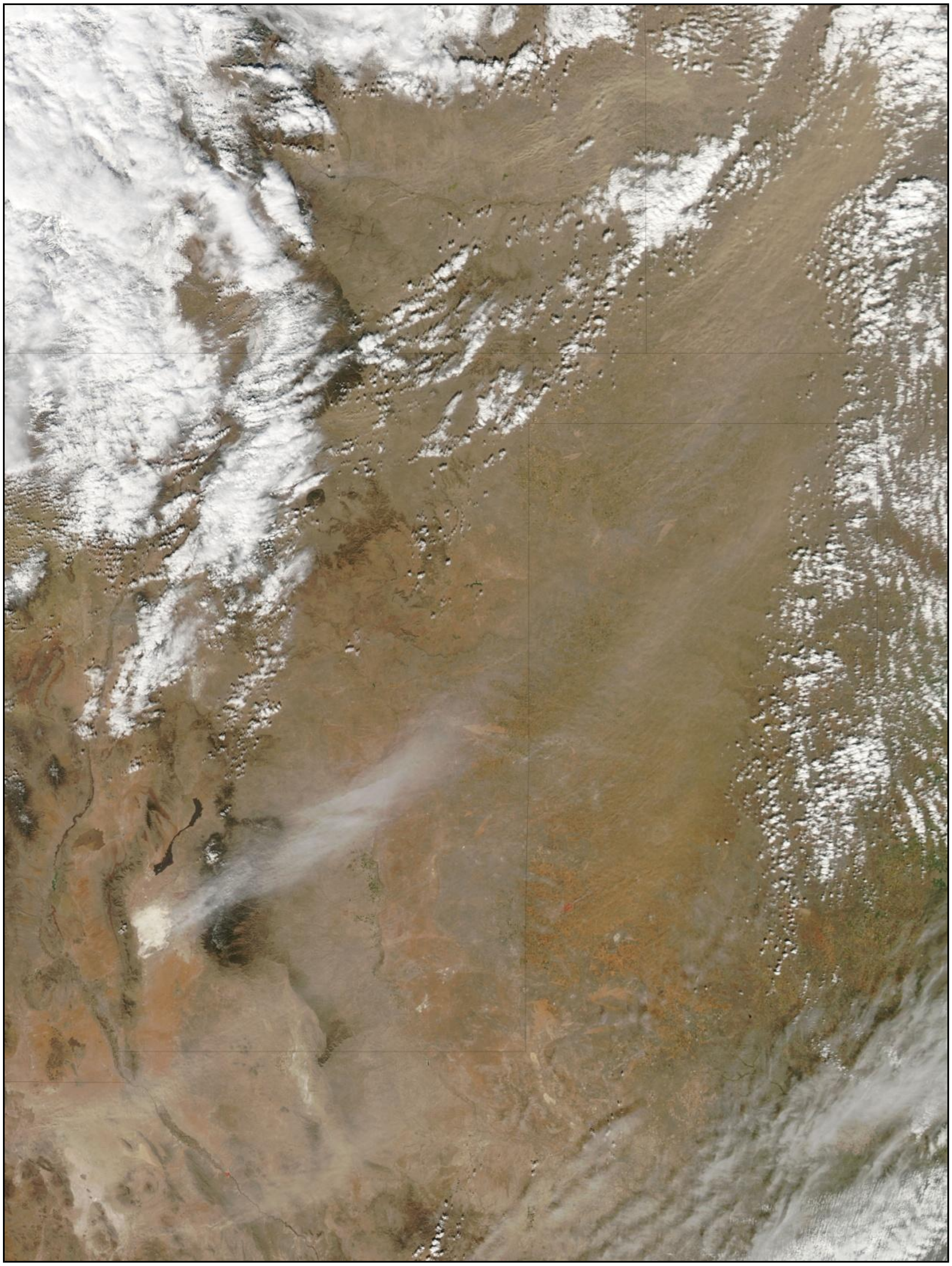


Figure 17: MODIS Aqua satellite image at approximately 1:20 PM MST (2020Z) February 28, 2012.
(Source: http://ge.ssec.wisc.edu/modis-today/index.php)

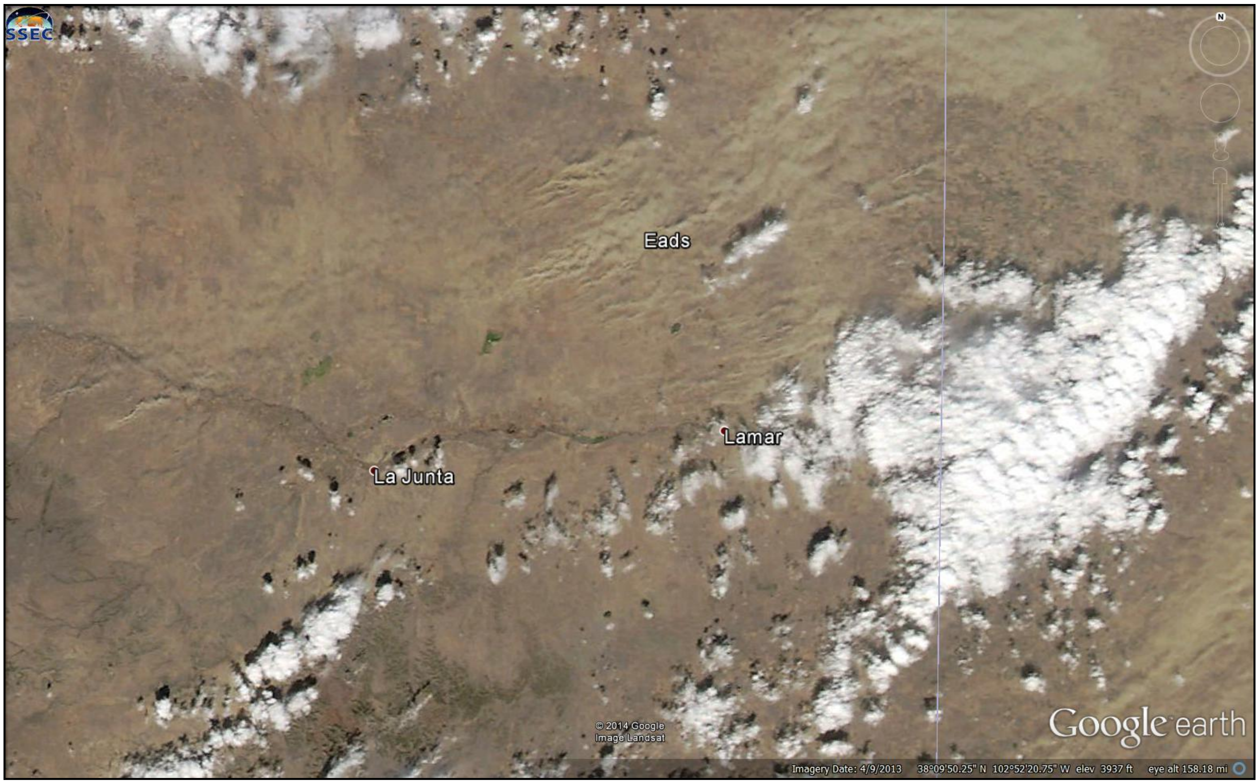


Figure 18: MODIS Aqua satellite image of southeast Colorado at approximately 1:20 PM MST (2020Z) February 28, 2012.
(Source: http://ge.ssec.wisc.edu/modis-today/index.php)

Figure 19: Eads, Colorado webcam image at 1:29 PM MST February 28, 2012. (Source: http://www.wunderground.com/webcams/kcpnews/1/show.html#cal)

Figure 20: Eads, Colorado webcam image at 1:30 PM MST February 26, 2012. (Source: http://www.wunderground.com/webcams/kcpnews/1/show.html#cal)

Additional satellite-generated data products also indicate that a regional dust storm caused the PM_{10} exceedance in Lamar. Figure 21 displays the AIRS (Atmospheric Infrared Sounder) Dust Score for the southern United States based on the MODIS Aqua satellite image from February 28, 2012 (see the following link for more information on Dust Score and other AIRS variables: http://disc.sci.gsfc.nasa.gov/nrt/data-holdings/airs-nrt-products). The tan to reddish brown colored pixels represent dust scores greater than 360, which is indicative of dust particles. Notice that large sections of east-central Colorado southward into northeast New Mexico recorded a dust score in excess of 400.

The GASP (GOES Aerosol Smoke Product) West Aerosol Optical Depth image at 3:45 PM MST on February 28, 2012 is displayed in Figure 22. Aerosol Optical Depth (AOD) is a measure of the degree to which aerosols, such as dust, prevent the transmission of light (see the following link for additional information on GASP: http://www.star.nesdis.noaa.gov/smcd/emb/aerosols/products_geo.php). In Figure 22, clusters of moderate AOD values of around 0.4 - 0.5 (circled in red) can be observed in southeast Colorado. At the approximate time of this image, Lamar reported sustained winds of 39 mph with gusts to 51 mph (Table 1). Haze and blowing dust were also being reported at two other weather observation stations (Pueblo and Trinidad, Table 3 and Table 5, respectively) in southeast Colorado during this time interval.

Satellite and webcam imagery reveal that a dust storm was taking place in southeast Colorado on February 28, 2012.

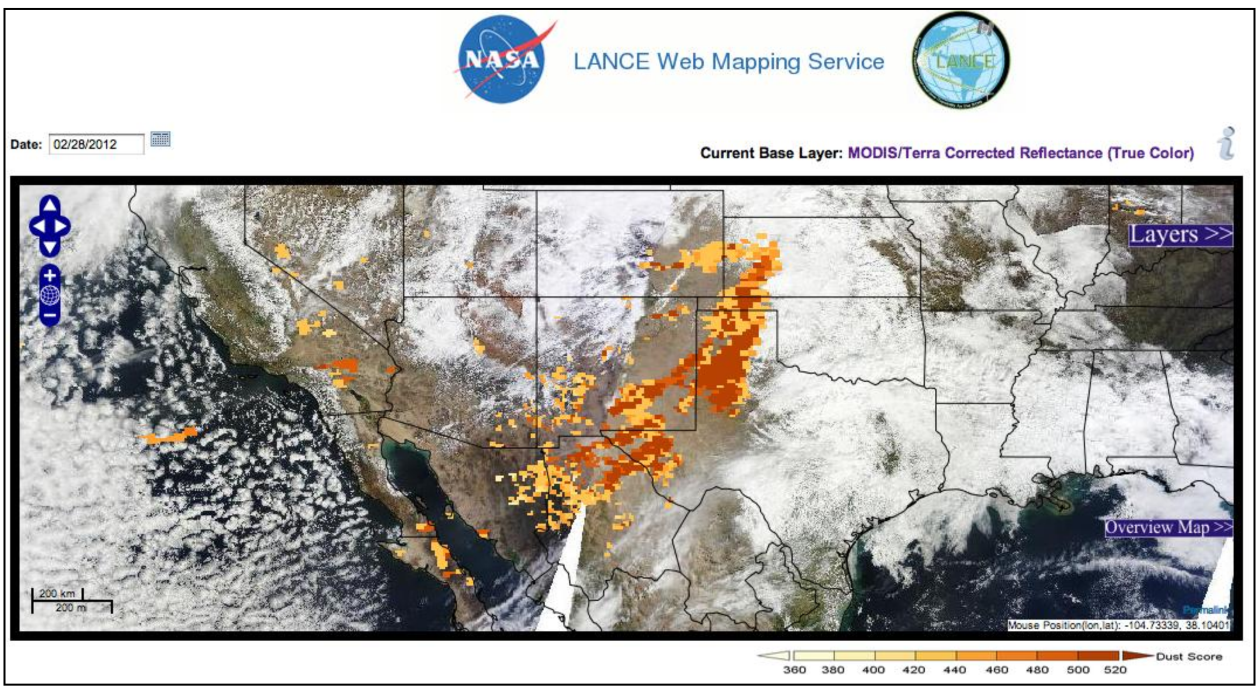


Figure 21: AIRS Dust Score for February 28, 2012.
(Source: http://alg.umbc.edu/usaq/archives/2012_02.html)

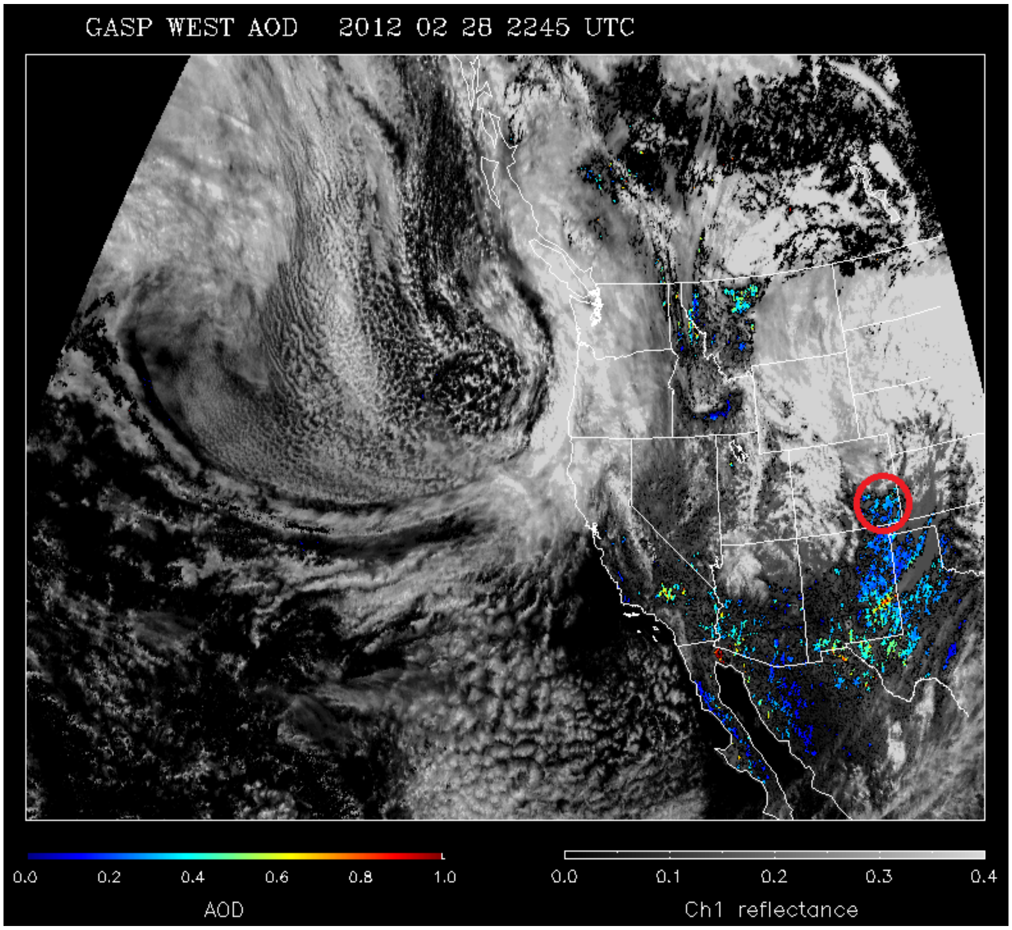


Figure 22: GASP West Aerosol Optical Depth image at 3:45 PM MST (2245Z) February 28, 2012.
(Source: http://www.star.nesdis.noaa.gov/smcd/spb/aq/index.php?product_id=2)

Figure 23 shows the total precipitation in inches for February 2012 for the southwestern United States. Almost the entirety of southeast Colorado and northeast New Mexico received less than 0.5 inches of precipitation during the month leading up to the February 28, 2012 dust event in Lamar. Based on previous research 0.5 to 0.6 inches of precipitation over a 30 day period has been found to be the approximate threshold, below which, blowing dust exceedances at Lamar are more likely to occur when combined with high winds (see Blowing Dust Climatologies available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

Furthermore, the Drought Monitor report for the western United States as of 5:00 AM MST February 28, 2012 (Figure 24) reveals that drought conditions were widespread across southeast Colorado and points upwind to the southwest, including northeast New Mexico. In fact, large portions of the region were classified as being in a “Severe” drought. According to the National Drought Mitigation Center, the definition of a severe drought includes, “Crop or pasture losses likely”, which would imply high rates of erosion and an increase in vulnerability to particulate suspension (see the following link for more information on drought severity classification from the National Drought Mitigation Center: http://droughtmonitor.unl.edu/AboutUs/ClassificationScheme.aspx).

MODIS False Color satellite imagery provides a striking visualization of the drought conditions in southeast Colorado during late February of 2012. False color imagery can be very useful in identifying ground that is covered by vegetation versus bare soil. Often desert or naturally bare soils which are low moisture will range in color from sandy pink to reddish-brown while vegetation will always appear green (for additional information on MODIS False Color imagery including the meaning of different band combinations: https://earthdata.nasa.gov/data/near-real-time-data/faq/rapid-response).

Figure 25 and Figure 26 show MODIS False Color satellite imagery from February 24, 2012 and February 16, 2010, respectively. Figure 25 reveals the ongoing severe drought conditions four days before the blowing dust event of February 28, 2012 while Figure 26 shows an example of southeast Colorado during non-drought conditions (Figure 27) at a similar time of year. From Figure 25 it is easy to discern the brighter pinks and reds to the west and south (upwind) of Lamar compared to those in Figure 26. As stated earlier, pinks and reds in MODIS False color imagery are the signature of bare, dry soils with little to no vegetation cover. Also note the brighter, more expansive green areas that can be found immediately surrounding Lamar in the non-drought year (Figure 26) in contrast to the duller, less abundant green shading just a few days before the dust storm of February 28, 2012 (Figure 25).

30-day precipitation and Drought Monitor reports along with MODIS False Color satellite imagery indicate that soils in southeast Colorado and northeast New Mexico were dry enough to produce blowing dust when winds were above the thresholds for blowing dust.

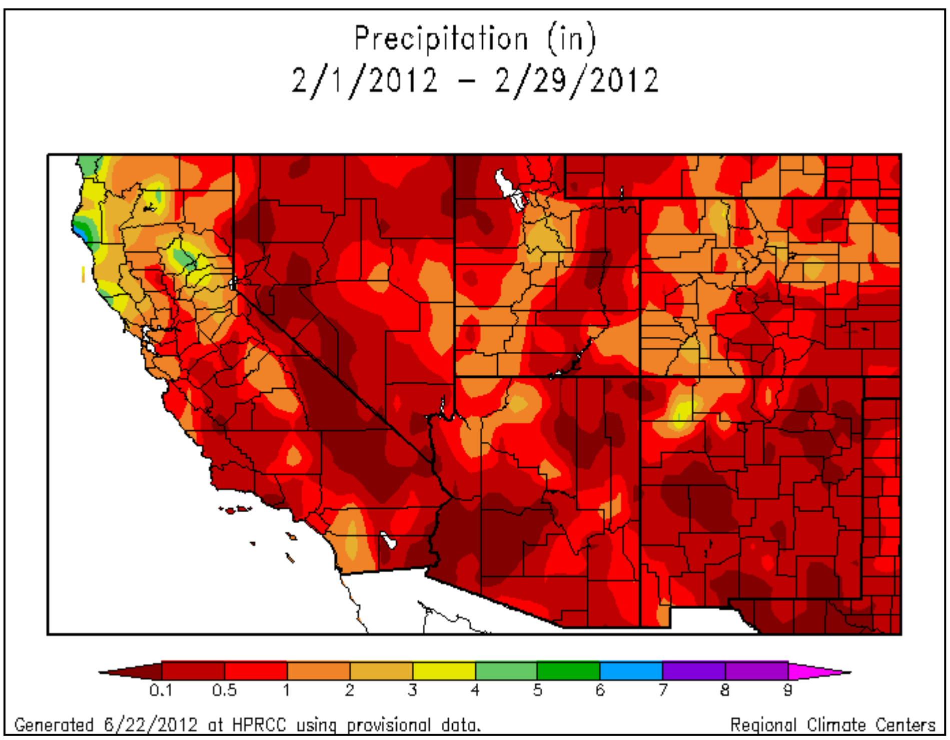


Figure 23: Total precipitation in inches for the southwestern United States, February 2012.
(Source: http://www.hprcc.unl.edu/maps/current/index.php?action=update_region&state=SW&region=WRCC).

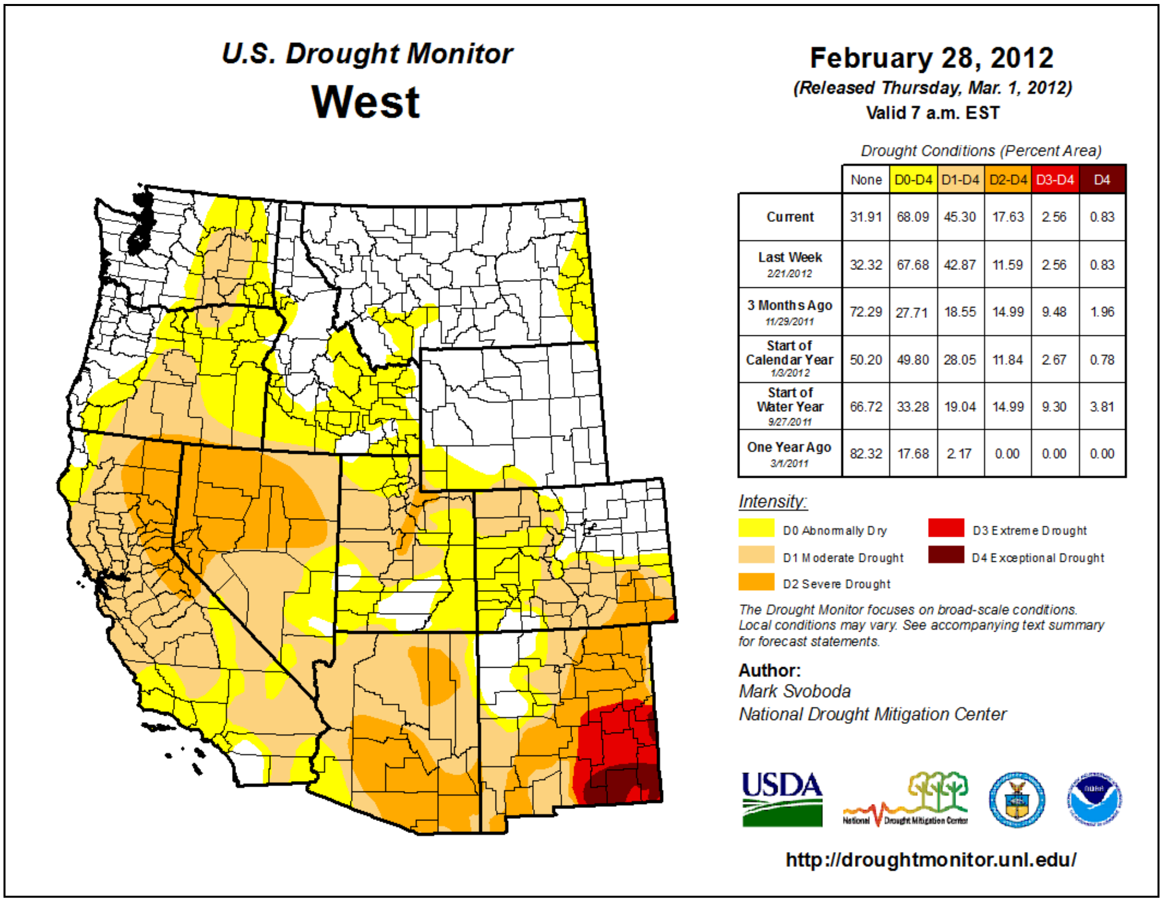


Figure 24: Drought conditions for the western United States at 5 AM MST February 28, 2012.
(Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

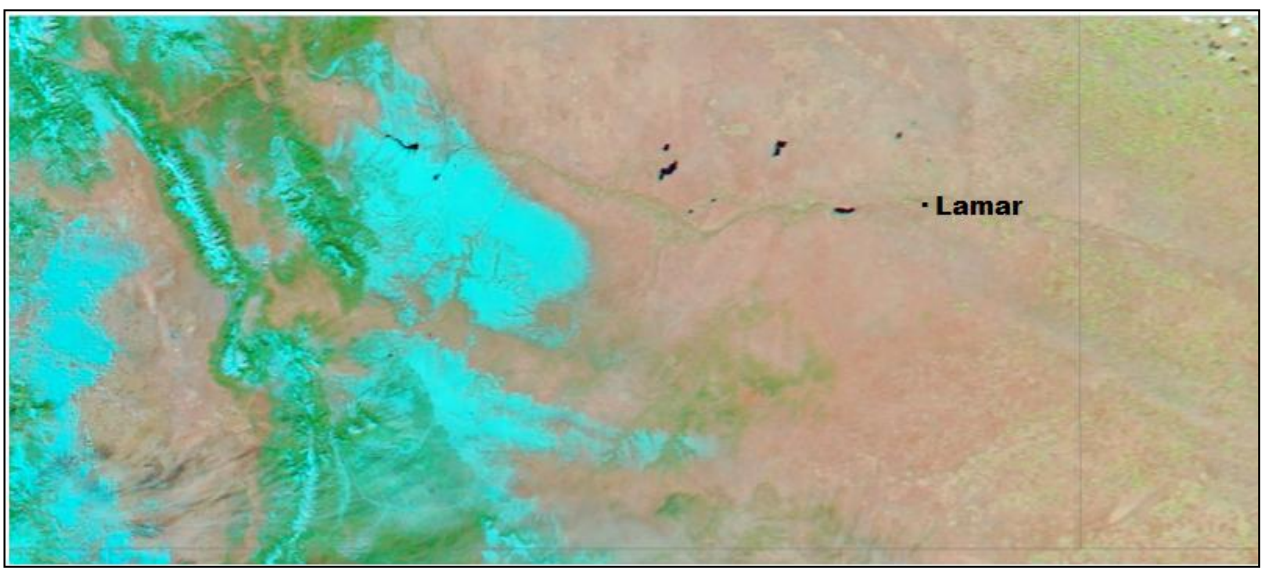


Figure 25: MODIS Terra false color satellite image on February 24, 2012.
(Source: http://ge.ssec.wisc.edu/modis-today/index.php)

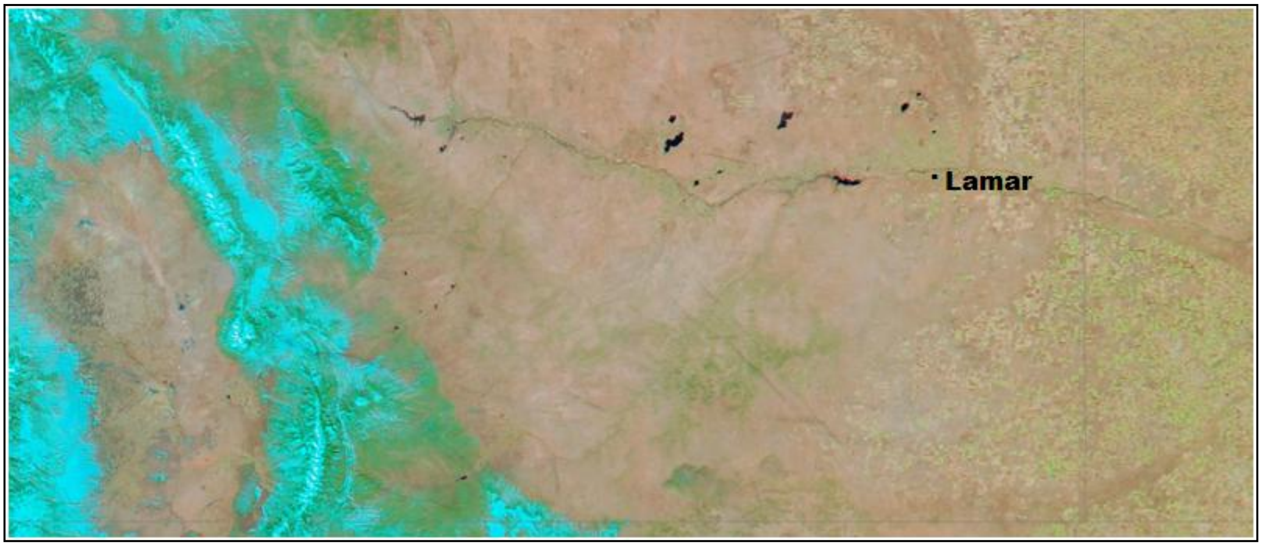


Figure 26: MODIS Terra false color satellite image on February 16, 2010. (Source: http://ge.ssec.wisc.edu/modis-today/index.php)

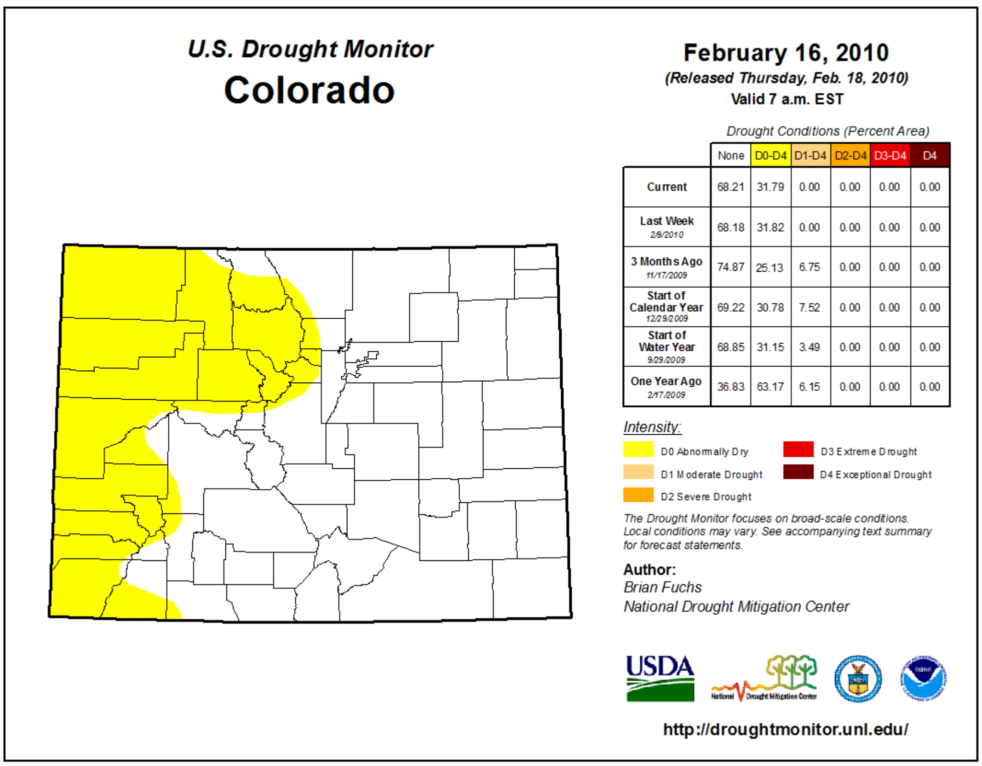


Figure 27: Drought conditions for Colorado at 5 AM MST February 16, 2010. (Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

Figure 28 shows the NOAA HYSPLIT 3-hour backward trajectories (Draxler and Rolph, 2012) for Lamar for a duration of 8 hours (9 AM MST to 5 PM MST February 28, 2012 -- see the following link for more information on HYSPLIT from the NOAA Air Resources Laboratory: http://www.arl.noaa.gov/HYSPLIT_info.php). This 8-hour period includes the highest winds recorded in Lamar on February 28, 2012 along with all of the reduced visibility observations (Table 1).

The trajectory analysis clearly shows the transport of air from northeast New Mexico early in the time period, and eventually from areas in southeast Colorado to west-southwest upwind of Lamar after the cold front passed. Both areas were experiencing "Severe" drought conditions according to Figure 24 and both are also known to be source regions for blowing dust in Lamar (see Blowing Dust Climatologies available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

NOAA HYSPLIT backward trajectories provide clear supporting evidence that dust from arid regions of southeast Colorado and northeast New Mexico which were experiencing severe drought conditions caused the PM_{10} exceedance measured in Lamar on February 28, 2012.

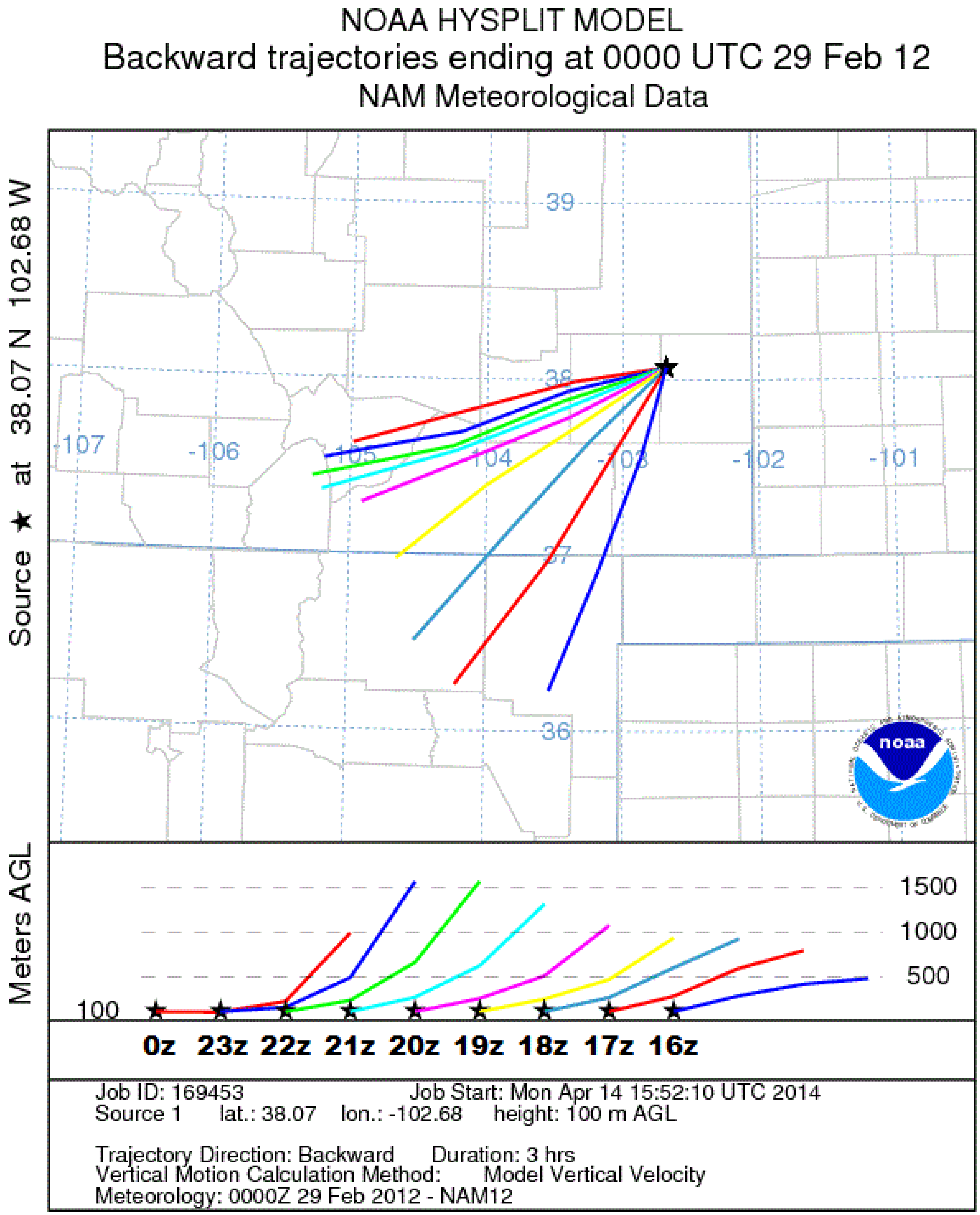


Figure 28: NOAA HYSPLIT NAM 12 3-hour back trajectories for Lamar, CO from 9 AM MST (16Z) February 28, 2012, to 5 PM MST (0Z February 29) February 28, 2012. (Source: http://ready.arl.noaa.gov/HYSPLIT.php)

The Pueblo National Weather Service (NWS) forecast office issues weather information and alerts for southeast Colorado, including Lamar. Local storm reports and warnings issued by this office on February 28, 2012, are presented in Appendix B. Additionally, the Colorado Department of Public Health and Environment (CDPHE) issued a Blowing Dust Advisory for southeast Colorado on February 28, 2012. This advisory can also be found in Appendix B.

The Smoke Text Product from the National Oceanic and Atmospheric Administration (NOAA) Satellite Services Division – Descriptive Text Narrative for Smoke/Dust Observed in Satellite Imagery mentions blowing dust in three consecutive text products (1800Z and 2345Z of February 28, 2012 and 1630Z of February 29, 2012). These narratives, which can be found in their entirety in Appendix B, show that significant blowing dust was occurring in southeast Colorado on February 28, 2012 and even continued to a lesser degree into the morning of February 29, 2012.

Text products and advisories issued by the NWS, CDPHE and NOAA show that very strong winds and areas of blowing dust were anticipated and did occur in southeast Colorado on February 28, 2012.

Figure 29 shows the output for blowing dust from the Navy Aerosol Analysis and Prediction System (NAAPS) Global Aerosol Model for 11 AM (18Z) on February 28, 2012. The NAAPS system models blowing dust emissions and transport based on soil moisture content, soil erodibility and a variety of meteorological factors known to be conducive for blowing dust (for a description of NAAPS see: http://www.nrlmry.navy.mil/aerosol_web/Docs/globaer_model.html).

The forecast panel in the lower left of Figure 29 shows highly elevated surface dust concentrations over much of New Mexico and southeast Colorado while corresponding elevated optical depth values can be found in the upper left panel. The model output suggests that this drought-stricken area was a major source region for blowing dust on February 28, 2012 in Lamar.

Forecast products from the Navy Aerosol Analysis and Prediction System model provide evidence for a regional blowing dust event, suggesting that significant source regions for dust in Lamar were located in New Mexico and southeast Colorado.

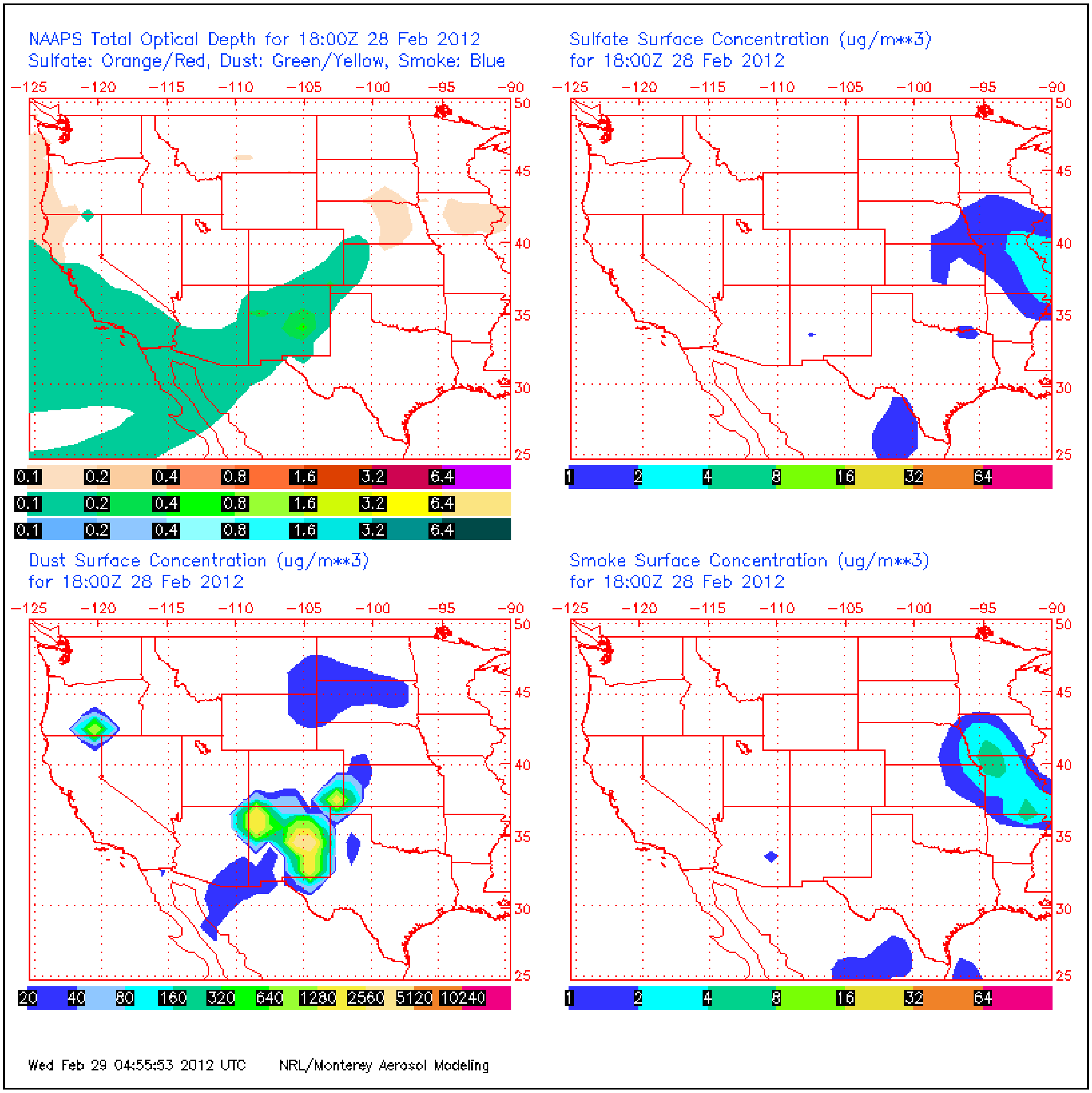


Figure 29: NAAPS forecasted dust concentrations for 11 AM MST (18Z) February 28, 2012. (Source: http://www.nrlmry.navy.mil/aerosol-bin/aerosol/display_directory_all?DIR=/web/aerosol/public_html/globaer/ops_01/wus/)

In a 1997 paper, "Factors controlling threshold friction velocity in semiarid and arid areas of the United States" (Marticorena et al., 1997), the authors characterized the erodibility of both disturbed and undisturbed desert soil types. The threshold friction velocity, which is described in detail in the Marticorena paper, is a measure for conditions necessary for blowing dust. This value is higher for undisturbed soils and lower for disturbed soils.

Friction velocities were calculated for 11 AM and 2 PM MST February 28, 2012 using the 12 km NAM (North American Mesoscale Model). These friction velocities are presented in Figure 30 and Figure 31. According to Marticorena et al. (1997), even undisturbed desert soils normally resistant to wind erosion will be susceptible to emission of blowing dust when threshold friction velocities are in the 1.0 to 2.0 meters per second range. In Figure 30, a wide area of southeast Colorado and northeast New Mexico show friction velocities exceeding 1.0 m/s. Therefore it is reasonable to assume that undisturbed soils in this region were vulnerable for blowing dust production at 11 AM MST on February 28, 2012.

Friction velocities continued to increase during the early afternoon hours and by 2 PM MST (Figure 31) much of the area near Lamar had reached or exceeded 1.5 m/s. Blowing dust will typically only occur where friction velocities are high and soils are dry. It has already been thoroughly documented that soils in southeast Colorado and northeast New Mexico were dry (Figure 23 and Figure 24), and now we have also established that friction velocity values were high in this area. Consequently, it is highly probable that undisturbed soils in southeast Colorado and northeast New Mexico were a highly significant contributor to the blowing dust that occurred in Lamar.

The elevated friction velocities shown in Figure 30 and Figure 31, the data on soil moisture conditions presented elsewhere in this report and the prevalence of winds above blowing dust thresholds (all occurring in traditional source regions in southeast Colorado and northeast New Mexico) prove that this dust storm was a natural event that was not reasonably controllable or preventable.

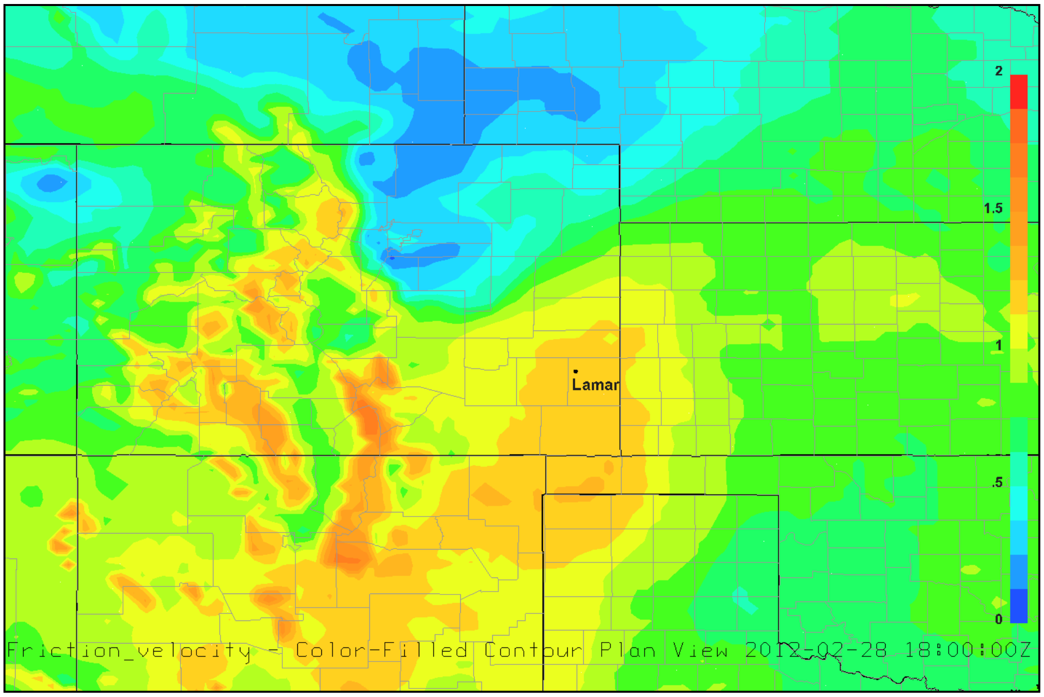


Figure 30: 12 km NAM friction velocities in meters/second at 11 AM MST February 28 (18Z February 28), 2012.
(Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

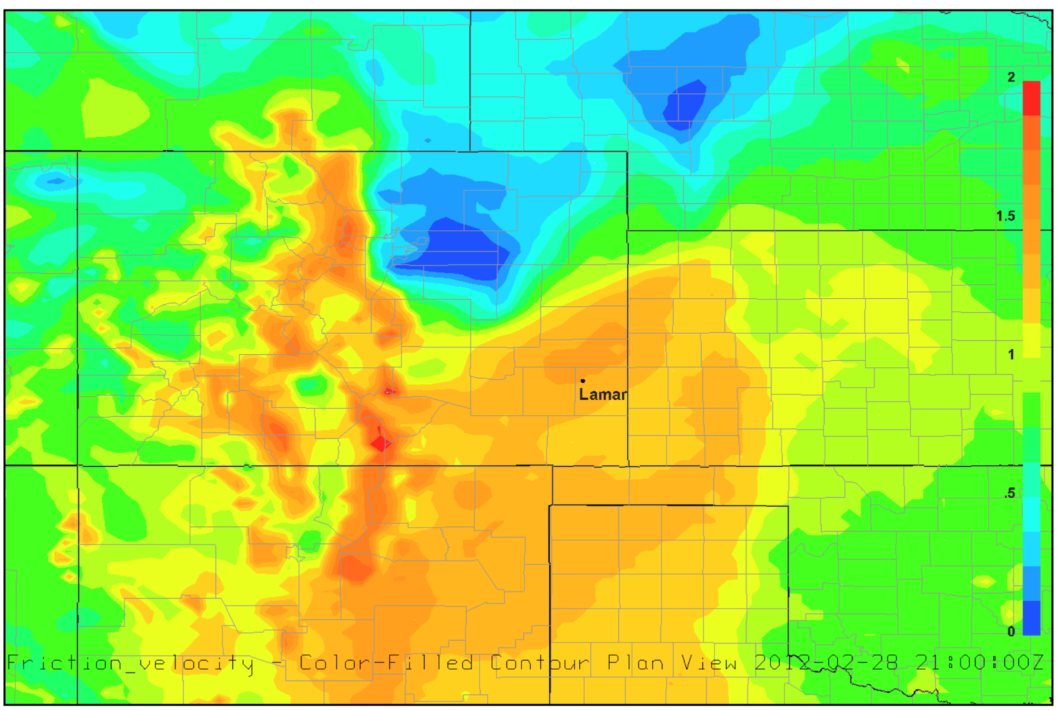


Figure 31: 12 km NAM friction velocities in meters/second at 2 PM MST February 28 (21Z February 28), 2012.
(Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

3.0 Evidence-Ambient Air Monitoring Data and Statistics

On February 28, 2012, an intense low pressure system and associated upper level trough moved across Colorado. The strong west to southwest winds associated with this system transported blowing dust from southeast Colorado and northeast New Mexico into the Lamar area, affecting PM10 samples in Lamar. During this event a sample in excess of 150 µg/m^3 was recorded at the Lamar Power Plant monitoring site (Lamar Power, 167 µg/m^3). An elevated sample was recorded at the Lamar Municipal monitoring site (Lamar Muni, 109 µg/m^3). No other sites/samples were affected by this event. The elevated PM_{10} readings in Lamar resulted from blowing dust associated with strong, gusty winds in lead of the cold front. The winds transported blowing dust into Lamar from southeastern Colorado and northeastern New Mexico.

3.1 Historical Fluctuations of PM_{10} Concentrations in Alamosa and Lamar

This evaluation of PM_{10} monitoring data for sites affected by the February 28, 2012, event was made using valid samples from PM_{10} samplers in Lamar from 2007 through 2012, APCD has been monitoring PM_{10} concentrations in the area since 1985. The overall data summary for the affected sites is presented in Table 16, with all data values being presented in µg/m^3.

Table 16: February 28, 2012, Event Data Summary

Evaluation	*Lamar Power*	*Lamar Muni*
2/28/2012	**167**	**109**
Mean	27.9	21.7
Median	24	19
Mode	23	15
St. Dev	21.13	15.26
Var	446.38	232.75
Minimum	3	1
Maximum	367	242
Count	2181	2114

A snapshot summary of data from both Lamar sites affected by the event is presented in Table 16. The approximate percentile value that the February 28, 2012, sample is representative of each site for its unique historical data set, for the month of the event (every sample in any February), and for the year of the event. All percentile calculations presented in this section were made using the entire dataset, including known high wind events. There is no difference between the two datasets (with and without high wind events) in regards to percentile calculations. Percentile calculations for both sites affected by the event are presented in Table 17.

Table 17: February 28, 2012 Site Percentile (All Affected Sites)

Evaluation	*Lamar Power*	*Lamar Muni*
2/28/2012	**167**	**109**
Overall	99.6%	99.5%
Any February	*99.4%*	*98.8%*
2012	99.4%	99.2%

The percentile calculations in Table 17 demonstrate that both the sample from Lamar Power of 167 μg/m^3 and the sample from Lamar Muni of 109 μg/m^3 are extreme examples for each dataset. Although the Lamar Muni sample is not in excess of 150 μg/m^3 it is still the 3rd largest sample recorded among all February samples from 2007 through 2012, the 4th largest sample in 2012, and the 12th largest sample in the Lamar Muni dataset. As PM_{10} sources are generally local and the sites are in close proximity the sites are reasonably correlated (r^2 = 0.70). However, the average of the absolute relative difference exceeds 28%. That both samples are representative of extreme values for their independent data sets suggests that there was a common contribution to each sample from other than local sources.

The data set for Lamar Power is further summarized by month in Table 18. As with previous submittals these summaries the data presents no obvious 'season'; PM_{10} levels at any particular site in Colorado do not necessarily fluctuate by season. Of greater importance affecting day-to-day, typical PM_{10} concentrations are local sources, e.g. road sanding and sweeping, local burning from agriculture and residential heating, vehicle contributions via road dust, unpaved lots or roads, etc. While the historic monthly mean values for the affected sites can be higher during the winter and spring months there is little month-to-month variation. Additionally, some of the sites exhibit monthly medians over these periods (winter and early spring) that are generally lower than other months of the year. This time frame (winter and early spring) is that which is most likely to experience the meteorological and dry soil conditions necessary for this type of event and are discussed elsewhere in this document. Although the maximum values for these months (winter and early spring) are the highest in the data set the 'typical' data (i.e. day-to-day, reflective of local conditions) are similar or lower than the same 'typical' data for the rest of the year. The summary data for the month of February (all samples in any February from 2007-2012) and for 2012 for both Lamar sites are presented in Table 18:

Table 18: February 28, 2012 PM_{10} Evaluation by Month and Year

	Lamar Power		*Lamar Muni*	
Evaluation	February	All 2012	February	All 2012
Mean	25.5	28.1	19.3	24.6
Median	20	24	15	20
Mode	16	27	15	17
St. Dev.	26.09	23.08	17.49	21.45
Variance	680.68	532.66	305.78	460.07
Minimum	3	3	4	3
Maximum	233	220	144	242
Count	168	361	164	364

Lamar Power Plant – 08-099-0001

The PM_{10} sample on February 28, 2012, at Lamar Power of 167 μg/m^3 is the 2nd largest sample recorded among all February samples from 2007 through 2012, is the 3rd largest sample of all 2012 data, and is greater than the 99th percentile value (104 μg/m^3) for the entire dataset. Overall, this sample is the 10th largest sample in the entire data set. All nine samples greater than the event sample are associated with a high wind event. There are 2181 samples in the Lamar Power dataset. The sample of February 28, 2012 clearly exceeds the typical samples for this site.

Figure 33 to Figure 35 graphically characterize the Lamar Power PM_{10} data. The first, Figure 32, is a simple time series; every sample in this dataset (2007 – 2012) greater than 150 μg/m^3 is identified. Note the overwhelming number of samples occupying the lower end of the graph; an interested reader can count the number of samples greater than 100 μg/m^3. Of the 2,181 samples in this data set, less than 1% are greater than 100 μg/m^3.

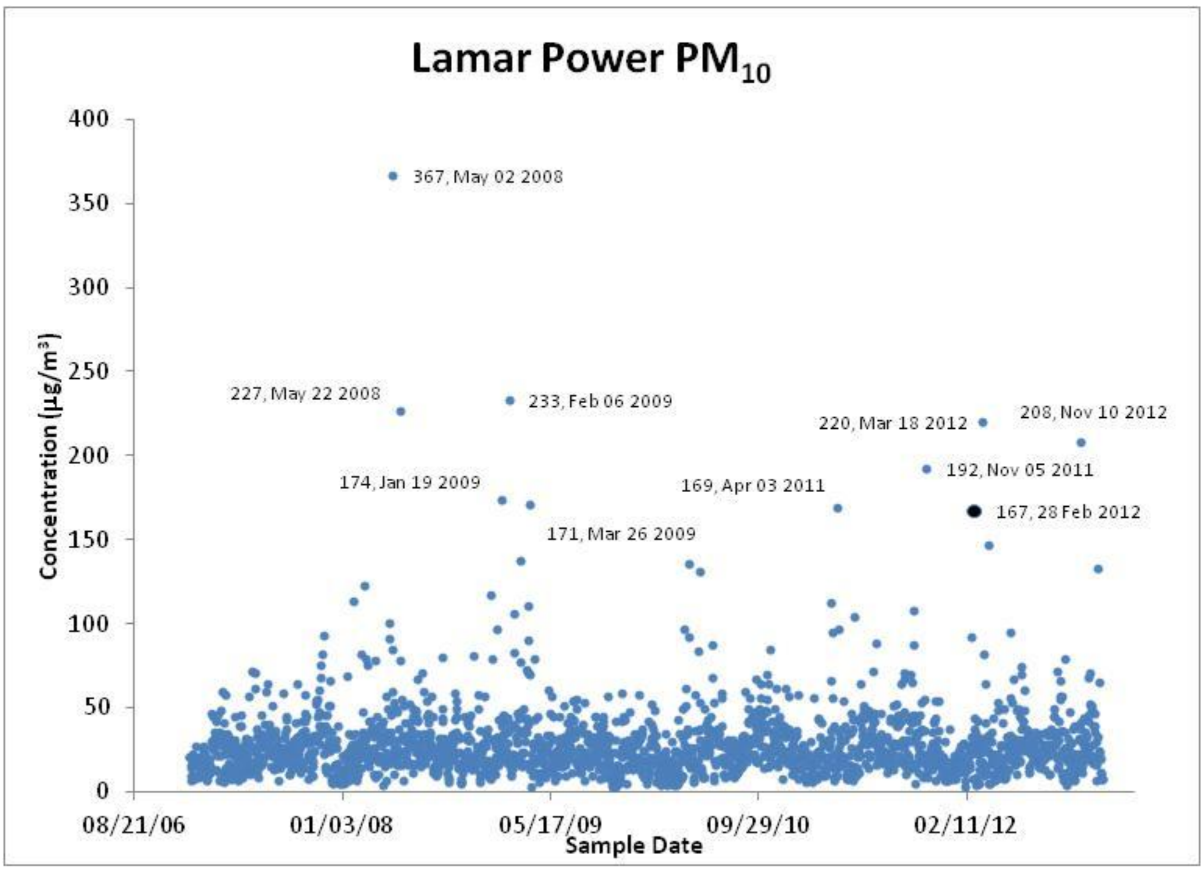


Figure 32: Lamar Power PM_{10} Time Series, 2007-2012

Figure 33 is a simple histogram, demonstrating the overwhelming weight of samples on the low end of the curve. This range of data can be considered typical, representing contributions from local sources. Well over 70% of the samples in this data set are less than 30 μg/m^3. Even in the highly variable months comprising winter and early spring over 90% of the samples are less than 50 μg/m^3. Clearly the sample of February 28, 2012, exceeds what is typical for this site.

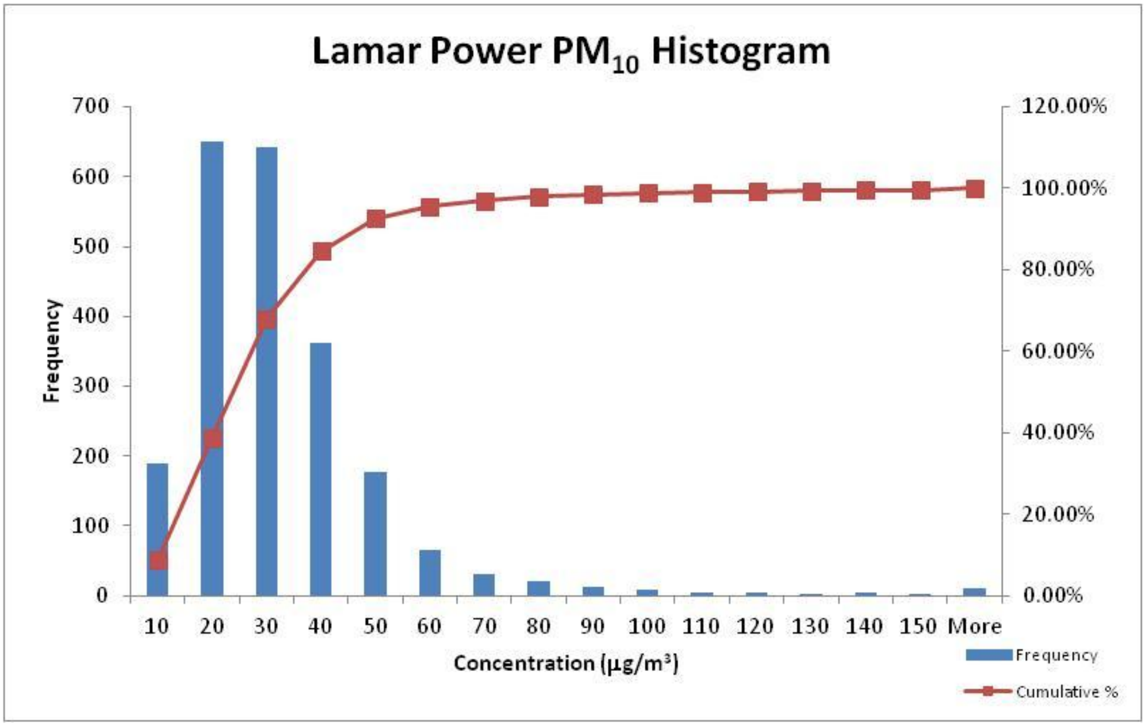


Figure 33: Lamar Power PM_{10} Histogram, 2007-2012

The monthly box-whisker plot (Figure 34), highlights the consistency of the majority of data from month to month. Note the greater variability (wider inner-quartile range) and greater range of the data through the winter and early spring months that's accompanied by typically greater monthly maxima. Recall, this time period experiences a greater number of days with meteorological conditions similar to those experienced on February 28, 2012. Although these high values affect the variability and central tendency (average) of the dataset they aren't representative of what is typical at the site.

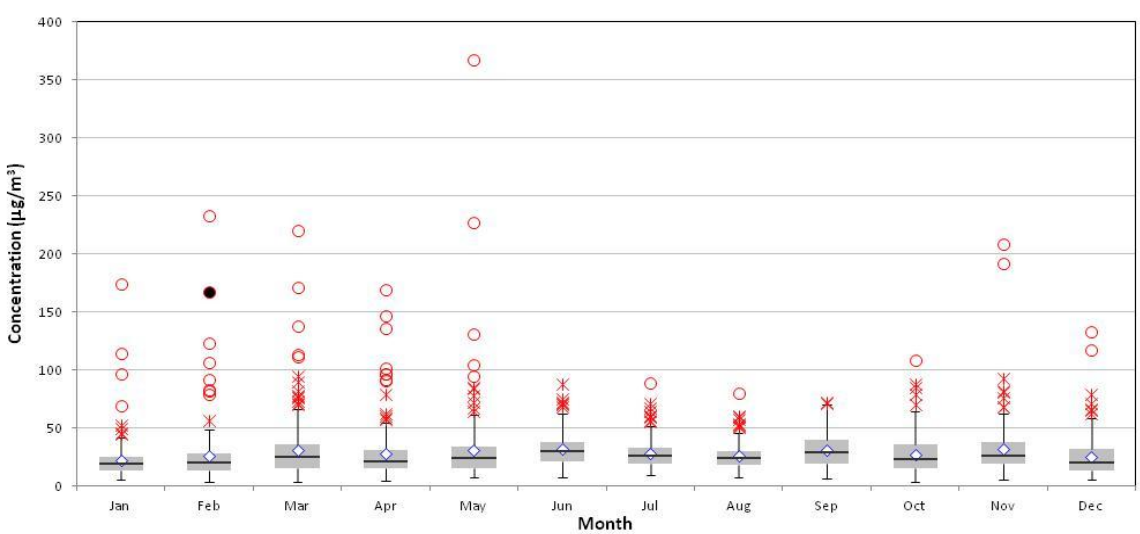


Figure 34: Lamar Power PM_{10} Box-Whisker Plot, 2007-2012

The box-whisper plots graphically represent the overall distribution of each data set including the mean ( ), the inner quartile range (IQR, defined to be the distance between the 75th% and 25th%), the median (represented by the horizontal black line) and two types of outliers identifed in these plots: outliers greater than 75th% +1.5*IQR ( )and outliers greater than 75th% + 3*IQR ( ). The outliers that satisfy the last criteria and are greater than 150 µg/m^3 are labeled with sample value and sample date. Each of these outliers is associated with a known high-wind event similar to that of February 28, 2012.

The presence of the extreme values distorts the graph, losing definition and distorting information presented across the range where the majority of data resides. The same plot graphed to 100 µg/m^3, which includes almost 99% of all the data, is presented in Figure 35. This expanded plot demonstrates that February is a month where contributions from local sources are similar to other months of the year but with a broad interquartile range – indicating a large amount of variation in samples.

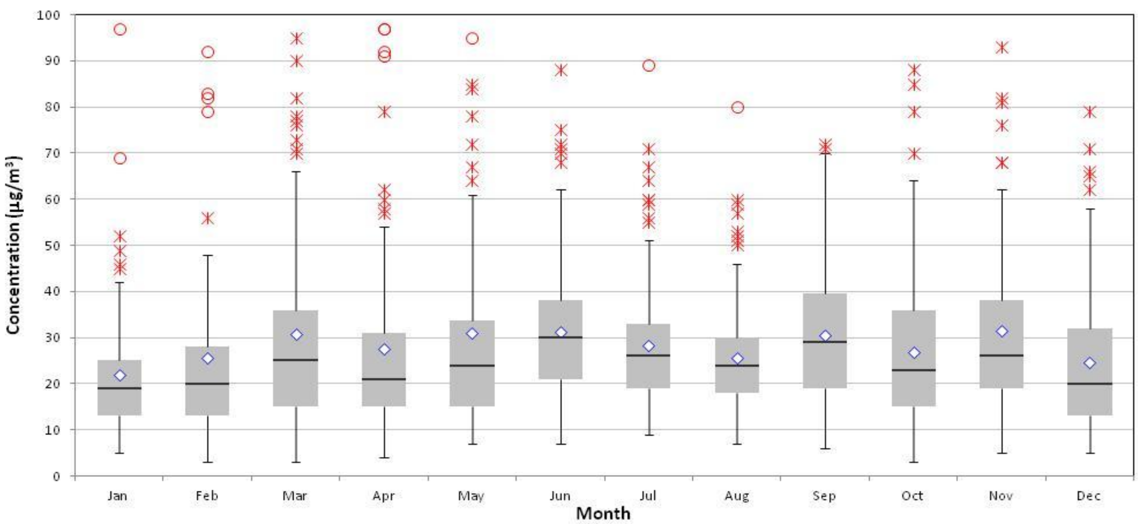


Figure 35: Lamar Power PM_{10} Box-Whisker Plot, Reduced Scale, 2007-2012

Note the degree to which the data in the months of fall through spring, beginning in October and extending through May, are skewed. The February mean (23.5 µg/m^3) is greater than the February median value (20 µg/m^3) and is greater than the 65% of all samples in any February. The skew in the data is due to the presence of a handful of extreme values and can create the perception that those months experiencing these high wind events are somehow 'dirtier' than other months of the year. This data exposes that perception as flawed, typical data subject to local sources of variation are similar to every other month of the year. Figure 35 suggests that typical, day to day PM_{10} concentrations exposures for the month of June and September are highest among all months. The sample of February 28, 2012, clearly exceeds the typical data at this site.

3.2 Wind Speed Correlations

Wind speeds in southeast Colorado increased early in the morning February 28, 2012 and stayed elevated throughout the day, gusting to speeds in excess of 50 mph. The following chart, Figure 36, displays wind speed (mph) as a function of date from the Lamar Airport (KLAA) for a number of days before and after the event.

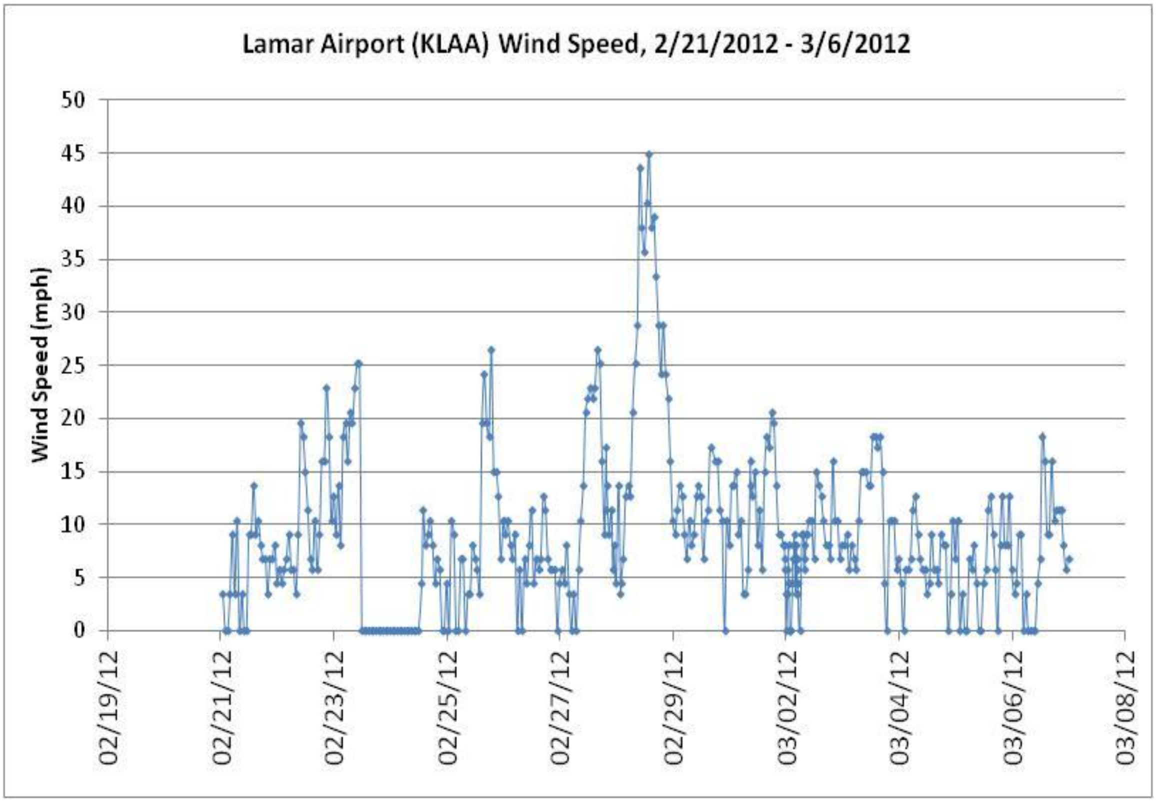


Figure 36: Wind Speed (mph) Lamar, CO, 02/16/2012 – 03/02/2012

Figure 37 plots PM_{10} concentrations from the affected sites in Lamar for the period for seven days prior to and following the sample(s) of February 28, 2012.

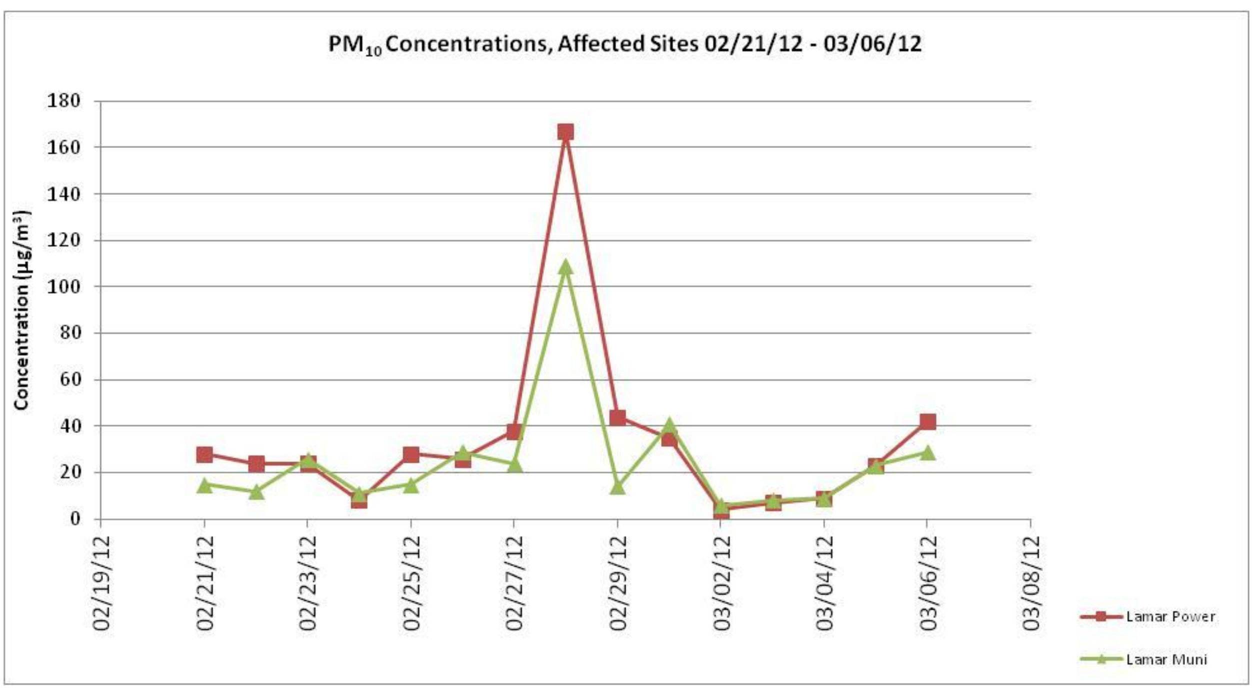


Figure 37: PM_{10} Concentrations, Affected Sites, 02/21/2012 – 03/06/2012

Figure 37 mimics the plots for wind speed, suggesting an association between the regional high winds and PM_{10} concentrations at the samplers in Lamar. Although both samples were affected to differing degrees by the high winds the elevated concentrations are clearly associated with the elevated wind speeds. Given the spatial dislocation of the sites the relationship between the two data sets would suggest that the regional high winds had an effect on PM_{10} samples in Lamar on February 28, 2012.

3.3 Percentiles

Monthly percentile plots in Figure 38 demonstrate a high degree of association between monthly median values and relatively high monthly percentile values, e.g. the Pearson's r value between the monthly 90th percentile value at Lamar Power and the monthly median is 0.34. As the percentile value decreases (i.e. 85%, 75%, etc) the correlation between those values and the monthly median values increases sharply.

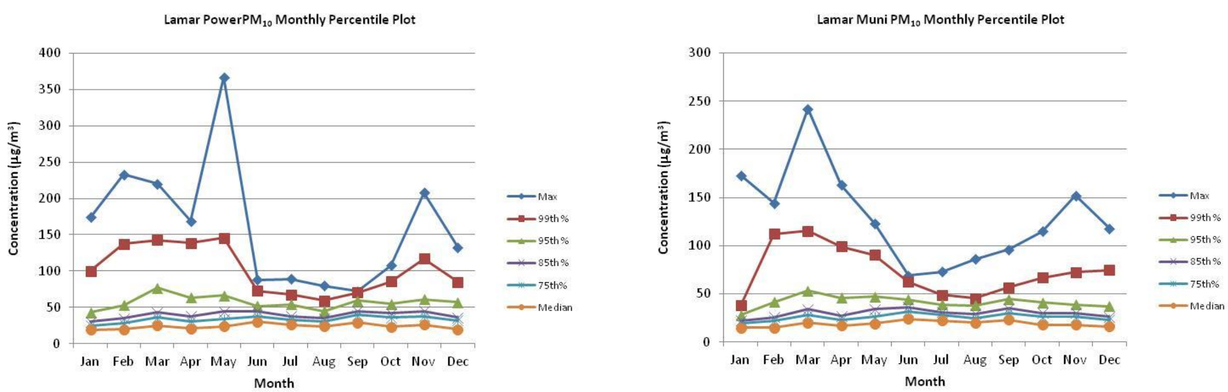


Figure 38: Monthly PM_{10} Percentile Plots

It is certainly the case that monthly median values are indicative of typical, day to day concentrations. Additionally, there is a range of samples that are a product of normal variation subject to typical, day to day local effects. This range may be restricted to percentile values that are well correlated with the median. For the data set of concern, Lamar Power, a robust estimate of the percentile value that is reflective of typical, day to day variation is the 75th percentile value. Nearly all of the variation (r = 0.84) in the monthly 75th percentile values of the Lamar Power data set can be explained by the variation in the monthly median. A less robust but more conservative estimate of the contribution to the event from local sources for these data sets may be the monthly 85th percentile value; the correlation between the Lamar Power monthly median value and the 85th percentile value is r = 0.78. For both estimates of local contribution (the 75th and 85^{h} percentile value) the portion of the sample concentration greater than these monthly percentile values would be the sample contribution due to the event; using both we can estimate a concentration range, from robust to conservative, due to the event.

Table 19 identifies various percentile values that are representative of the maximum contribution due to local sources for Lamar Power from all February data. In Table 19, the range estimate in the 'Est. Conc. Above Typical' column is derived using the difference between the actual sample value and the 85^{h} percentile as the minimum (conservative) event contribution estimate and the difference between the actual sample value and the 75th percentile as the maximum (robust) event contribution estimate.

Table 19: Estimated Maximum Event PM_{10} Contribution - Lamar Power

Site	Event Day Concentration (µg/m^3)	February Median (µg/m^3)	February Average (µg/m^3)	February 75th % (mg/m3)	February 90th % (mg/m3)	Est. Conc. Above Typical (µg/m^3)
Lamar Power	167	20	25.5	28	35	**132 – 139**

Clearly, there would have been no exceedance on February 28, 2012, but for the additional contribution to the PM_{10} sample provided by the event.

4.0 News and Credible Evidence

High Winds Maul Main Street

Russ Baldwin | Feb 29, 2012 | Comments 0

The weatherman was on target with his call for strong winds in southeastern Colorado Tuesday, February 28. Winds in excess of 50mph were whipping up the usual tumbleweeds, but some business signs and businesses along Main Street in Lamar didn't fare very well.

The Car Palace on North Main Street lost a four foot by four foot window. Owner Bill Wootten said, "The window just started buckling under the wind pressure until it reached its breaking point, and then shattered all over the floor." An identical window only several feet away, also on the west side of the building snapped from it's bottom support, and was blown almost horizontal to the ground, held in place by just a couple of bolts in the framework. It was secured in place by a couple of 2 by 4's hammered into the framework. A top window also cracked under the wind pressure and will have to be replaced. No one was injured by the broken glass.

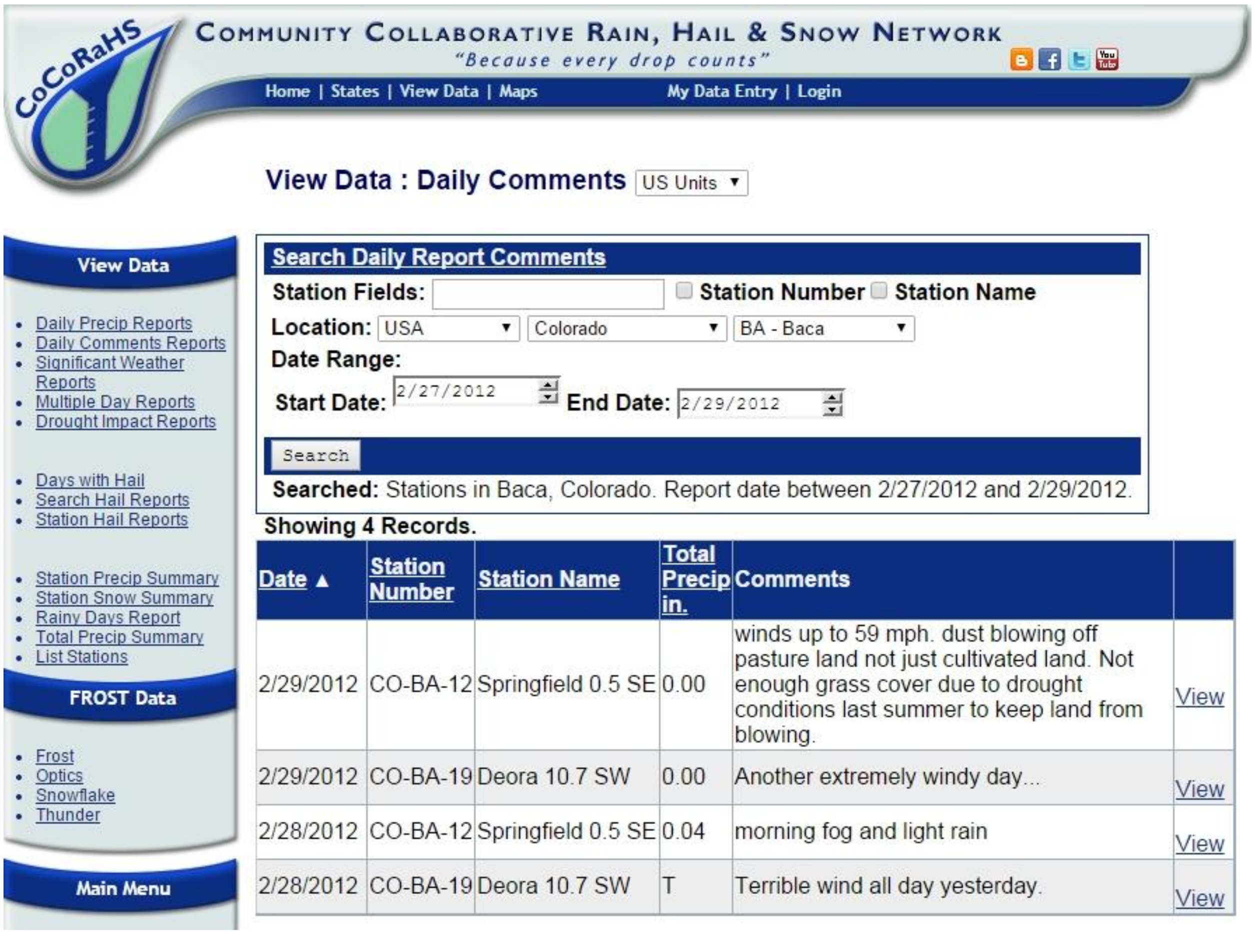
Just next door, the winds cracked the southern facing Subway sandwich shop sign and just up the road, the Roadway sign on the Cow Palace Inn marquee was starting to tear at its edges. The bookstore on south Main Street also had its sign damaged.

There was the usual jumble and tumble of empty or near empty dumpsters rolling around the streets and alleyways until homeowners were able to put them into place once the winds had died down. A number of homeowners around the town were taking a headcount of lost or broken roof shingles that will have to be replaced.

Photo by Russ Baldwin

By Russ Baldwin

Retrieved from: http://theprowersjournal.com/2012/02/high-winds-maul-main-street/



Community Collaborative Rain, Hail & Snow Network

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Start Date: 2/27/2012 **End Date:** 2/29/2012

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Searched: Stations in Baca, Colorado. Report date between 2/27/2012 and 2/29/2012.

Showing 4 Records.

Date ▲	Station Number	Station Name	Total Precip in.	Comments	
2/29/2012	CO-BA-12	Springfield 0.5 SE	0.00	winds up to 59 mph. dust blowing off pasture land not just cultivated land. Not enough grass cover due to drought conditions last summer to keep land from blowing.	View
2/29/2012	CO-BA-19	Deora 10.7 SW	0.00	Another extremely windy day...	View
2/28/2012	CO-BA-12	Springfield 0.5 SE	0.04	morning fog and light rain	View
2/28/2012	CO-BA-19	Deora 10.7 SW	T	Terrible wind all day yesterday.	View

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Station Fields: Station Number Station Name

Location: USA Colorado KW - Kiowa

Date Range:

Start Date: 2/27/2012 **End Date:** 2/29/2012

Search

Searched: Stations in Kiowa, Colorado. Report date between 2/27/2012 and 2/29/2012.

Showing 8 Records.

Date ▲	Station Number	Station Name	Total Precip in.	Comments	
2/29/2012	CO-KW-27	Sheridan Lake 0.2 SE	0.00	Wind-LOL! :)	View
2/29/2012	CO-KW-4	Eads .45 E	0.00	Damaging wind	View
2/29/2012	CO-KW-25	Sheridan Lake 4.2 E	0.00	Winds reaches average measured speed of 34 MPH with a Gust Measured at 40 MPH Wind striped bark off dead tree blew medium objects around. Gust blew a Lawn tractor trailer tumbling across yard.	View
2/29/2012	CO-KW-26	Eads 0.3 NE	0.00	All=0.00	View

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FROST Data

- Frost
- Optics

Search Daily Report Comments

Station Fields: Station Number Station Name

Location: USA Colorado CH - Cheyenne

Date Range:

Start Date: 2/27/2012 **End Date:** 2/29/2012

Search

Searched: Stations in Cheyenne, Colorado. Report date between 2/27/2012 and 2/29/2012.

Showing 3 Records.

Date ▲	Station Number	Station Name	Total Precip in.	Comments	
2/29/2012	CO-CH-28	Cheyenne Wells 1.6 N	0.00	27°, 27% humidity, clear skies, west wind	View
2/28/2012	CO-CH-28	Cheyenne Wells 1.6 N	T	43°, 94% humidity, cloudy & hazy, strong south wind	View
2/27/2012	CO-CH-28	Cheyenne Wells 1.6 N	0.00	25°, 23% humidity, clear skies, south wind	View

Retrieved from: http://www.cocorahs.org/ViewData/ListDailyComments.aspx

5.0 Not Reasonably Controllable or Preventable: Local Particulate Matter Control Measures

While it is likely that some dust was generated within the local communities as gusts from the regional dust storm passed through the area, the amount of dust generated locally was easily overwhelmed by, and largely unnoticeable as compared to the dust transported in from northeast New Mexico and southeast Colorado. The following sections will describe in detail the regulations and programs in place designed to control PM_{10} in the affected community. These sections will demonstrate that the event was not reasonably controllable, as laid out in Section 50.1(j) of Title 40 CFR 50, within the context of reasonable local particulate matter control measures. As shown from the meteorological and monitoring analyses (Sections 2 and 3), the source region for the associated dust that occurred during the February 28, 2012 event originated outside of the monitored areas, primarily from the desert regions of northeast New Mexico, and southeast Colorado.

The APCD conducted thorough analyses and outreach with local governments to confirm that no unusual anthropogenic PM_{10}-producing activities occurred in these areas and that despite reasonable control measures in place, high wind conditions overwhelmed all reasonably available controls. The following subsections describe in detail Best Available Control Measures (BACM), other reasonable control measures, applicable federal, state, and local regulations, appropriate land use management, and an in-depth analysis of potential areas of local soil disturbance for each affected community during the February 28, 2012, event. This information confirms that no unusual anthropogenic actions occurred in the local area of Lamar during this time.

5.1 Regulatory Measures - State

The APCDs regulations on PM_{10} emissions are summarized in Table 20.

Table 20: State Regulations Regulating Particulate Matter Emissions

Rule/Ordinance	Description
Colorado Department of Public Health and Environment Regulation 1- Emission Control For Particulate Matter, Smoke, Carbon Monoxide, And Sulfur Oxides	Applicable sections include but are not limited to: Everyone who manages a source or activity that is subject to controlling fugitive particulate emissions must employ such control measures and operating procedures through the use of all available practical methods which are technologically feasible and economically reasonable and which reduce, prevent and control emissions so as to facilitate the achievement of the maximum practical degree of air purity in every portion of the State. Section III.D.1.a) Anyone clearing or leveling of land greater than five acres in attainment areas or one acre in non-attainment areas from which fugitive particulate emissions will be emitted are required to use all available and practical methods which are

	technologically feasible and economically reasonable in order to minimize fugitive particulate emissions.(Section III.D.2.b) Control measures or operational procedures for fugitive particulate emissions to be employed may include planting vegetation cover, providing synthetic cover, watering, chemical stabilization, furrows, compacting, minimizing disturbed area in the winter, wind breaks and other methods or techniques approved by the APCD. (Section III.D.2.b) Any owner or operator responsible for the construction or maintenance of any existing or new unpaved roadway which has vehicle traffic exceeding 200 vehicles per day in the attainment/maintenance area and surrounding areas must stabilize the roadway in order to minimize fugitive dust emissions (Section III.D.2.a.(i))
Colorado Department of Public Health and Environment Regulation 3- Stationary Source Permitting and Air Pollutant Emission Notice Requirements	Construction Permit required if a land development project exceeds 25 acres and spans longer than 6 months in duration (Section II.D.1.j) All sources with uncontrolled actual PM_{10} emissions equal to or exceeding five (5) tons per year, must obtain a permit. The new source review provisions require all new and modified major stationary sources in non-attainment areas to apply emission control equipment that achieves the "lowest achievable emission rate" and to obtain emission offsets from other stationary sources of PM_{10}.
Colorado Department of Public Health and Environment Regulation 4- New Wood Stoves and the Use of Certain Woodburning Appliances During High Pollution Days	Regulates wood stoves, conventional fireplaces and woodburning on high pollution days. Prohibits the sale and installation a wood-burning stove in Colorado unless it has been tested, certified, and labeled for emission performance in accordance with criteria and procedures specified in the Federal Regulations and meets emission standards. (Section II) Section III regulates pellet stoves. Section IV regulates masonry heaters. Section VII limits the use of stoves on high pollution days.
Colorado Department of Public Health and Environment Regulation 6- Standards of	Implements federal standards of performance for new stationary sources including ones that have particulate matter emissions. (Section I)

Performance for New Stationary Sources	
Colorado Department of Public Health and Environment Regulation 9- Open Burning, Prescribed Fire, and Permitting	Prohibits open burning throughout the state unless a permit has been obtained from the appropriate air pollution control authority. In granting or denying any such permit, the authority will base its action on the potential contribution to air pollution in the area, climatic conditions on the day or days of such burning, and the authority's satisfaction that there is no practical alternate method for the disposal of the material to be burned. Among other permit conditions, the authority granting the permit may impose conditions on wind speed at the time of the burn to minimize smoke impacts on smoke-sensitive areas. (Section III)
Colorado Department of Public Health and Environment- Common Provisions Regulation	Applies to all emissions sources in Colorado When emissions generated from sources in Colorado cross the state boundary line, such emissions shall not cause the air quality standards of the receiving state to be exceeded, provided reciprocal action is taken by the receiving state. (Section II A)
Federal Motor Vehicle Emission Control Program	The federal motor vehicle emission control program has reduced PM_{10} emissions through a continuing process of requiring diesel engine manufacturers to produce new vehicles that meet tighter and tighter emission standards. As older, higher emitting diesel vehicles are replaced with newer vehicles; the PM_{10} emissions in areas will be reduced.

5.2 Lamar Regulatory Measures and Other Programs

Natural Events Action Plan (NEAP)

In response to exceedances of the PM_{10} NAAQS (two in 1995 and one in 1996), the APCD, in conjunction with the City of Lamar's Public Works Department, Parks and Recreation, and Prowers County Commissioners, the Natural Resources Conservation Services, the Burlington Northern Santa Fe Railroad, and other agencies developed a Natural Events Action Plan. That Plan was presented to EPA in 1998 and subsequently approved. Since 1998, it is this plan that has assisted the area in addressing blowing dust due to uncontrollable winds.

The NEAP for High Wind Events in Lamar, Colorado was updated in 2003 and again in 2012. The NEAP addresses public education programs, public notification and health advisory programs, and determines and implements Best Available Control Measures (BACM) for anthropogenic sources of windblown dust in the Lamar area. The City of Lamar, Prowers County, the APCD, and participating federal agencies worked diligently to identify contributing sources and to develop appropriate BACM as required by the Natural Events Policy.

Please refer to the Final NEAPs for Lamar, available at
http://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=LamarNaturalEventsActionPlan2003.pdf and
http://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=LamarNaturalEventsActionPlan2012.pdf for more detail if needed.

Control Measures from the December 2012 Maintenance Plan

Control of Emissions from Stationary Sources
Although there are few stationary sources located in the Lamar attainment/maintenance area, the State's comprehensive permit rules listed in Table 20 will limit emissions from any new source that may, in the future, locate in the area.

The EPA approval of the original PM_{10} Maintenance Plan, effective on 11/25/2005, reinstates the prevention of significant deterioration (PSD) permitting requirements in the Lamar Attainment/Maintenance area. The federal PSD requirements apply to new or modified major stationary sources which must utilize "best available control technology" (BACT).

Federal Motor Vehicle Emission Control Program (FMVECP)
The FMVECP has reduced PM_{10} emissions through a continuing process of requiring diesel engine manufacturers to produce new vehicles that meet tighter and tighter emission standards. As older, higher emitting diesel vehicles are replaced with newer vehicles through fleet turnover; tailpipe PM_{10} emissions in the Lamar area will be further reduced.

Voluntary and State-Only Measures
Additional activities in Lamar that result in the reduction of PM_{10} emissions include:

- The City of Lamar has historically cleaned their streets in town throughout the winter and spring using street sweepers. The frequency of this voluntary effort is determined by weather. As of October 2013, the Public Works Director informed APCD that the streets are swept on a weekly basis unless there is snow on the streets.
- The City of Lamar and immediately surrounding areas require that new developments have paved streets. As of October 2013, the City's Planning Commission is been working on making this an official city ordinance. In the past, it has been required despite the lack of official rule.

State Implementation Plan Measures
Any owner or operator responsible for the construction or maintenance of any existing or new unpaved roadway which has vehicle traffic exceeding 200 vehicles per day in the Lamar attainment/maintenance area and surrounding areas must stabilize the roadway in order to minimize fugitive dust emissions. These statewide requirements are defined in detail in the AQCC's Regulation No. 1 as listed in Table 20.

City of Lamar

The City of Lamar has been very proactive in addressing potential PM10 sources within the Lamar area including the application of grass turf at baseball fields, implementing and enhancing a street sweeping program, and chip-seal paving of many unpaved roads. The City of Lamar - Public Works Department has implemented the following BACM controls within the area:

1. *Wind Break*

Beginning in the spring of 1997, a wind break of trees was planted north of the Power Plant monitoring site (080990001). The Russian Olive tree wind break is located approximately one half mile north of the Power Plant monitoring site and will block potential contributing blowing dust sources such as the Lamar Transfer Station and other unpaved equipment traffic areas to the north. The Russian Olive is a quick growing large shrub/small tree that thrives despite the semi-arid and windy climate of Lamar. As of October 2013, the Public Works Director states that most of the trees are still alive and in place. According to section 3.5.2.1 of EPA guidance entitled "*Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures*", dated September 1992, one-row of trees is considered an effective windbreak.

In addition to the plantation of tree wind breaks, a drip irrigation system has been installed to promote sustained tree growth. As of October 2013, the Public Works Director states that the drip system is still operational but due to the drought the City has been on strict water restrictions.

2. *Landfill Controls*

The East Lamar Landfill is located approximately six (6) miles east of the city limits. The landfill has a CDPHE Permit (#09PR1379) which specifies that visible emissions shall not exceed twenty percent (20%) opacity during normal operation of the source and that fugitive PM_{10} cannot exceed 5.77 tons per year. The permit also contains a Particulate Emissions Control Plan that states that:

- No off-property transport of visible emissions shall apply to on-site haul roads.
- There shall be no off-property transport of visible emissions from haul trucks.
- All unpaved roads and other disturbed surface areas on site shall be watered as often as needed to control fugitive particulate emissions.
- Surface area disturbed shall be minimized.
- Exposed land areas to be undisturbed for more than six months shall be revegetated.

According to section 3.5.1 of the "Operations and Closure Plan for the East Lamar Landfill", the Director of the Public Works Department and/or the landfill operator is required to do the following litter control measures under high wind conditions:

- Soil cover is required to be placed on the working face of the landfill daily during periods of wind in excess of 30 mph; and,
- The landfill must be closed down when sustained winds reach 35 mph or greater.

An on-site wind gauge monitors wind speed at the landfill. Operators have radios in their equipment connecting them with the main office so that when the decision to close the landfill is made, it can take place immediately. According to the Director of Public Works, landfill operators have been directed to close the landfill at their discretion. Because trash debris (paper) begins to lift and blow into the debris fences at wind speeds of 25 to 30 mph, the operator usually closes the landfill prior to wind speeds reaching 30 mph. The City of Lamar has agreed to make the closure of the Lamar landfill mandatory when wind speeds reach 30 mph, which reduces windblown dust from the landfill as earth moving activities are reduced or eliminated during periods of shut down. As of October 2013, the Public Works Director states that all of these practices are still enforced.

In addition, the placement of chain link fencing and various debris fences have been added to the previous litter entrapment cage. These additional fences better minimize the release of materials during high wind conditions. The Public Works Director states that this is a dynamic process; as the debris moves, the fences are moved too.

3. *Vegetative Cover/Sod*

The Lamar Recreation Department installed 100,000 square feet of turf sod at a recreational open space called Escondido Park in the early 2000s. Escondido Park is located in northwest Lamar at 11th and Logan Streets. A sprinkler system has also been installed by the Parks and Recreation Department. The sod provides a vegetative cover for the open area. This dense turf cover provides an effective control against windblown soil from the open area of the park.

In addition, the Lamar Public Works Department stabilizes the entrance road leading to and from Escondido Park with chemical soil stabilizer and chip-seal to reduce dirt tracked out onto city streets and minimize additional releases of PM_{10}. This is done on an as needed basis.

4. *Additional Public Works Projects*

The Public Works Department implemented the following projects to further reduce emissions of PM_{10}:

- The purchase of a TYMCO regenerative air street sweeper (May 2001) which is much more effective in reducing dust during street sweeping activities. The use of this sweeper allows for improved cleaning of the streets (e.g., sweeps the gutter and street);
- The fencing of an area around the City Shop at 103 North Second Street in 2011 to reduce vehicle traffic that may be responsible for lifting dust off of the dirt area between the railroad tracks and the Shop;
- The stabilization of a large dirt and mud hole in 2008on the north side of the City Shop by installing a curb and gutter that allows for better drainage. This project is credited with keeping mud from being tracked out into the street and becoming airborne by vehicular traffic;
- The ongoing commitment to search for other stabilization projects that benefit the community and improve area air quality, and;
- The relocation of the Municipal Tree Dump in the early 2000s (formerly located in the northeastern corner of the city) to approximately six miles east of the city (now housed at the Municipal Landfill). This relocation eliminates a major source of smoke from agricultural burns that may have previously affected the community.

Regulatory Measures - City

Lamar has an ordinance that requires that all off-street parking lots shall have a dust-free surface to control PM_{10} emissions (City of Lamar Charter and Code, ARTICLE XVII, Sec. 16-17-60).

Burlington-Northern/Santa Fe Rail Line

The rail line running east-west of the Lamar Power Plant monitoring site was deemed to be an important PM10 source during conditions of high winds and low precipitation. Ground disturbance from vehicle traffic, which damages vegetation and breaks-up the hard soil surfaces, resulted in re-entrainment of dust from traffic, high winds or passing trains. This area is problematic in the two block area immediately west of the Power Plant monitoring site as shown in Figure 40 as Site M. Control of this open area requires a close working agreement between the Burlington-Northern/Santa Fe Railroad Company (BNSF) and the City of Lamar Public Works Department. The purpose of this BACM is to reduce the amount of particulate matter susceptible to wind erosion under high wind conditions and general re-entrainment of dust in the ambient air as a result of local train traffic passing in close proximity of the PM10 monitor.

In September 1997, the City chemically stabilized exposed lands north of the rail line between Fourth and Second Street where there was evidence of vehicle traffic. All other lands on either side of the rail road tracks between Main Street (Fifth) and Second Street and extending westward have either natural, undisturbed ground cover or it is used for commercial/recreation purposes that do not allow for significant re-entrainment (BNSF is responsible for maintaining 50 feet of property on either side of the main track). Most of these lands are leased by the City. After September 1997, the City negotiated the lease of these lands. Once acquired, a long term plan, will be developed for these lands such as restricting vehicle access, permanently stabilizing lands with vegetation and gravel, increasing park and recreational use, and using the lands for city maintenance and storage activities. As of October 2013, the Public Works Director stated that gravel has been periodically added to minimize blowing dust.

According to the Manager of Environmental Operations for BNSF, the railroad company owns the main rail line and 200 feet on either side of the track. Much of this property has been sold or leased under private contracts. At this time BNSF is responsible only for the main rail line and for 50 feet of property on either side of the main track. All property sold or under contract is not the responsibility of BNSF. As a result, BNSF has stabilized the railroad corridor 50 feet on either side of the main rail line.

In May 1997, BNSF placed chips (gravel) 50 feet on either side of the main track from Main Street to Second Street (three blocks) to control fugitive dust emissions from this section of the track. Graveling exposed surfaces not exposed to regular vehicle traffic is considered a permanent mitigation measure. Details of this arrangement can be found in the documentation under the 1998 SIP Maintenance Plan submittal.

Prowers County

Prowers County Land Use Plan:

Beginning in 1997, Prowers County with the assistance of local officials, environmental health officers and the general public began preparing a county land use plan. The Prowers County Land Use Plan is designed to have wide-reaching authority over the myriad of land use issues involving building (construction sites), citing, health, fire, environmental codes, and other social concerns associated with the City of Lamar and Prowers County. The county land use plan, entitled “*Guidelines and Regulations for Areas and Activities of State Interest – County of Prowers – State of Colorado*”, was adopted on April 19, 2004 and amended on August 17, 2006. The plan incorporates provisions to minimize airborne dust including re-vegetation of disturbance areas associated with land development. The Prowers County Land Use Master Plan can be found on the County’s website at: http://www.prowerscounty.net.

Regulations and ordinances of the Land Use Plan specific to reducing blowing dust and its impacts include:

- Additional regulations on development of fragile lands and vegetation to protect topsoil;
- Development of performance standards and best management practices to prevent soil erosion;
- Development of best management practices to reduce blowing sands and movement of area sand dunes across the county;
- Development of new special use permits to address the citing of animal feedlots and feed yards;
- Development of special use permits for other future stationary sources. The special use permits will also likely include the requirement for comprehensive fugitive dust control plans for both construction and operation of facilities;
- Consideration and review of enforcement capabilities through the area zoning ordinances, and;
- Planned public review and comment processes following the legal update of the draft County Land Use Plan.

Windblown Dust from Disturbed Soils

The City of Lamar is located in Prowers County in southeastern Colorado. Situated along the Arkansas River and near the Kansas border, Lamar serves as the largest city and the agricultural center for southeast Colorado. The area surrounding Lamar consists of gently rolling to nearly level uplands where the dominant slopes are less than 3 percent. The climate is generally mild and semiarid. Annual precipitation is about 15 inches. Summers are long and have hot days and cool nights. In winter and spring, windstorms are common, especially in drier years. It is due to these high velocity dust storms and drought conditions that Lamar experiences most of the PM_{10} problems for the area.

Figure 39 through Figure 52 illustrate potential areas of local soil disturbance that have been evaluated by the APCD for the Lamar Power Plant PM_{10} monitor (080990001).

Figure 39: Wind Direction relative to the Lamar Power Plant PM_{10} monitor for the February 28, 2012 event (Google Earth Image 2014)

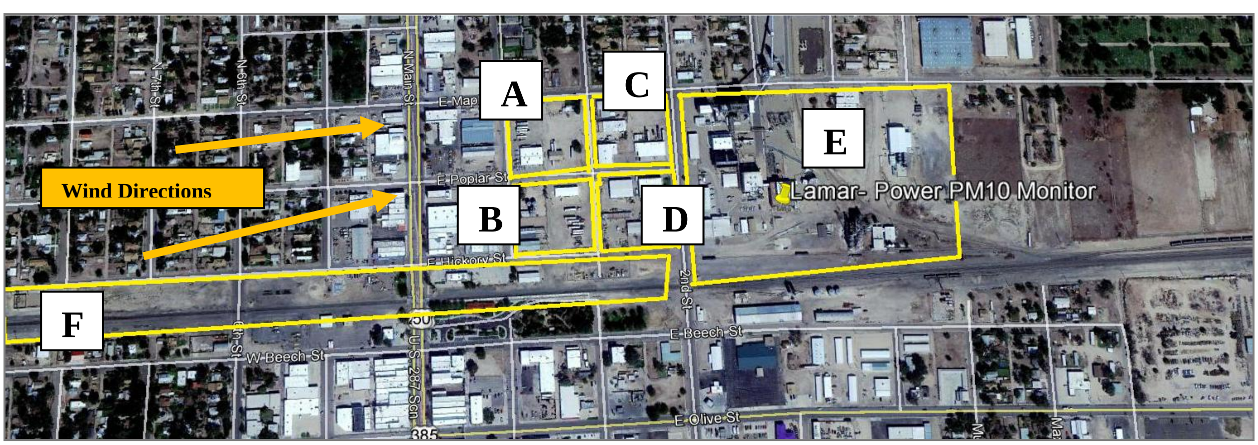

Figure 40: West of the Lamar Power Plant PM_{10} Monitor (Google Earth Image 8-2013)

Site A in Figure 40 is west of the Lamar PM_{10} monitor at 200 N 4th St. The site is owned by "Heath & Turpin Trucking", a company that repairs large trucks and shared with "HVH Transportation Inc", a freight service trucking company. This site consists of well maintained gravel as shown in Figure 41. The APCD considers maintained gravel and limited access to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years, is in an economic recession, and is owned by multiple small businesses to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 41: Site A - Heath & Turpin Trucking (Google Image 2012)

Site B in Figure 40 is west of the Lamar PM_{10} monitor. The site is shared by a few businesses. All businesses have restricted access by fences surrounding the property. "Cowboy Corral Storage" at 102 North 4th St is one of the businesses on the lot. It has a very small gravel parking lot and is no longer in business according to the previous owner as of October 2013. The storage company has a small gravel parking lot with access being restricted by a security fence as shown in Figure 42. The lot is also shared with the "Prowers Area Transit" county bus garage. The bus garage is very small, only four bays. The garage has a concrete slab that runs to the asphalt road to avoid the busses driving on the gravel in order to mitigate fugitive dust. The gravel lot is watered on an as needed basis. The other business is an old feed supply company with grain storage as shown in Figure 43.The feed supply company is out of business and the grain elevators are not being utilized. The APCD considers maintained gravel and limited access to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years, is in an economic recession, and is owned by multiple small businesses to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 42: Site B - Cowboy Corral Storage (Google Image 2012)

Figure 43: Site B - Feed Storage Company (Google Image 2012)

Site C in Figure 40 is west of the Lamar PM_{10} monitor at about 201 N 2^{nd} Street. The gravel parking lot on site is owned by "Heath & Son & Turpin Trucking" and is shown in Figure 44. The lot is used to store trucks when not in use. This site consists of well maintained gravel. The APCD considers maintained gravel and limited access to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years, is in an economic recession, and is owned by multiple small businesses to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 44: Site C - Heath & Son & Turpin Trucking Storage Lot (Google Image 2012)

Site D in Figure 40 is west of the Lamar PM_{10} monitor at about 103 North 2nd Street. It is the "Lamar Water Department". Also on site D is the "Lamar-Prowers County Volunteer Fire Department" at 300 E Poplar Street. Both sites have restricted access with security fences. The City of Lamar maintains their gravel lots by grating and watering them on an as needed basis. The APCD considers maintained gravel. limited access, grating, and watering to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years, is in an economic recession, and is owned by multiple small businesses to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site E in Figure 40 is the power plant that the Lamar PM_{10} monitor is located within at100 North 2nd Street. "Lamar Light and Power" historically operated a natural gas-fired boiler that produced steam for a 25 MW turbine/generator set. This boiler was constructed prior to 1972 and was grandfathered from construction permitting requirements. In the early 2000s, factors such as increasing costs of natural gas made the plant uneconomical to run. As a result, Lamar Light and Power purchased power and ran the natural gas-fired boiler very infrequently or not at all. In February 2006, the APCD issued a permit for Lamar Light and Power to replace the existing natural gas-fired boiler with a coal-fired circulating fluidized bed (CFB) boiler rated at approximately 42 MW. The conversion prompted legal challenges from Lamar residents partnered and WildEarth Guardians, a New Mexico-based environmental group. Lamar Light and Power settled and agreed to shut down the coal-fired power plant. The power plant was shut down on November 11, 2011. The settlement also calls for the plant to stay offline until at least 2022, when the current agreement to supply electricity to Lamar and other communities expires.

"Lamar Light and Power" has an air quality permit (CDPHE # 05PR0027). The permit includes the following point and fugitive dust control measures:

- Limestone and ash handling, processing, and storage are controlled by high efficiency baghouses

- Water wash-down-systems are used for flushing down any accumulated dust on walkways, platforms, and other surfaces to prevent re-entrainment of the dust into the atmosphere.
- On-site haul roads are paved, and these surfaces are inspected at least once each day in which hauling activities occur, and cleaned as needed. Various cleaning methods are used depending on the extent of dust accumulations. These activities emit less than 1 ton per year of PM_{10} and are APEN Exempt.
- All transport vehicles containing substances that potentially generate fugitive particulate matter emissions (such as trucks containing limestone, inert material, or ash) are fully enclosed, or covered with a mechanical closing lid or a tight tarp-like cover at all times while on the facility grounds except during loading / unloading operations.
- Emissions from emergency coal stockpile are effectively controlled with a water dust suppression system.

Access to the power plant is restricted by security fences. The APCD considers the enforceable conditions of the permit, including identified Best Available Control Technology (BACT) for limestone and ash handling, paving, wash-down systems, and enclosures, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site. The winds speeds on February 28, 2012 did exceed the blowing dust thresholds of 30 mph or greater and gusts of 40 mph or greater at which the APCD expects stable surfaces (i.e., controlled anthropogenic and undisturbed natural surfaces) to be overwhelmed (wind speeds were as high as 51 mph with wind gusts up to 70 mph).

Site F in Figure 40 is the Burlington Northern Santa Fe railroad that runs past the Lamar PM_{10} monitor to the south. On either side of the rail road tracks is gravel as shown in Figure 45. In May 1997, Burlington Northern Santa Fe placed chips (gravel) 50 feet on either side of the main track from Main Street to Second Street (three blocks) to control fugitive dust emissions from this section of the track. Graveling exposed surfaces not exposed to regular vehicle traffic is considered a permanent mitigation measure. Also, all the train tracks are raised up on 3 inch diameter rock and tracks. Areas that are not used by the railroad are allowed to be naturally vegetated with Xeriscape. With regard to AQCC Regulation 1 requirements (Section III.D), the APCD considers gravel and 'Xeriscape' vegetation to be the appropriate available and practical method that is technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this type of source.

Figure 45: Site F - Railroad tracks with gravel on each side (Google Image 2012)

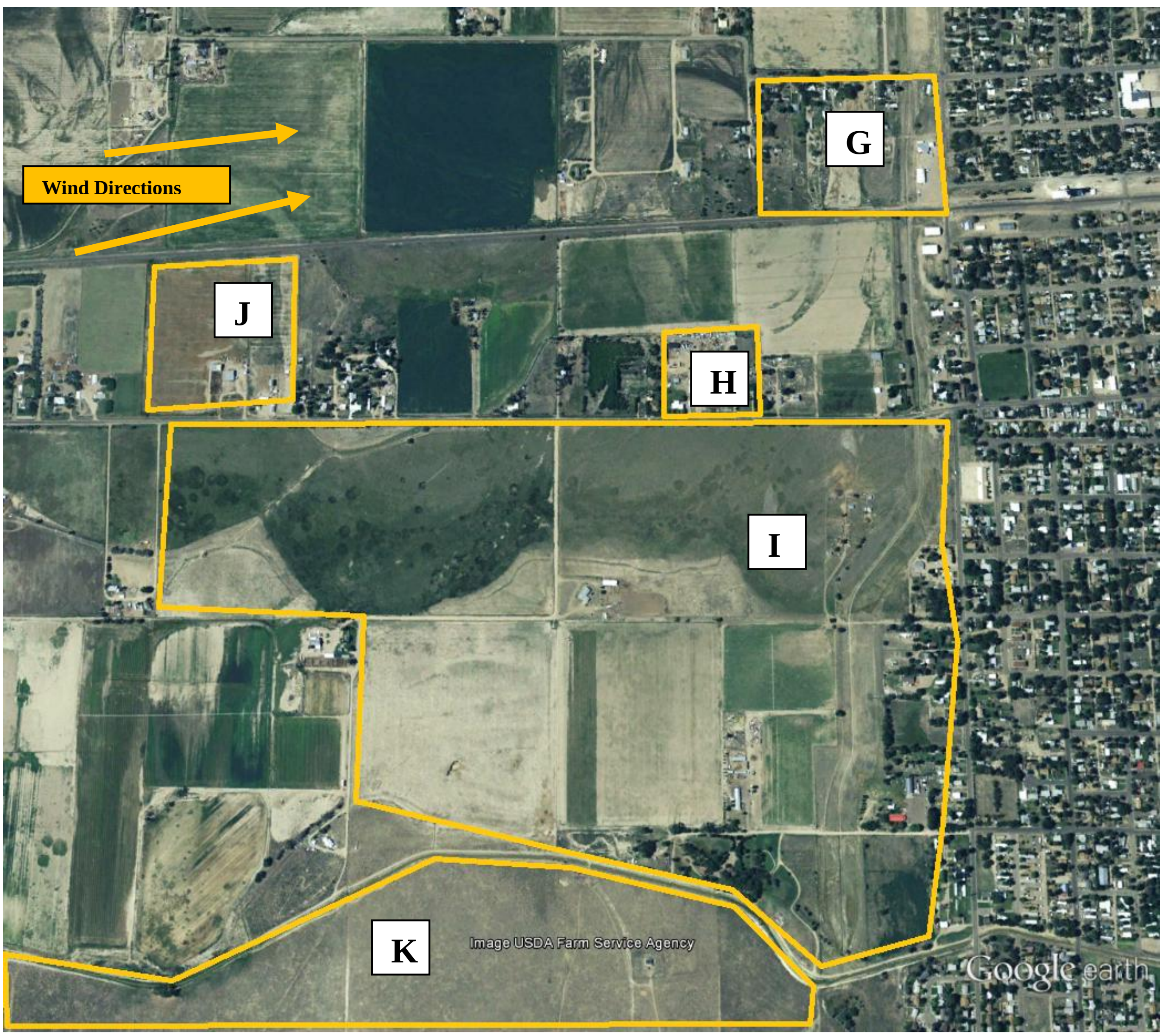

Figure 46: Further West of the Lamar Power Plant PM_{10} Monitor (Google Earth Image 8-2012)

Site G in Figure 46 is a residential area to the west of the Lamar PM_{10} monitor bordered County Road HH on the north and S. 13th St. on the west. This area is mainly in Prowers County; however the eastern portion has dense natural vegetation and is a floodway owned by the City. Most of the area is vegetated with restricted access as shown in Figure 47. With regard to AQCC Regulation 1 requirements (Section III.D), the APCD considers undisturbed, natural vegetation to be the appropriate available and practical method that is technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this type of source.

Figure 47: Site G - Vegetated, residential land (Google Image 8/2012)

Site H in Figure 46 is a metal recycling, welding, and custom fabrication business located at about 6673 County Road HH. "Out West Equipment CO INC" and "Lamar Scrap and Salvage" own the land. This small three (3) acre lot is mostly gravel. The owner does water the site on an as needed basis to protect assets and mitigate fugitive dust. Site H has reasonable dust control measures in place with regard to AQCC Regulation 1 requirements (Section III.D.1(a)). The APCD considers restricted maintained gravel and watering to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site I in Figure 46 is naturally vegetated, undisturbed land as shown in Figure 48 and Figure 49. There are a few residential homes on the land but it is mostly natural. With regard to AQCC Regulation 1 requirements (Section III.D), the APCD considers undisturbed, natural vegetation to be the appropriate available and practical method that is technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this type of source.

Figure 48: Site I - Undisturbed land-aerial view (Google Image August 2011)

Figure 49: Site I - Undisturbed land-ground view (Google Image August 2012)

Site J in Figure 46 is restricted access property located just north of County Road HH and slightly east of County Road 6.2. The land is naturally vegetated and undisturbed as shown in Figure 50. With regard to AQCC Regulation 1 requirements (Section III.D), the APCD considers undisturbed, natural vegetation to be the appropriate available and practical method that is technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this type of source.

Figure 50: Site J - Restricted access, naturally vegetated land (Google Image Aug 2012)

Site K in Figure 46 is restricted access property located just south of County Road 6.5 and Fort Bent Canal. The land is naturally vegetated and undisturbed as shown in Figure 51. With regard to AQCC Regulation 1 requirements (Section III.D), the APCD considers undisturbed, natural vegetation to be the appropriate available and practical method that is technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this type of source.

Figure 51: Site K - Restricted access, naturally vegetated land (Google Image Aug 2012)

Figure 52: 5 miles West of Lamar - "Carder Inc"- 32625 County Rd 3.75 Lamar, CO (Google Earth 2012)

Site L in Figure 52 is "Carder Inc" at 32625 County Rd 3.75 (about 5 miles west of Lamar). Carder Inc mines this site, known as the Hard Scrabble Pit, for sand and gravel primarily for road construction. This site has a permit from CDPHE (#99PR0179F) and emits about 8 tons per year of PM_{10}. This is a wet mining operation so it produces minimal fugitive dust. The dust control measures that are part of the permit include watering the disturbed area as needed, re-vegetation within one year of disturbance, compacting of piles, mining moist materials, vehicles cannot exceed 10 mph on site at all times, and temporary roads are covered with gravel and watered as needed. The APCD considers the enforceable conditions of the permit, including identified continuous controls such as gravel roads with miles per hour restrictions, compaction, re-vegetation, watering, and extraction limitation, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site. The winds speeds on February 28, 2012, did exceed the blowing dust thresholds of 30 mph or greater and gusts of 40 mph or greater at which the APCD expects stable surfaces (i.e., controlled anthropogenic and undisturbed natural surfaces) to be overwhelmed (wind speeds were as high as 51 mph with wind gusts up to 70 mph). .

The APCD conducted thorough assessments to determine if the potential soil disturbances shown in Figure 39 through Figure 52 were present during the 2012 exceedances in Lamar. During the course of these assessments, the APCD discovered that these sites were either reasonably controlled or considered to be natural sources during the February 28, 2012, high wind event. Therefore, these sites were not significant contributors to fugitive dust in the Lamar area during the February 28, 2012, high wind event.

Colorado State University CO-OP Extension Office

While the following initiatives are not meant to be enforceable, the CSU Co-Op Extension Office has many efforts underway that further reduce blowing dust and its impacts. These include:

- Crop residue efforts that encourage no- or low-till practices. These have been deemed appropriate and useful in reducing blowing dust.
- Ongoing outreach efforts to educate area agricultural producers on soil management programs. These include one-on-one visitations and annual meetings with various corn and wheat programs to discuss crop management.
- Drought workshops to protect topsoil throughout the county.

USDA: Natural Resources Conservation Service (NRCS)

1. *Conservation Reserve Program*

Prowers County is a predominately agricultural area that is made up of 1,053,037acres of land area – 1,037,336 acres (or 92.7%) of which is land in farms.[2] For comparison, Baca County to the south is 78.4% land in farms, Bent County to the west is 88.9% land in farms, and Kiowa County to the north is 83.8% land in farms. It should be noted that cropland percentage in Bent County is lower than other Southeast Colorado counties at 21%. Figure 53 illustrates the counties of Southeast Colorado. Of the farm land acreage in Prowers County, cropland accounts for over half of the total (552,476 acres) and is approximately 53% of the total land in the county. Water, and often the lack of it, coupled with the frequent high winds experienced during late fall and early spring commonly destroy crops, encourage pests, and damage soil surfaces lending them susceptible to wind erosion, especially in recent drought

[2] 2007 Census of Agriculture. Vol. 1: Geographic Area Series, Part 6 Colorado State & County Data. U.S. Dept. Of Commerce: Bureau of Census.

years. Prowers County has been in a severe drought for almost three years, and entered an extreme drought in 2013. In 2011, most of Prowers County cropland acreage is farmed using dryland practices (versus irrigated) and consists of soils classified as highly-erodible-land (HEL) by the Department of Agriculture.

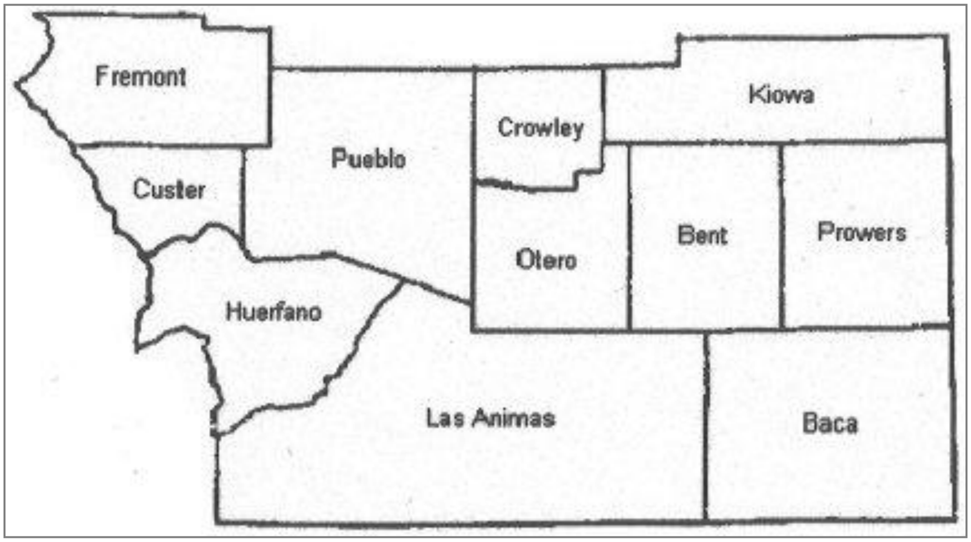

Figure 53: Southeast Colorado Counties

Recognizing the problems associated with erodible land and other environmental-sensitive cropland, the U.S. Department of Agriculture (USDA) included conservation provisions in the Farm Bill. This legislation created the Conservation Reserve Program (CRP) to address these concerns through conservation practices aimed at reducing soil erosion and improving water quality and wildlife habitat.

The CRP encourages farmers to enter into contracts with USDA to place erodible cropland and other environmentally-sensitive land into long-term conservation practices for 10-15 years. In exchange, landowners receive annual rental payments for the land and cost-share assistance for establishing those practices.

The CRP has been highly successful in Prowers County by placing approximately 156,195 acres of Prowers County cropland, or 27% of total cropland, under contract. Most of this land has been planted with a perennial grass cover to protect the soil and retain its moisture. Strong support of the program by Prowers County farmers continues as 38% of the counties HEL cropland has been offered for conservation practices. Prowers County employs NRCS practices at approximately 1.6 times the rate of the surrounding nine-county Southeast Colorado area (including Bent, Kiowa, Baca, Crowley, Otero, Las Animas, Cheyenne, Lincoln, and Prowers) as of 2011.

While the following initiatives are not meant to be enforceable, many efforts are underway that further reduce blowing dust and its impacts. These include:

- The CRP has moved to include all available area lands into area contracts. These contracts are good through 2007. Success of the CRP initiatives is measured through ongoing monitoring of the contracts to ensure ample grass coverage to minimize blowing dust.

- CRP sends out information several times per year through radio and the area newspaper to further reach farmers interested in topsoil protection.

- In response to the significant Colorado drought (2011-2013) the NRCS and FSA are working with multiple parties in extensive annual planning efforts to limit blowing dust and its impacts. These planning efforts change year to year depending on the severity of the drought.

2. *Limestone-Graveyard Creeks Watershed Project*

A watershed improvement project is currently underway in the Limestone-Graveyard Creeks Watershed. This project covers approximately 60,000 acres of land north of the Arkansas River between Hasty (Bent County) and Lamar. An estimated 44,500 acres of the watershed area are classified as priority land due to the highly erodible nature of the soil. Over 2,000 acres of agricultural cropland northwest of Lamar are included in this watershed project. As of 2013, NRCS informed the APCD that this project is approximately 99% complete.

Working with the NRCS, each farmer will create their own conservation plan with costs for improvements split equally between farmers and the federal government. The 15-year project will help reduce soil erosion and improve water quality and efficiency through conservation tillage practices and/or other conservation efforts. In short, the Limestone-Graveyard Creeks Watershed Project will help to reduce soil erosion and lower the impacts of blowing soils during future high wind events.

More recently (since the 1998 NEAP submittal), the Watershed project has been evaluated and is seen as an ongoing successful program as most eligible acres are signed up.

3. *New Initiatives*

While the following initiatives are not meant to be enforceable, the Natural Resources Conservation Service has many efforts underway that further reduce blowing dust and its impacts. These include:

- A comprehensive rangeland management program;
- Tree planting program;
- Drip irrigation purchase program, and;
- A multi-party drought response planning effort coordinated through the State of Colorado Governor's office.
- In 2013, NRCS also tried a proactive approach to drought management by offering producers incentives to mitigate erosion hazard areas before they became an erosion problem.

These are but a few of the efforts at the local, county, and regional level underway to reduce emissions of PM_{10} and limit impacts.

6.0 Summary and Conclusions

APCD is requesting concurrence on exclusion of the exceedance PM_{10} value from Lamar Power (08-099-0001) on February 28, 2012.

An elevated 24-hour PM_{10} concentration was recorded in Lamar, Colorado on February 28, 2012. The noted February 28, 2012, twenty-four-hour PM_{10} concentration was above the 90^{th} percentile concentration for the location (see Table 19). This event produced the 2^{nd} largest sample recorded among all February samples from 2007 through 2012, was the 3^{rd} largest sample of all 2012 data, and was greater than the 99^{th} percentile value (104 $\mu g/m^3$) for the entire dataset. The statistical and meteorological data clearly shows that but for this high wind blowing dust event, Lamar would not have exceeded the 24-hour NAAQS on February 28, 2012. Since at least 2005, there has not been an exceedance that was not associated with high winds carrying PM_{10} dust from distant sources in these areas. This is evidence that the event was associated with a measured concentration in excess of normal historical fluctuations including background.

The PM_{10} exceedance in Lamar on February 28, 2012, would not have occurred if not for the following: (a) dry soil conditions over northeast New Mexico and southeast Colorado with 30-day precipitation totals below the threshold identified as a precondition for blowing dust in southeast Colorado and northeast New Mexico; (b) an intense low pressure system and associated upper level trough that caused strong west to southwest winds over the area of concern; and (c) friction velocities over regions of northeastern New Mexico and southeastern Colorado that were high enough to allow entrainment of dust from natural sources with subsequent transport of the dust to southern Colorado in strong winds.

Surface weather maps show evidence of widespread blowing dust and winds above the threshold speeds for blowing dust on February 28, 2012. The combination of an intense low pressure system and associated upper level trough with strong west to southwest winds caused regional surface winds over 40 mph with gusts exceeding 50 mph for several hours. These speeds are above the thresholds for blowing dust identified in EPA draft guidance and in detailed analyses completed by the State of Colorado *(*see Blowing Dust Climatologies available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2). Specifically, these high values were the consequence of high winds from an intensifying low pressure system and associated upper level trough in combination with dry conditions which caused significant blowing dust across northeast New Mexico and southern Colorado. These PM_{10} exceedances were due to an exceptional event associated with regional windstorm-caused emissions from erodible soil sources over a large area of northeast New Mexico and southern and eastern Colorado. These sources are not reasonably controllable during a significant windstorm under abnormally dry or moderate drought conditions.

The blowing dust climatology for Lamar (see Blowing Dust Climatologies available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2) indicates that the area can be susceptible to blowing dust when winds are high. . Landform imagery shows that northeastern Arizona and southeastern Utah in particular have experienced a long-term pattern of wind erosion and blowing dust when winds have been southwesterly and blowing into Colorado. Forecast products from the Navy Aerosol Analysis and Prediction System model provide evidence for a widespread blowing dust event, suggesting that significant source regions for dust in Colorado were located in arid regions of Arizona, New Mexico and Colorado. NOAA HYSPLIT forward and backward trajectories provide clear supporting evidence that dust from arid regions of northeastern New Mexico and southeastern Colorado caused the PM_{10} exceedances measured across portions of southern and southeastern Colorado on February 28, 2012. Soils in southeast Colorado and northeast New Mexico were dry enough to produce blowing dust when winds were above the thresholds for blowing dust.

Both wind speeds and soil moisture in northeast New Mexico and southeastern Colorado were conducive to the generation of significant blowing dust. Multiple sources of data for the event in question and analyses of past dust storms in this area prove that this was a natural event and, more specifically, a significant natural dust storm originating in northeastern New Mexico, and southeastern Colorado. But for the dust storm on February 28, 2012, this exceedance would not have occurred.

Friction velocities provide a measure of the near-surface meteorological conditions necessary to cause blowing dust. Friction velocities across a wide area of northeast New Mexico and southern and eastern Colorado were above 1.0 meters per second on February 28, 2012. Even undisturbed desert soils normally resistant to wind erosion will be susceptible to blowing dust when friction velocities are greater than about 1.0 to 2.0 meters per second. Note that blowing dust will typically only occur where these values are high and the soils are dry and not protected by vegetation, forest cover, boulders, rocks, etc. This is why blowing dust occurred in the desert and more arid sections of northeast New Mexico and southeastern Colorado on February 28, 2012. These elevated friction velocities (shown in Figure 30 and Figure 31) and the data on soil moisture conditions presented elsewhere in this report, and the prevalence of winds above blowing dust thresholds (all occurring in traditional source regions in northeastern New Mexico and southeastern Colorado) prove that this dust storm was a natural event that was not reasonably controllable or preventable.

GASP satellite and webcam imagery reveal that a dust storm was taking place in southeast Colorado on February 28, 2012. This is consistent with the climatology for many dust storms in Colorado as described in the Lamar, Colorado, Blowing Dust Climatology report contained in Appendix A, found at the end of this document. The observations of winds above blowing dust thresholds and restricted visibilities in the areas of concern demonstrate that this is a natural event that cannot be reasonably controlled or prevented.

As demonstrated in Section 3 and particularly in Table 17, the PM_{10} exceedance in Lamar on February 28, 2012, would not have occurred “but for” the large regional dust storm on February 28, 2012.

7.0 References

Draxler, R.R. and G.D. Rolph. 2012. *HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) Model access via NOAA ARL READY Website (http://ready.arl.noaa.gov/HYSPLIT.php)*. NOAA Air Resources Laboratory, Silver Spring, MD.

Marticorena, B., G. Bergametti, D. Gillette, and J. Belnap. 1997. Factors controlling threshold friction velocity in semiarid and arid areas of the United States, *Journal of Geophysical Research 102 D19*, 23,277-23, 287.

United States Environmental Protection Agency, June 2012. *Draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule*.

Appendix A

Weather Advisories and Text Products
Blowing Dust Event
February 28, 2012

464
WWUS75 KPUB 281053
NPWPUB

URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE PUEBLO CO
353 AM MST TUE FEB 28 2012

COZ086>089-093-094-097>099-281700-
/O.UPG.KPUB.HW.A.0003.120228T1800Z-120229T0100Z/
/O.NEW.KPUB.HW.W.0006.120228T1800Z-120229T0100Z/
PUEBLO AND VICINITY/PUEBLO COUNTY BELOW 6300 FT-
WALSENBURG VICINITY/UPPER HUERFANO RIVER BASIN BELOW 7500 FT-
TRINIDAD VICINITY/WESTERN LAS ANIMAS COUNTY BELOW 7500 FT-
CROWLEY COUNTY-LA JUNTA VICINITY/OTERO COUNTY-
EASTERN LAS ANIMAS COUNTY-LAS ANIMAS VICINITY/BENT COUNTY-
LAMAR VICINITY/PROWERS COUNTY-SPRINGFIELD VICINITY/BACA COUNTY-
INCLUDING...PUEBLO...WALSENBURG...TRINIDAD...ORDWAY...
OLNEY SPRINGS...LA JUNTA...ROCKY FORD...BRANSON...KIM...
LAS ANIMAS...LAMAR...SPRINGFIELD...WALSH
353 AM MST TUE FEB 28 2012

...HIGH WIND WARNING IN EFFECT FROM 11 AM THIS MORNING TO 6 PM
MST THIS EVENING...

THE NATIONAL WEATHER SERVICE IN PUEBLO HAS ISSUED A HIGH WIND
WARNING...WHICH IS IN EFFECT FROM 11 AM THIS MORNING TO 6 PM MST
THIS EVENING. THE HIGH WIND WATCH IS NO LONGER IN EFFECT.

* LOCATION...PUEBLO...HUERFANO...LAS ANIMAS...CROWLEY...OTERO...
  BENT...PROWERS AND BACA COUNTIES.

* TIMING...STRONG WESTERLY WINDS ARE EXPECTED TO DEVELOP OVER THE
  WATCH AREA BY LATE THIS MORNING. THE STRONGEST WINDS ARE
  ANTICIPATED BY TUESDAY AFTERNOON.

* WIND...WEST AT 35 TO 45 MPH WITH WIND GUSTS OF 55 TO 65 MPH AT
  TIMES.

* IMPACT...POSSIBLE PROPERTY DAMAGE...ESPECIALLY TO MOBILE HOMES
  AND CONSTRUCTION PROJECTS. DRIVERS...ESPECIALLY OF HIGH
  PROFILE VEHICLES...WILL BE VULNERABLE TO THE THREAT OF STRONG
  CROSS WINDS. OTHER POTENTIAL IMPACTS MAY INCLUDE POWER
  OUTAGES...TREE DAMAGE...FLYING DEBRIS AND BLOWING DUST.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

HIGH WINDS CAPABLE OF CAUSING POWER OUTAGES AND PROPERTY DAMAGE
ARE EXPECTED.

THESE WINDS CAN CAUSE LIGHTWEIGHT OBJECTS TO BECOME DANGEROUS AIRBORNE PROJECTILES. HIGH PROFILE VEHICLES AND VEHICLES PULLING TRAILERS CAN BE FLIPPED BY CROSSWINDS. BLOWING DUST CAN QUICKLY REDUCE VISIBILITY TO NEAR ZERO...RESULTING IN HAZARDOUS DRIVING CONDITIONS AND ACCIDENTS INVOLVING MOTORISTS TAKEN BY SURPRISE. BLOWING DUST OR SAND CAN ALSO BE A HEALTH HAZARD FOR THOSE WITH RESPIRATORY PROBLEMS. SECURE LIGHTWEIGHT OBJECTS. AVOID TRAVELING ON ROADS WITH CROSSWINDS.

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SR

398
NWUS55 KPUB 290027
LSRPUB

PRELIMINARY LOCAL STORM REPORT...SUMMARY
NATIONAL WEATHER SERVICE PUEBLO CO
526 PM MST TUE FEB 28 2012

```
..TIME...   ...EVENT...      ...CITY LOCATION...     ...LAT.LON...
..DATE...   ....MAG....      ..COUNTY LOCATION..ST.. ...SOURCE....
            ..REMARKS..

0430 PM     NON-TSTM WND GST 4 NE PUEBLO             38.31N 104.56W
02/28/2012  M72.00 MPH       PUEBLO            CO   BROADCAST MEDIA

            GUST REPORT FROM WEATHER STATION NEAR CSU PUEBLO RELAYED
            BY BROADCAST MEDIA.

0328 PM     NON-TSTM WND DMG WALSENBURG              37.63N 104.78W
02/28/2012                   HUERFANO          CO   PUBLIC

            THREE 18 WHEELERS HAVE BEEN BLOWN OVER BY THE STRONG
            WINDS ALONG I-25 BETWEEN WALSENBURG AND PUEBLO, CO. TIME
            OF WHEN THESE EVENTS OCCURRED IS UNKNOWN.

0258 PM     NON-TSTM WND GST 9 N BEULAH              38.21N 104.98W
02/28/2012  M66.00 MPH       PUEBLO            CO   MESONET

            MEASURED BY RED CREEK RAWS.

0257 PM     NON-TSTM WND GST 1 W COLORADO CITY       37.94N 104.86W
02/28/2012  M65.00 MPH       PUEBLO            CO   MESONET

            MEASURED BY COLORADO CITY RAWS.
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0232 PM NON-TSTM WND GST 4 S AIR FORCE ACADEMY 38.92N 104.86W
02/28/2012 M58.00 MPH EL PASO CO MESONET

MEASURED BY MESONET C5171

0224 PM NON-TSTM WND GST 3 ESE HOEHNE 37.26N 104.34W
02/28/2012 M67.00 MPH LAS ANIMAS CO ASOS

KTAD ASOS

0157 PM NON-TSTM WND GST 3 NNW COLORADO CITY 37.98N 104.87W
02/28/2012 M60.00 MPH PUEBLO CO MESONET

AT MESONET STATION D2845.

0154 PM NON-TSTM WND GST 3 ESE HOEHNE 37.26N 104.34W
02/28/2012 M58.00 MPH LAS ANIMAS CO ASOS

KTAD ASOS

0150 PM NON-TSTM WND GST 6 S COLORADO CITY 37.86N 104.85W
02/28/2012 M69.00 MPH HUERFANO CO MESONET

I-25 AT APACHE CITY CDOT SENSOR.

0141 PM NON-TSTM WND GST 5 NNE LA JUNTA 38.05N 103.51W
02/28/2012 M63.00 MPH OTERO CO ASOS

0130 PM NON-TSTM WND GST 6 S COLORADO CITY 37.86N 104.85W
02/28/2012 M64.00 MPH HUERFANO CO AWOS

CO029 CDOT WIND SENSOR

0127 PM NON-TSTM WND GST 4 W LAMAR 38.07N 102.69W
02/28/2012 M61.00 MPH PROWERS CO ASOS

1145 AM NON-TSTM WND GST 1 SW MANZANOLA 38.10N 103.88W
02/28/2012 M59.00 MPH OTERO CO MESONET

D0505 MESONET STATION.

1125 AM NON-TSTM WND GST 5 NNE LA JUNTA 38.05N 103.51W
02/28/2012 M60.00 MPH OTERO CO ASOS

1055 AM NON-TSTM WND GST 4 N SPRINGFIELD 37.46N 102.62W
02/28/2012 M63.00 MPH BACA CO MESONET

K8V7

1024 AM NON-TSTM WND DMG 5 N LA JUNTA 38.05N 103.54W
02/28/2012 OTERO CO TRAINED SPOTTER

POWER POLES DOWN

1013 AM NON-TSTM WND GST 5 NNE LA JUNTA 38.05N 103.51W
02/28/2012 M59.00 MPH OTERO CO ASOS

0951 AM NON-TSTM WND GST 23 S LAMAR 37.75N 102.62W
02/28/2012 M58.00 MPH PROWERS CO MESONET

GOBBLERS KNOB CDOT SENSOR.

0948 AM HEAVY SNOW 4 SW SOUTH FORK 37.63N 106.67W
02/28/2012 M24.0 INCH RIO GRANDE CO TRAINED SPOTTER

DRIFTS 2 TO 4 FEET. SNOW STILL OCCURRING. SNOW BEGAN AROUND SUNSET YESTERDAY

0822 AM SNOW 10 SW CREEDE 37.75N 107.06W
02/28/2012 M14.0 INCH MINERAL CO TRAINED SPOTTER

0745 AM SNOW 4 WNW BUENA VISTA 38.86N 106.20W
02/28/2012 M1.5 INCH CHAFFEE CO TRAINED SPOTTER

OVERNIGHT. STILL SNOWING.

0735 AM SNOW 1 SSE WOLF CREEK PASS 37.47N 106.79W
02/28/2012 M13.0 INCH MINERAL CO TRAINED SPOTTER

0719 AM NON-TSTM WND GST 16 WSW WALSENBURG 37.54N 105.05W
02/28/2012 M65.00 MPH HUERFANO CO MESONET

D8514 MESONET STATION.

0634 AM SNOW 2 W SOUTH FORK 37.67N 106.65W
02/28/2012 M10.0 INCH RIO GRANDE CO TRAINED SPOTTER

OVERNIGHT ACCUMULATION. STILL SNOWING.

&&

KT

CDPHE Air Quality Advisory

Denver Metro/Front Range:
Issued: 2/28/2012 2:46:00 PM
Residential Burning Unrestricted - No Action Day
Effective: 2/28/2012 4:00:00 PM - 2/29/2012 4:00:00 PM
Adequate winds and mixing tonight and Wednesday should keep air quality in the Good-to-Moderate range through the period.

Other Areas:
Blowing Dust Advisory for southeastern Colorado until 8 PM Tuesday February 28. Strong gusty winds and areas of blowing dust will continue to cause elevated particulate concentrations in many areas of southeastern Colorado until around 8 PM. Areas affected include Pueblo, La Junta, Lamar, Springfield, Kit Carson, and other nearby locations. If visibility is less than 10 miles across a wide area, people with heart or lung disease, older adults and children should reduce prolonged or heavy exertion.

Tuesday, February 28, 2012

DESCRIPTIVE TEXT NARRATIVE FOR SMOKE/DUST OBSERVED IN SATELLITE IMAGERY THROUGH 1800Z February 28, 2012

Southwestern US/Southern Plains/Northern Mexico:
Multiple areas of sand/dust are blowing east NE across a large section of central/eastern New Mexico, western Texas, Oklahoma/Texas Panhandles, southeast Colorado and southwest Kansas. The largest area of sand/dust seen is coming from the White Sands region in south-central New Mexico. A few areas in Northern Mexico just south of the New Mexico border are blowing sand/dust into southeast New Mexico and into western Texas. The windy conditions causing the blowing sand/dust are associated with a front moving through the Colorado/New Mexico region.

Otherwise, a large area of cloudiness covers most of the central US, southeast, the Rockies and moving into the Pacific Northwest.

J Kibler

Tuesday, February 28, 2012

DESCRIPTIVE TEXT NARRATIVE FOR SMOKE/DUST OBSERVED IN SATELLITE IMAGERY THROUGH 2345Z February 28, 2012

Southwestern US/Southern Plains/Northern Mexico:
A developing potent and large storm system in the Central Plains is bringing very strong winds, in excess of 50mph in some areas, that have whipped up a broad area of significant blowing dust. The dust is being

generated over multiple areas from northern Chihuahua, eastern New Mexico, western Texas and the Texas Panhandle, southeast Colorado, the Oklahoma Panhandle and western Kansas. This large mass of dust is moving to the east and northeast with the leading edge reaching southeast Nebraska, central Kansas, central Oklahoma and roughly a Wichita Falls/Abilene line by sunset.

An area of light aerosol, believed to be long range trans Pacific dust based on the Navy Aerosol Analysis and Prediction System forecast, was seen over southern California, southern Arizona, northern Baja and Sonora and extending into adjacent areas of the Pacific.

Cuba/Bahamas:
Numerous fires on Cuba were producing modest smoke plumes that were mainly light density and moving to the west across the southeast Gulf of Mexico and northern Caribbean. A fire on Abaco Island in the northern Bahamas was generating a smoke plume that extended to the west and was moving toward West Palm Beach.

New Jersey:
Numerous fires over central New Jersey were generating light smoke plumes that were moving to the east and off the coast into the Atlantic.

Ruminski

Wednesday, February 29, 2012

DESCRIPTIVE TEXT NARRATIVE FOR SMOKE/DUST OBSERVED IN SATELLITE IMAGERY THROUGH 1630Z February 29, 2012

Southern/Central Plains/Mississippi Valley/Ohio and Tennessee Valley/Great Lakes:
A large area of dust stretching from New Mexico to Indiana is moving rapidly east across the Central US. Dust spreads across central/eastern New Mexico, northern Texas, most of Oklahoma, central/eastern Kansas, southern Iowa, most of Missouri and into most of Illinois and Indiana. The heaviest band of dust extends through northern Texas, central Oklahoma, southeast Kansas, central Missouri and Illinois and into northern Indiana.
Another area of dust, but minor in nature to the above is moving out of eastern Colorado/New Mexico and into western Kansas and the Oklahoma/Texas Panhandle.

J Kibler