Technical Support Document For the March 18, 2012, Alamosa and Lamar Exceptional Event

COLORADO

Department of Public Health & Environment

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

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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 On May 2, 2011, in an attempt to clarify this rule, EPA released draft guidance documents on the implementation of the EER to State, tribal and local air agencies for review.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 March 18, 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EPA's June 2012, Draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule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 in the San Luis Valley of south-central Colorado and the plains of southeast Colorado.

On March 18 of 2012, a powerful late winter storm system caused multiple exceedances of the twenty-four hour PM_{10} standard in Alamosa and Lamar, Colorado. Exceedances were recorded in Alamosa at the Adams State College monitor with a concentration of 324 $\mu g/m^3$ and the Alamosa Municipal Building monitor with a concentration of 237 $\mu g/m^3$. Approximately 180 miles to the east in Lamar, an exceedance of the PM_{10} standard occurred at the Lamar Municipal Building monitor with a reading of 242 $\mu g/m^3$ and the Lamar Power Plant monitor at 220 $\mu g/m^3$.

The exceedances in Alamosa and Lamar were the result of intense surface winds in advance of an approaching cold front. These surface features were associated with a strong upper-level trough that was moving across the western United States. The surface winds were predominantly out of a south to southwesterly direction and moved over erodible dry soils in New Mexico and southern Colorado producing significant blowing dust. This storm system

[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.

transported PM_{10} dust into the southern and southeastern portions of Colorado. These sources are not reasonably controllable during a significant windstorm under abnormally dry or moderate drought conditions.

APCD is requesting concurrence on exclusion of the PM_{10} values from Alamosa – Adams State College (08-003-0001), Alamosa – Municipal Building (08-003-0003), Lamar – Power Plant (08-099-0001) and Lamar – Municipal Building (08-099-0002) on March 18, 2012.

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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 eastern Colorado advising citizens of the potential for high wind/dust events on March 18, 2012. This area includes: the Denver metro area, Greeley, Fort Collins, Limon, Ft Morgan, Sterling, Colorado Springs, Pueblo, and Lamar. The advisories that were issued on March 18, 2012 can be viewed at: http://www.colorado.gov/airquality/forecast_archive.aspx?seeddate=03%2f18%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 March 18, 2012, four sample values greater than 150 µg/m^3 were taken at multiple sites across southern Colorado during the high wind event that occurred that day. These were the monitors located in Alamosa at Adams State College (SLAMS) and the Municipal building (SLAMS), and in Lamar at the Municipal building (SLAMS) and at the Power monitor (SLAMS). All of these monitors are operated by APCD in partnership with local operators.

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 March 18, 2012, Blowing Dust Event and PM_{10} Exceedance – Conceptual Model and Wind Statistics

On March 18 of 2012, a powerful late winter storm system caused multiple exceedances of the twenty-four hour PM_{10} standard in Alamosa and Lamar, Colorado (Figure 1). Exceedances were recorded in Alamosa at the Adams State College monitor with a concentration of 324 $\mu g/m^3$ and the Alamosa Municipal Building monitor with a concentration of 237 $\mu g/m^3$. Approximately 180 miles to the east in Lamar, an exceedance of the PM_{10} standard occurred at the Lamar Municipal Building monitor with a reading of 242 $\mu g/m^3$ and the Lamar Power Plant monitor at 220 $\mu g/m^3$ The elevated readings and the location of each of the monitors are plotted on the maps of the Greater Alamosa and Lamar areas in Figure 2 and Figure 3, respectively. The exceedances in Alamosa and Lamar were the result of intense surface winds in advance of an approaching cold front. These surface features were associated with a strong upper-level trough that was moving across the western United States. The surface winds were predominantly out of a south to southwesterly direction and moved over dry soils in New Mexico and southern Colorado producing significant blowing dust.

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 New Mexico and southern Colorado.

Figure 1: Locations of Alamosa and Lamar, Colorado.

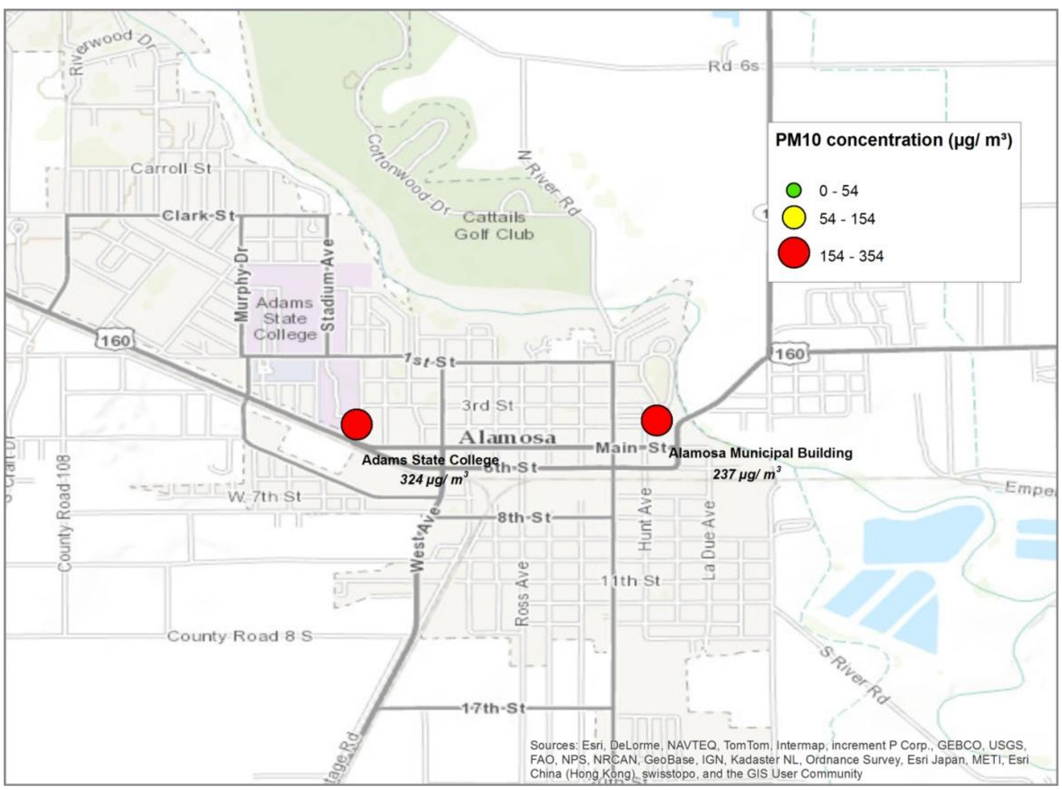


Figure 2: 24-hour PM_{10} concentrations for Alamosa monitors, March 18, 2012. (Source: http://webapps.datafed.net/datafed.aspx?dataset=AQS_D&parameter=pm10)

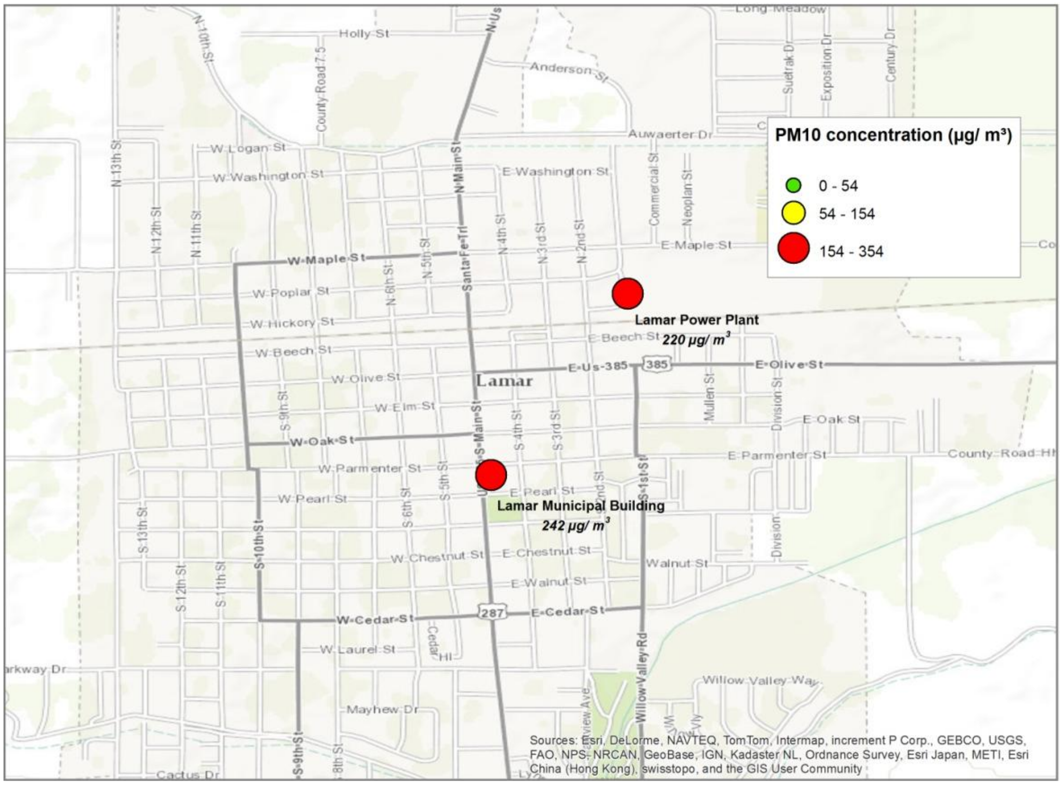


Figure 3: 24-hour PM10 concentrations for Lamar monitors, March 18, 2012.
(Source: http://webapps.datafed.net/datafed.aspx?dataset=AQS_D&parameter=pm10)

The surface weather associated with the storm system of March 18, 2012, is presented in Figure 4 through Figure 7; the surface analyses for 11 AM, 2 PM, 5 PM and 8 PM MST, respectively. Significant surface features during this period of time included a cold front that swept across Colorado. This front was associated with a strong area of surface low pressure that was slowly moving northward through northwestern Wyoming.

In addition, the upper level trough with this storm system aided in producing very strong winds at the surface. Figure 8 and Figure 9 show the 700 mb height analysis maps for 5 AM MST and 5 PM MST March 18, 2012, respectively while Figure 10 and Figure 11 display the 500 mb charts for the same time intervals. The 700 mb level is roughly 3 kilometers above mean sea level (MSL) and the 500 mb level is generally located approximately 6 kilometers above MSL. These four charts show that a deep trough of low pressure aloft was present before and during the blowing dust event of March 18, 2012 and that it was moving over the southwestern United States.

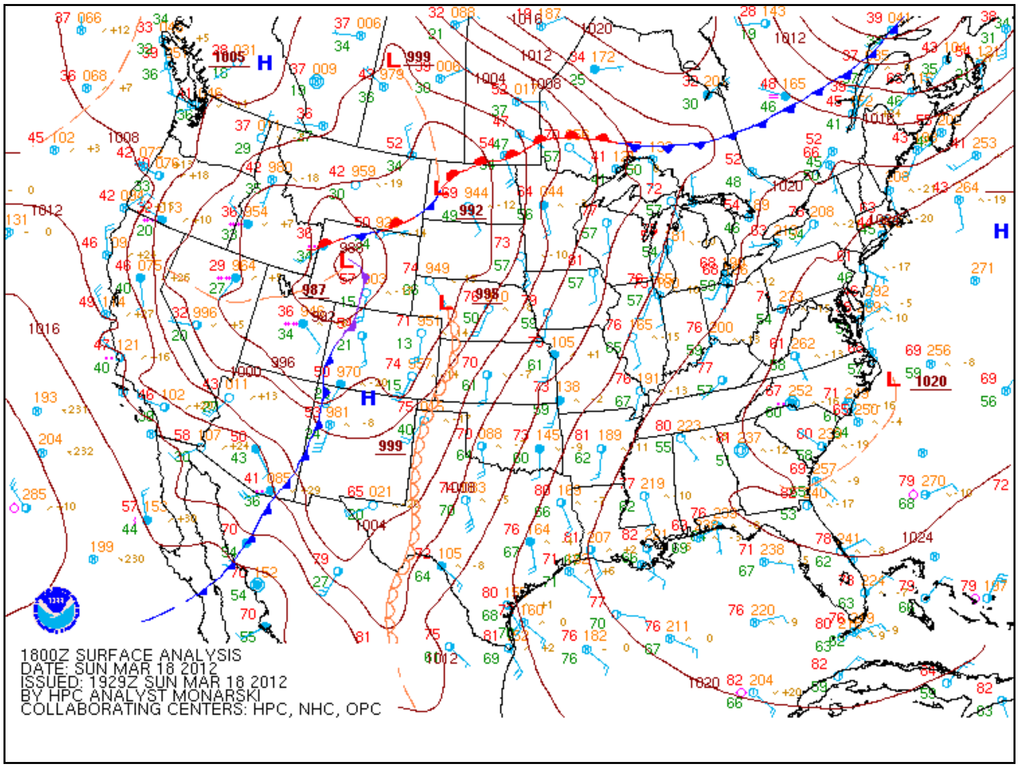


Figure 4: Surface Analysis for 18Z March 18, 2012, or 11 AM MST March 18, 2012. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

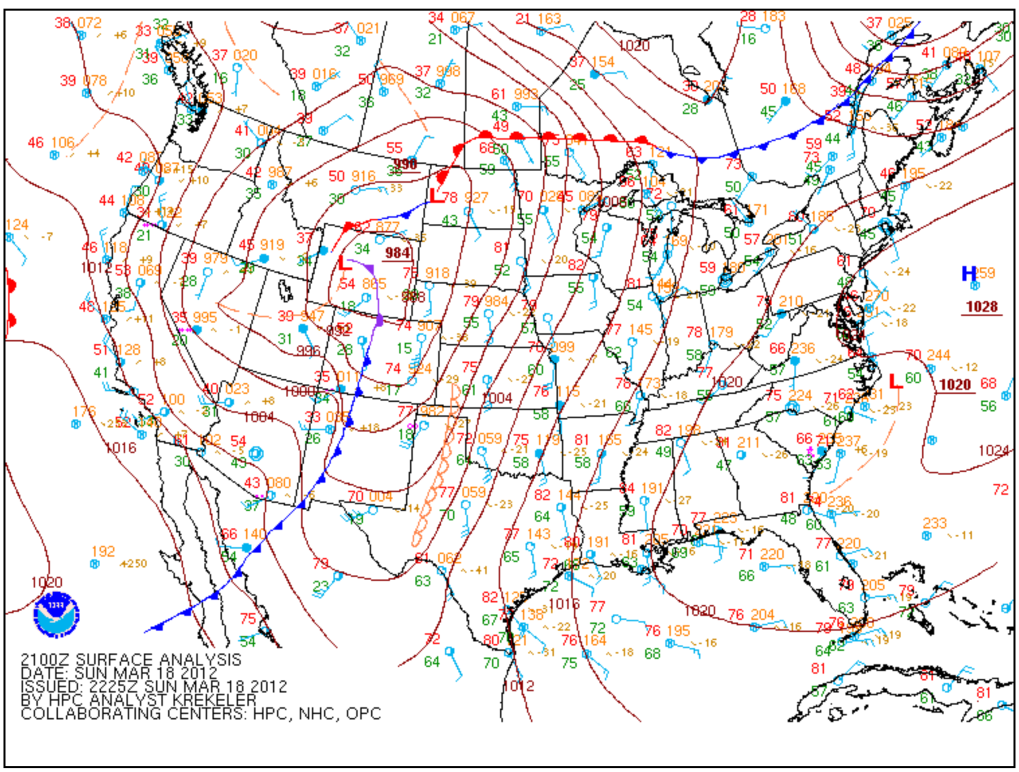


Figure 5: Surface Analysis for 21Z March 18, 2012, or 2 PM MST March 18, 2012. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

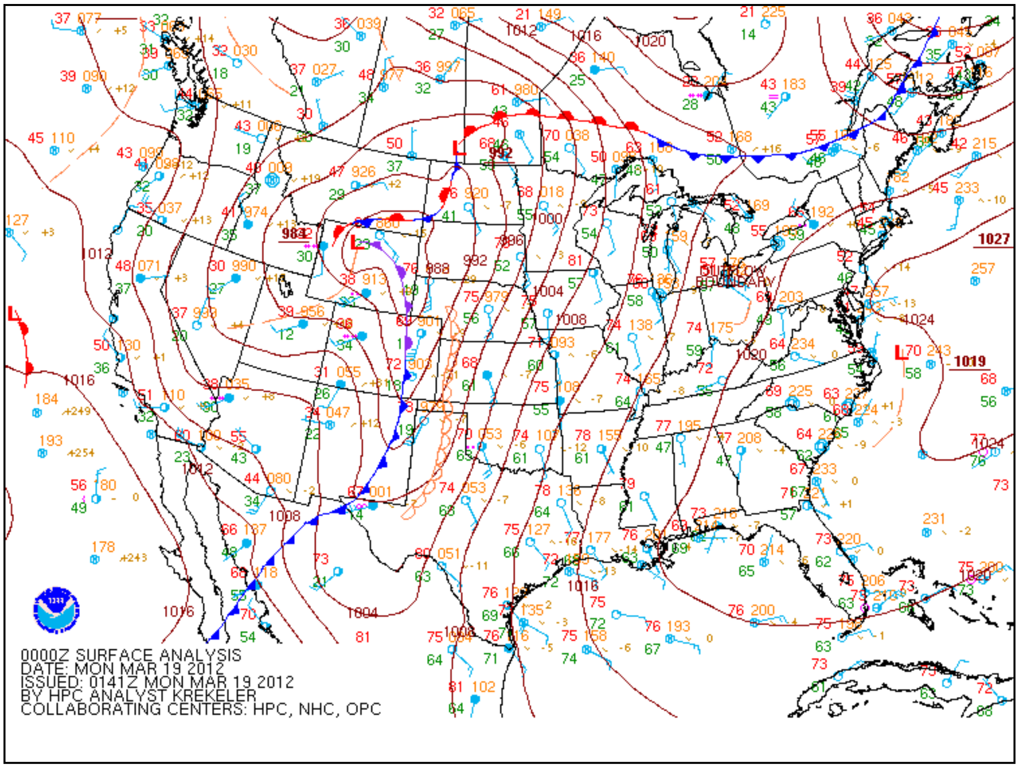


Figure 6: Surface Analysis for 00Z March 19, 2012, or 5 PM MST March 18, 2012. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

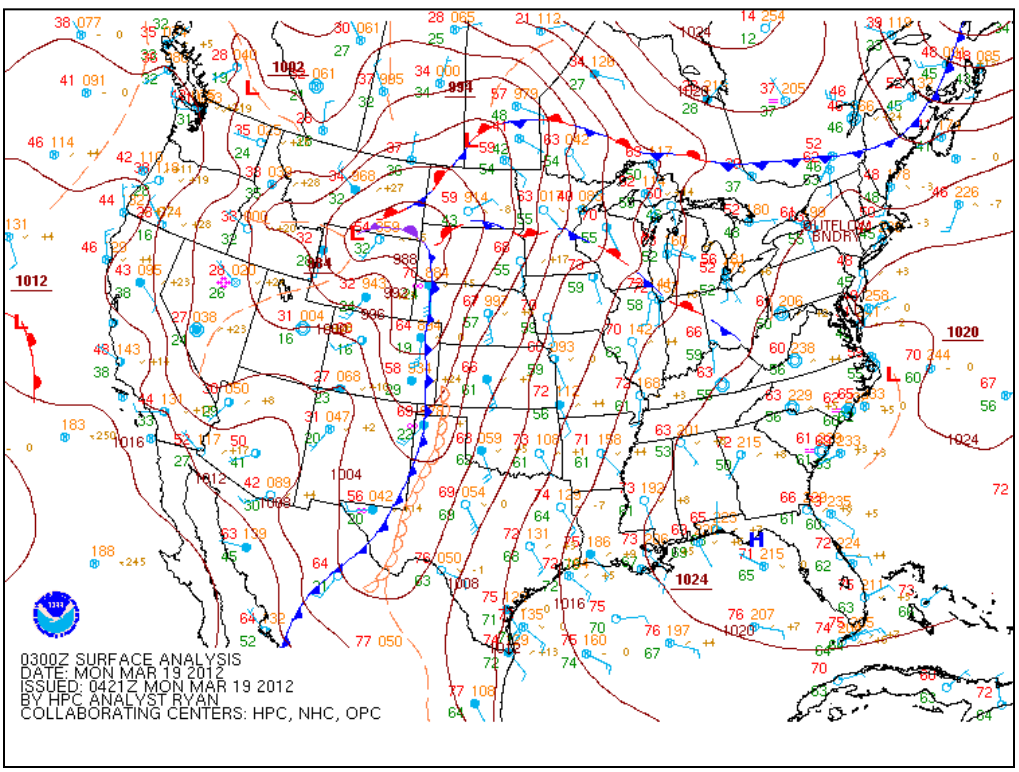


Figure 7: Surface Analysis for 3Z March 19, 2012, or 8 PM MST March 18, 2012. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

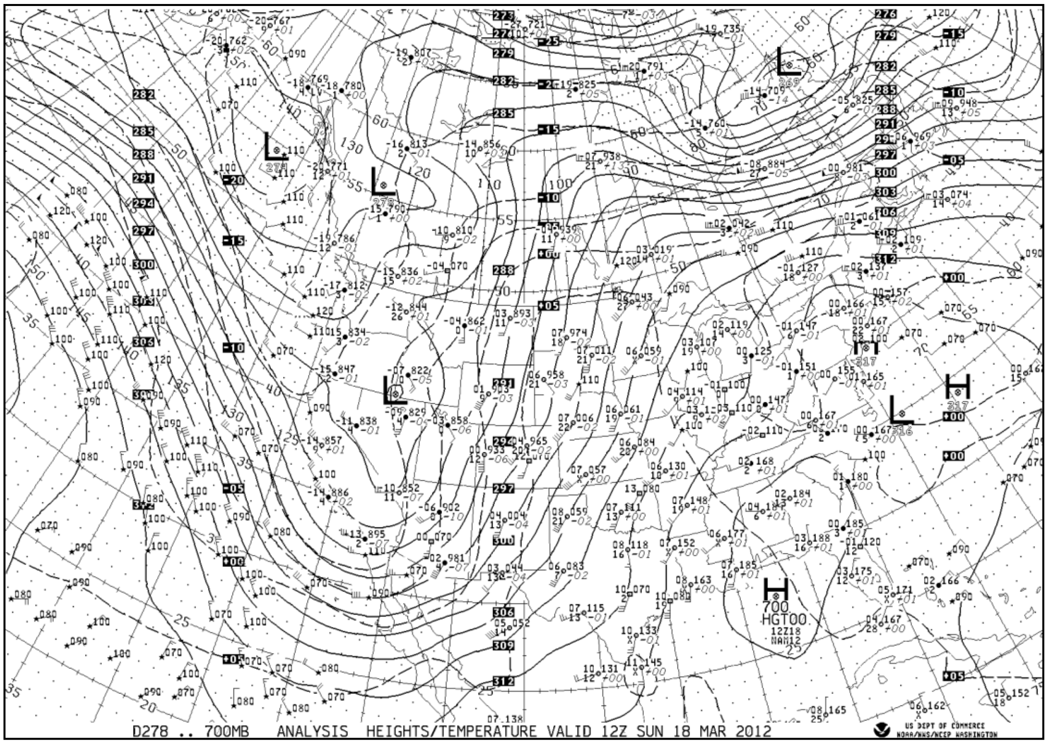


Figure 8: 700 mb (about 3 kilometers above mean sea level) analysis for 12Z March 18, 2012, or 5 AM MST March 18, 2012.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

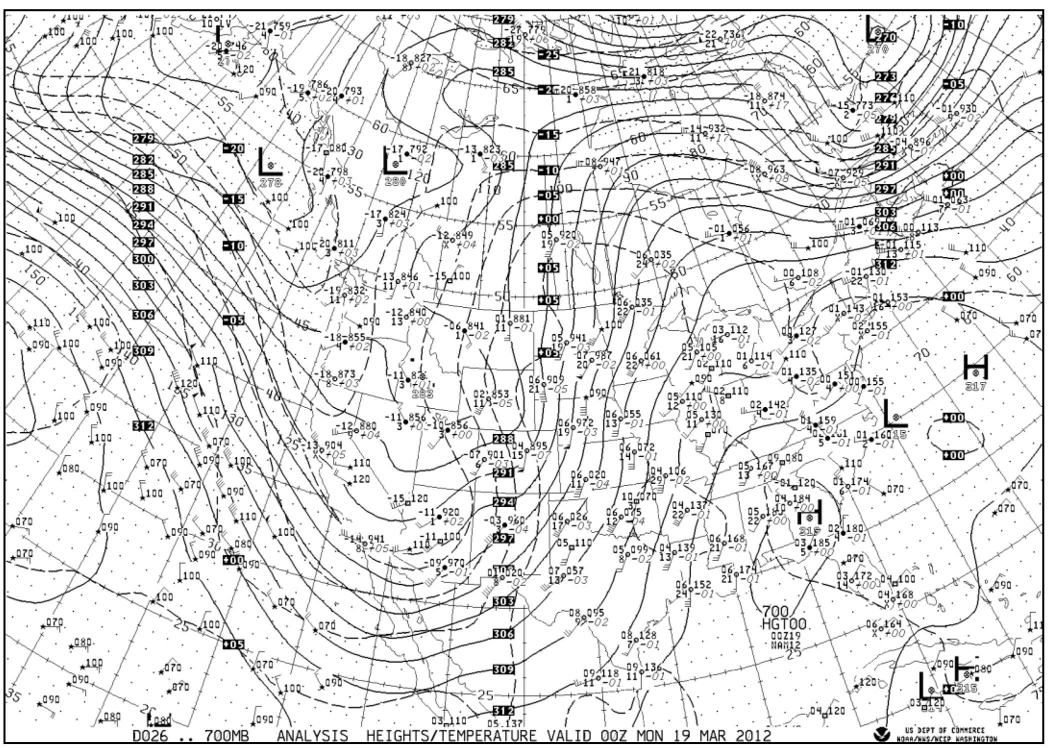


Figure 9: 700 mb (about 3 kilometers above mean sea level) analysis for 0Z March 19, 2012, or 5 PM MST March 18, 2012.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

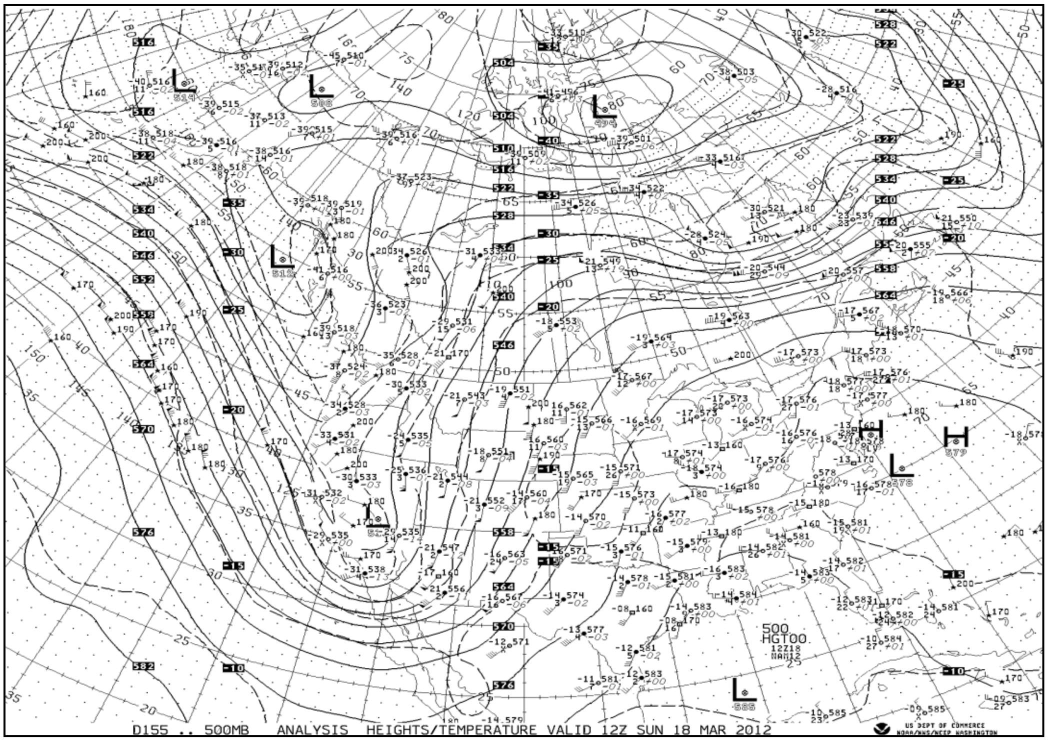


Figure 10: 500 mb (about 6 kilometers above mean sea level) analysis for 12Z March 18, 2012, or 5 AM MST March 18, 2012.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

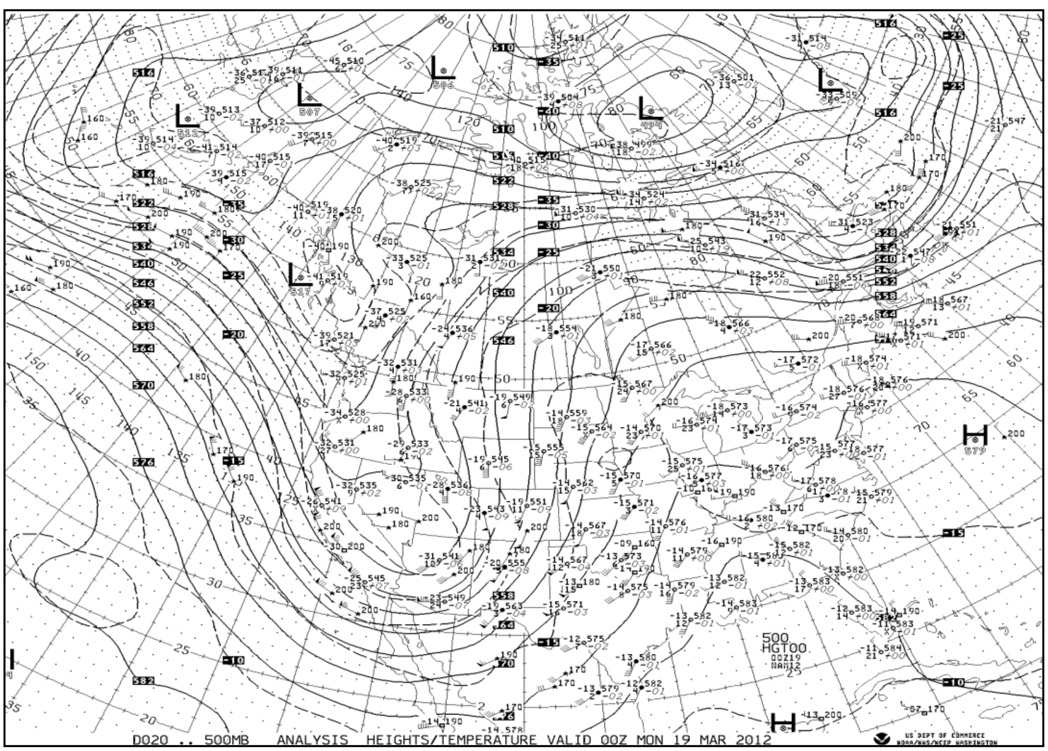


Figure 11: 500 mb (about 6 kilometers above mean sea level) analysis for 0Z March 19, 2012, or 5 PM MST March 18, 2012.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

The synoptic weather conditions described above impacted a region that was in the midst of a moderate to severe drought. This combination of factors set the stage for the dust storm of March 18, 2012. Figure 12 shows the total precipitation in inches for a section of the western United States including Colorado and New Mexico, from February 18 to March 17, 2012. Notice that the south-central and southeastern parts of Colorado which surround Alamosa and Lamar generally received less than 0.5 inches of precipitation in the 30 days prior to March 18, 2012. Similar precipitation amounts can be found upwind from Alamosa and Lamar across much of New Mexico. 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 in Colorado 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 March 13, 2012 (Figure 13) reveals that moderate to severe drought conditions were in place over south-central and southeast Colorado along with large sections of New Mexico prior to the dust event of March 18, 2012. 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).

Thirty-day precipitation and Drought Monitor reports indicate that soils in south-central and southeast Colorado along with much of New Mexico were dry enough to produce blowing dust when winds were above the thresholds for blowing dust.

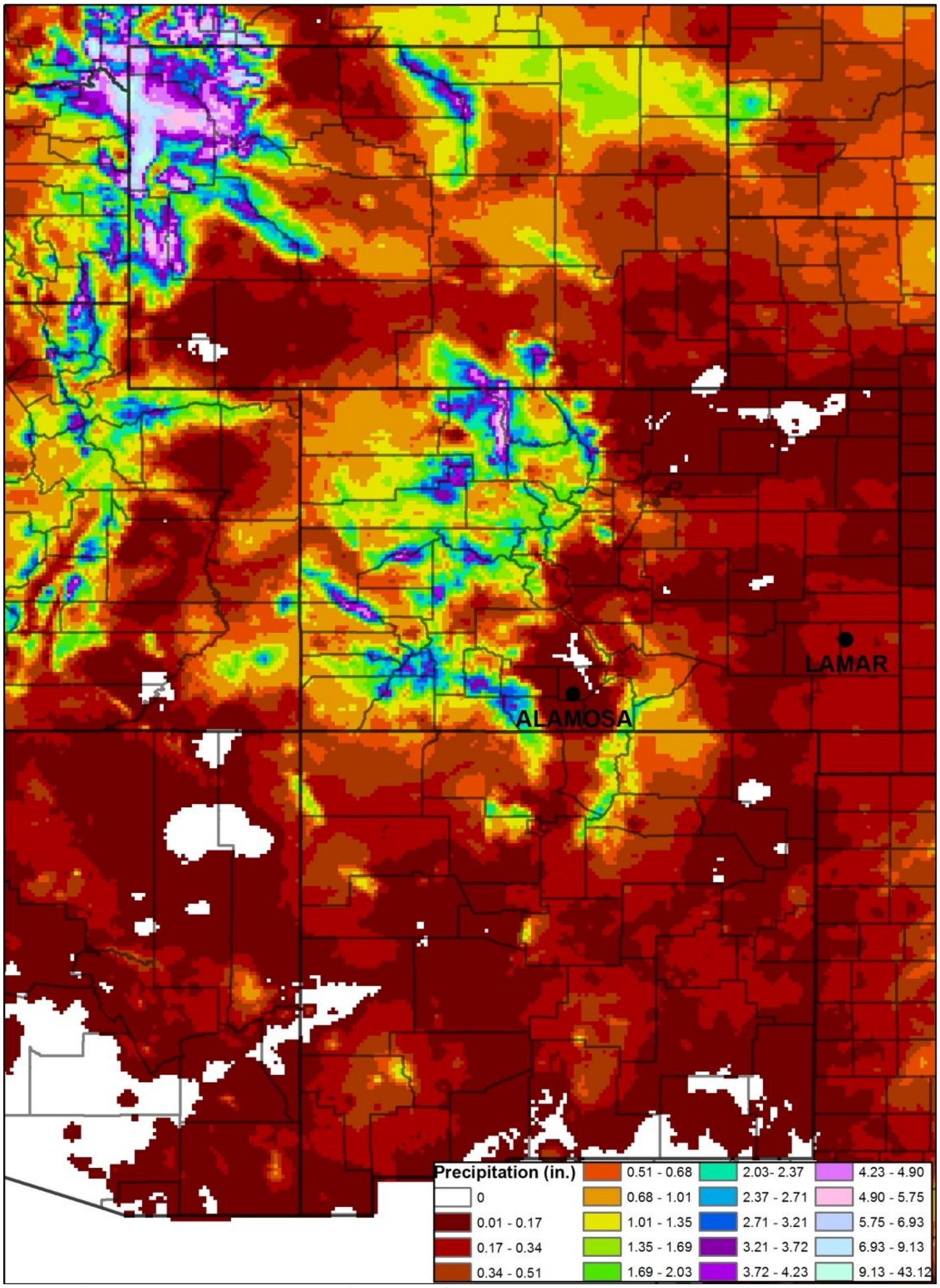


Figure 12: Total precipitation in inches, February 18, 2012 – March 17, 2012. (Source: http://prism.nacse.org/recent/).

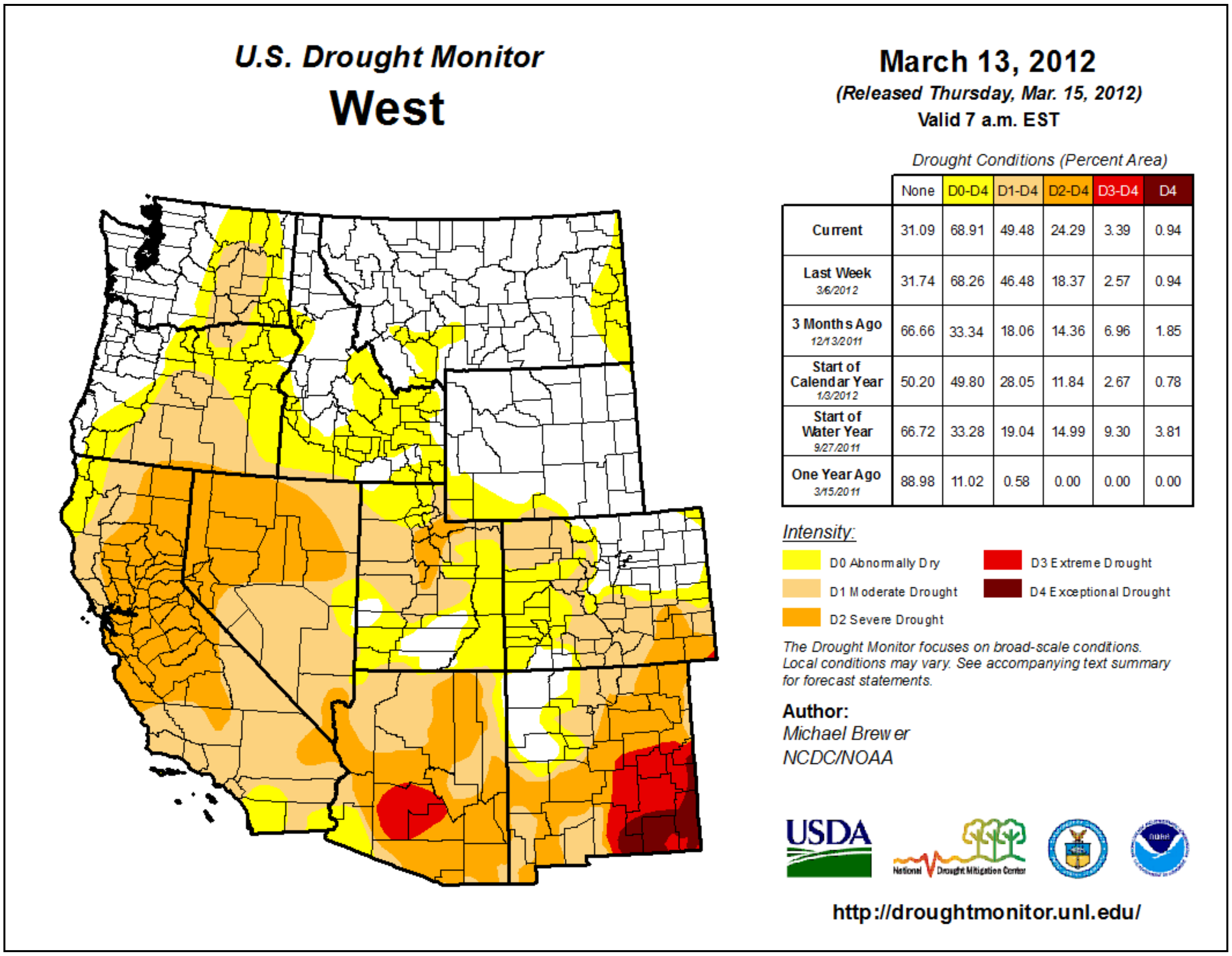


Figure 13: Drought conditions for the western United States at 5 AM MST March 13, 2012. (Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

Surface weather observations from Colorado and New Mexico provide strong evidence that a dust storm took place on March 18, 2012. Hourly surface observations were gathered from several stations located in south-central and southeast Colorado along with large sections of New Mexico. Figure 14 provides a reference map containing the location of each station utilized for this analysis along with the local topography. Table 1 and Table 2 list weather observations for the PM_{10} exceedance locations of Alamosa and Lamar. Table 3 through Table 18 contain the surface weather conditions for all the remaining stations that are displayed in Figure 14. Observations that are climatologically consistent with blowing dust conditions are highlighted in yellow.

The tables reveal that both Alamosa and Lamar experienced several hours of reduced visibility along with sustained wind speeds and gusts at or above the thresholds for blowing dust established earlier in this paper. Meanwhile, stations upwind from Alamosa and Lamar, predominantly in New Mexico, also reported numerous hours of blowing dust and/or haze along with significantly diminished visibility. It should be noted that many of the blowing dust conditions upwind from Alamosa and Lamar occurred several hours earlier in the day. This suggests the possibility that at least some portion of the dust that produced the exceedances in Alamosa and Lamar was transported from outside of Colorado. This will be explored in more detail later in this paper.

Observations of sustained wind speeds and gust speeds at or above the blowing dust thresholds and reduced visibilities on March 18, 2012, at weather stations in south-central and southeast Colorado along with large sections of New Mexico show that a dust storm event occurred under south to southwesterly flow in advance of a cold front.

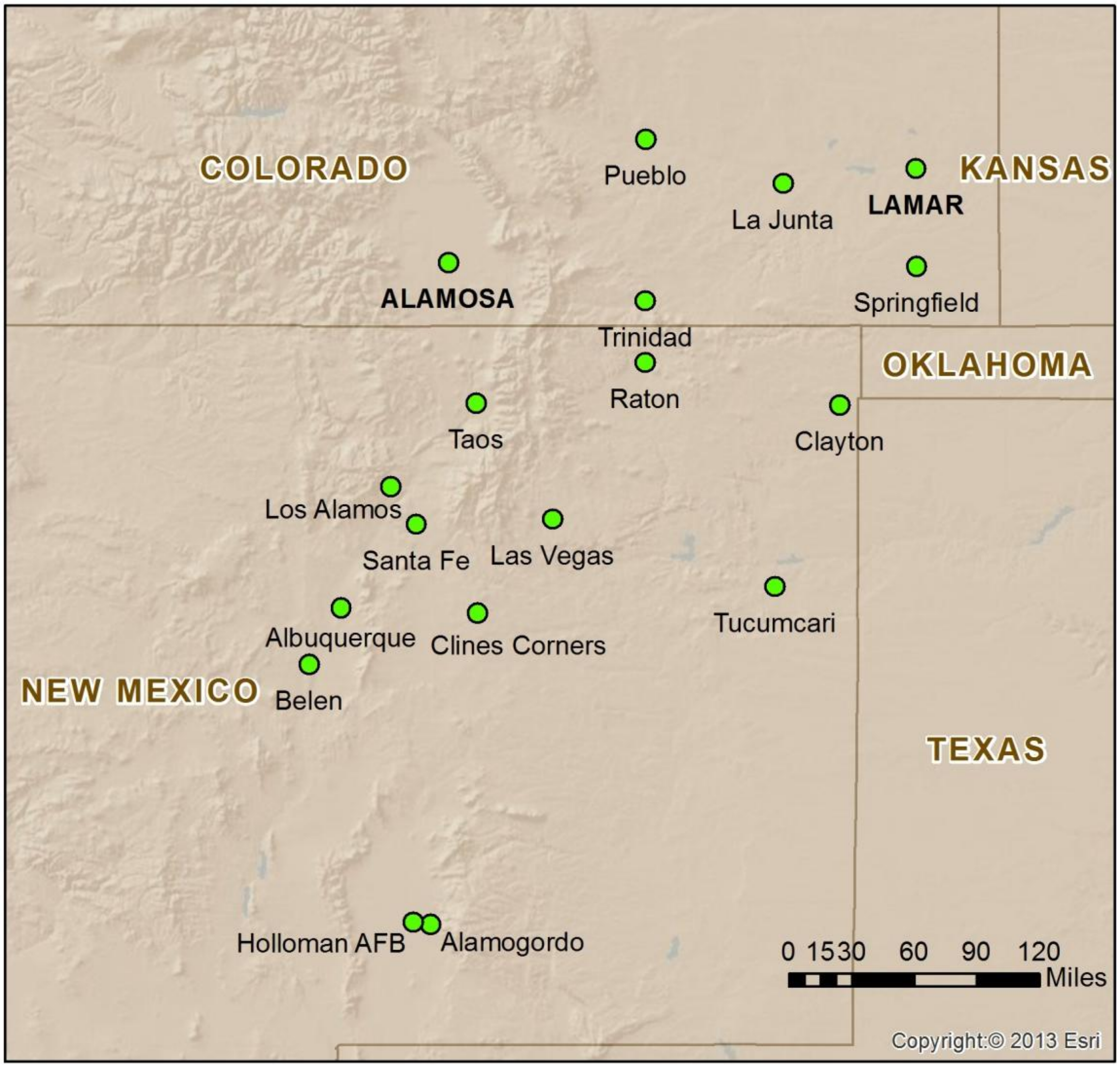


Figure 14: Weather observation stations for March 18, 2012 analysis.

Table 1: Weather observations for Alamosa, Colorado, on March 18, 2012
(Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:52	36	34	10		150		10
1:52	33	34	10		160		10
2:52	32	36	9		170		10
3:52	30	37	9		140		10
4:52	33	36	10		140		10
5:52	35	36	8		130		10
6:52	35	38	9		130		10
7:52	44	31	13		180		10
8:52	47	31	20	30	190		10
9:52	50	27	36	48	190	haze	4
10:10	52	26	40	48	180	haze	2.5
10:28	52	24	37	50	180	haze	3
10:52	52	23	38	50	190	haze	5
11:52	53	23	36	54	200	haze	2
12:05	54	24	37	47	200	haze	4
12:30	54	24	41	50	210	haze	2.5
12:45	54	26	38	56	210	haze	1.75
12:52	51	29	35	52	210	haze	2.5
13:00	50	32	31	47	210	haze	5
13:17	52	30	31	50	210		7
13:32	54	26	45	55	200	haze	1.75
13:41	52	30	39	54	210	haze	3
13:52	49	34	35	45	220	haze	5
14:41	50	37	33	43	210		7
14:52	50	37	33	46	210		8
15:08	48	40	33	44	200		10
15:52	47	39	30	47	210		8
16:20	37	81	33	52	220	lt snow	2
16:26	36	93	25	40	210	lt snow; fog	1.75
16:30	37	87	29	35	210	lt snow; fog	3

Table 2: Weather observations for Lamar, Colorado, on March 18, 2012
(Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 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	56	15	15		210		10
1:53	57	15	16		210		10
2:53	55	17	16		200		10
3:53	50	22	14		190		10
4:53	58	16	20		180		10
5:53	56	18	16		200		10
6:53	57	19	16		190		10
7:53	70	14	20		180		10
8:53	74	12	25	33	190		10
9:53	77	12	29	35	210		10
10:53	78	11	21	36	180		10
11:53	79	10	27	48	190		10
12:53	77	9	29	44	190		10
13:53	81	9	37	48	180		10
14:53	77	12	36	46	180	haze	5
15:12	77	11	40	50	180		9
15:53	76	10	38	51	190		9
16:53	75	11	39	48	190		9
17:53	72	13	28	45	190		8
18:22	72	14	31	40	180	haze	4
18:48	70	15	28	35	180		8
18:53	69	15	24	35	180		8
19:53	67	15	24	31	190	haze	6
20:53	68	13	35	45	200	haze	4
21:53	65	14	20	27	210	haze	5
22:09	55	30	21		280		10
22:53	53	31	14		280		10
23:53	50	30	15	24	280		10

Table 3: Weather observations for La Junta, Colorado, on March 18, 2012
(Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 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	56	14	16		210		10
1:53	57	14	18		220		10
2:53	51	19	9		210		10
3:53	51	19	8		210		10
4:53	55	17	7		190		10
5:53	53	18	10		180		10
6:53	54	19	7		180		10
7:53	65	15	9		160		10
8:53	69	15	20	27	190		10
9:53	73	12	24	35	200		10
10:53	74	11	32	41	200		10
11:53	74	11	30	39	180		10
12:53	76	9	38	52	200		8
13:53	74	11					10
14:53	74	11					9
15:53	74	12					10
16:53	72	13					9
17:53	70	14					10
18:53	69	13				haze	5
19:53	58	33					10
20:53	53	32					10
21:53	48	35					10
22:53	47	34					10
23:53	46	30					10

Table 4: Weather observations for Pueblo, Colorado, on March 18, 2012 (Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 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	57	14	12		190		10
1:53	56	15	7		190		10
2:53	51	18	5				10
3:53	45	23	6		330		10
4:53	49	20	13		180		10
5:53	50	20	8		170		10
6:53	52	20	8		170		10
7:53	56	19	4		110		10
8:53	64	14	17	23	170		10
9:53	69	12	15	22	170		10
10:53	69	12	16	24	140		10
11:53	70	13	9	17	220		10
12:53	70	11	16	25	200		10
13:53	72	13	36	47	180		9
14:16	70	13	29	45	170		8
14:29	70	15	30	40	190		10
14:53	70	14	36	53	190	blowing dust	4
15:23	70	16	39	47	180	blowing dust	9
15:36	66	18	32	46	180	haze	6
15:53	66	18	18	37	200		10
16:53	62	24	21	27	220		9
17:53	60	25	25	40	240		9
18:14	57	33	36	55	240	blowing dust	2.5
18:22	55	35	30	45	240	blowing dust	7
18:53	55	34	29	41	240		10
19:53	53	28	24	35	240		10
20:53	49	25	22	36	250		10
21:53	47	24	18	32	250		10
22:53	45	27	18	28	250		10
23:53	45	21	22	35	260		10

Table 5: Weather observations for Springfield, Colorado, on March 18, 2012 (Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 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	53	17	12		250		
1:56	51	19	14		240		
2:56	52	20	16		220		
3:56	44	28	7		230		
4:56	40	33	6		240		
5:56	40	36	6		230		
6:56	45	34	12		220		
7:56	55	30	17		210		
8:56	64	30	22		210		
9:56	70	23	25	33	210		
10:56	72	19	31	41	210		
11:56	74	13	35	44	220		
12:56	75	13	35	44	210		
13:56	75	13	36	47	210		
14:56	73	12	37	52	220		
15:56	72	13	44	54	220		
16:56	71	14	40	52	210		
17:56	68	15	37	51	200		
18:56	66	16	27	33	210		
19:56	65	17	20	29	220		
20:56	64	20	27	39	220		
21:56	62	18	16	28	230		
22:56	58	24	14	23	260		
23:56	56	28	24	35	250		

Table 6: Weather observations for Trinidad, Colorado, on March 18, 2012
(Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 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	54	15	12	20	180		10
1:54	51	16	9		230		10
2:54	50	18	6	20			10
3:54	50	18	8		150		10
4:54	53	17	7	17			10
5:54	52	20	6		220		10
6:54	55	20	15	23	140		10
7:03	55	21	15	25	140		10
7:54	57	21	14	20	110		10
8:36	63	19	24	36	190		10
8:54	64	17	21	33	190		10
9:52	63	17	36	46	200		8
9:54	63	17	31	46	200		9
10:41	66	15	41	61	210	haze	1.75
10:47	66	14	43	58	190	haze	2
10:54	66	14	47	58	200	haze	4
11:05	64	15	48	64	200	haze	2
11:21	63	16	45	56	200	haze	3
11:36	63	17	39	54	190	haze	2
11:38	63	17	40	54	190	haze	1.75
11:54	62	18	40	53	190	haze	2.5
12:15	63	17	43	59	200	haze	4
12:54	64	16	41	53	180	haze	5
13:54	65	18	36	52	210	haze	4
14:54	67	15	32	47	170	haze	6
15:19	66	13	43	64	190	haze	1.75
15:37	66	13	38	53	180	haze	4
15:54	65	14	37	64	180	haze	2.5
16:05	64	14	44	56	180	haze	4
16:31	64	15	41	61	180	haze	2.5
16:54	63	15	32	56	190	haze	2.5
17:12	63	16	33	60	200	haze	1.5
17:54	60	17	37	64	200	haze	1.5
18:01	61	17	36	59	200	haze	3
18:54	54	30	20	24	250		9

Table 7: Weather observations for Alamogordo, New Mexico, on March 18, 2012 (Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
9:35	68	18	25	33	160		10
9:55	68	18	27	39	190		8
10:15	68	18	30	38	190	haze	4
10:35	68	18	31	40	190		7
10:55	70	17	29	39	180		9
11:15	72	14	30	38	210		7
11:35	72	14	35	44	190		7
11:55	72	14	31	46	210	haze	5
12:15	73	13	30	45	210	haze	6
12:35	73	13	32	45	200	haze	5
12:55	73	13	29	41	210	haze	5
13:15	73	13	31	41	210	haze	6
13:35	73	14	28	43	210	haze	5
13:55	70	18	29	41	240	haze	1
14:15	68	19	29	41	230	haze	0.75
14:35	68	21	27	48	230	haze	0.75
14:55	66	21	25	43	230	haze	1.25
15:15	66	21	28	43	220	haze	1.25
15:35	66	21	27	41	210	haze	1.25
15:55	66	16	33	44	210	haze	2
16:15	64	20	29	40	220	haze	1.25
16:35	64	19	25	36	220	haze	1
16:55	64	18	27	35	220	haze	1
17:15	63	20	25	39	230	haze	1.25
17:35	63	22	32	43	230	haze	1
17:55	61	23	27	37	230	haze	1.5
18:15	59	23	32	45	220	haze	1.75
18:35	59	21	25	43	220	haze	3
18:55	57	23	25	32	220	haze	1.75
19:15	57	24	21	30	230	haze	3
19:35	57	24	18	24	220	haze	3
19:55	55	26	18	29	220	haze	5
20:15	55	26	15	23	220		7
20:35	54	26	13	21	220		10

Table 8: Weather observations for Albuquerque, New Mexico, March 18, 2012
(Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
6:52	56	26	20	28	180		10
7:52	57	27	29	36	190		7
8:52	58	27	31	43	190	blowing dust	6
9:46	63	22	39	58	190	blowing dust	1
9:52	62	22	44	56	180	blowing dust	1
10:08	61	23	45	58	180	blowing dust	0.75
10:52	63	20				blowing dust	
10:59	63		44	66	180	blowing dust	0.75
11:52	64	16	46	64	200	blowing dust	0.75
12:32	64	16	44	58	190	blowing dust	1.5
12:46	64	16	47	60	190	blowing dust	0.5
12:52	64	16	47	60	190	blowing dust	0.5
13:00	64	16	48	60	190	blowing dust	1
13:18	64	16	35	48	220	blowing dust	2
13:42	64	26	32	46	230	blowing dust	4
13:52	65	24	32	46	230	blowing dust	5
14:39	64	26	38	59	180	blowing dust	0.75
14:52	65	25	38	59	180	blowing dust	0.75
15:35	55	30	30	40	270	blowing dust	2
15:52	57	32	24	40	270	blowing dust	2
16:38	50	40	27	35	260	blowing dust	3
16:52	47	49	18		250	blowing dust	7
17:52	45	50	5		150		10

Table 9: Weather observations for Belen, New Mexico, March 18, 2012
(Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
7:55	57	27	22	30	180		10
8:15	57	27	27	35	190		10
8:35	58	26	32	40	190		10
8:55	59	25	36	46	190	haze	3
9:15	60	25	36	44	180	haze	1.75
9:35	61	24	37	47	180	haze	2.5
9:55	61	23	40	51	180	haze	2
10:15	62	22	41	55	170	haze	1
10:35	63	21	38	50	190	haze	1.5
10:55	63	21	36	46	180	haze	2
11:15	63	20	40	54	180	haze	1
11:35	63	21	43	51	180	haze	4
11:55	64	21	40	52	180	haze	2
12:15	65	20	39	51	190	haze	1.25
12:35	63	22	45	59	200	haze	0.5
12:55	57	37	21	33	220	lt rain	10
13:15	54	56	16	24	210	lt drizzle	10
13:35	59	38	22		210		10
13:55	63	22	33	51	200	haze	5
14:15	64	18	29	40	220		7
14:35	63	19	32	37	200		10
14:55	64	16	39	47	220	haze	5
15:15	65	13	35	50	220	haze	2
15:35	64	15	32	40	220		7
15:55	62	17	43	51	260	haze	1.75
16:15	54	39	35	50	260	haze	0.75
16:35	48	55	27	33	270		10
16:55	47	57	24	28	270		10

Table 10: Weather observations for Clayton, New Mexico, on March 18, 2012 (Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 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	50	18	10		240		10
1:55	47	23	14	23	200		10
2:55	46	25	14		200		10
3:55	41	31	8		200		10
4:55	47	25	10		230		10
5:55	43	30	8		210		10
6:55	46	37	9		220		10
7:55	56	40	16		200		10
8:55	65	27	24	36	200		10
9:55	65	26	27		200		10
10:55	68	22	28	35	200		10
11:55	71	18	33	46	200		10
12:55	72	13	38	47	180		10
13:55	69	13	38	45	190		10
14:55	71	13	39	52	180		10
15:55	69	14	38	48	190		10
16:55	68	14	37	50	180		10
17:55	65	16	25	35	200		10
18:55	64	18	28	37	210	haze	6
19:16	63	24	38	71	190	lt rain; squalls	4
19:55	62	16	36	50	210	haze	4
20:07	63	16	32	46	210	haze	4
20:55	60	21	28	40	210	haze	5
21:16	59	23	28	36	210	haze	4
21:55	57	27	29	47	220	haze	5
22:23	55	28	23	31	220		7
22:55	54	31	23	31	220		10
23:55	49	39	18	25	240		10

Table 11: Weather observations for Clines Corners, New Mexico, on March 18, 2012 (Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 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	49	24	15		210		10
1:53	48	26	15		210		10
2:53	47	30	13		210		10
3:53	47	30	15		200		10
4:53	47	33	15		190		10
5:53	46	35	16		210		10
6:53	46	37	12		180		10
7:53	49	33	17		190		10
8:53	52	28	23		200		10
9:53	56	21	36	47	220		10
10:53	59	18	44	55	210		10
11:53	59	17	38	62	210	squalls	10
12:53	62	16	44	56	210		10
13:53	59	23	46	55	220	haze	5
14:36	57	24	41	59	210	haze	3
14:53	57	23	46	59	220	haze	4
15:10	55	26	38	64	220	haze	4
15:53	54	26	40	54	210	haze	6
16:34	52	28	39	52	230		9
16:53	51	27	40	54	230		8
17:10	50	25	47	59	230		7
17:44	43	49	27	35	270		10
17:53	40	59	21	30	290		10
18:53	41	53	33	46	230		10
19:53	36	73	23		280		10
20:53	34	79	18		270		10
21:53	33	85	15		270		10
22:38	34	80	21	28	270	lt snow	7
22:48	34	80	24	30	250		10
22:53	35	75	27	33	250		10
23:53	34	72	17				10

Table 12: Weather observations for Holloman AFB, New Mexico, on March 18, 2012 (Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
13:55	74	13	33	41	210		10
14:24	73	15	38	46	230		7
14:32	72	19	32	46	240	haze	2
14:33	72	19	32	46	240	haze	2
14:40	72	20	31	45	230	haze	1.5
14:55	70	20	31	44	230	haze	1.25
15:17	68	23	39	46	230	haze	1.5
15:27	68	23	38	46	240	haze	1.25
15:50	68	19	36	48	220	haze	2.5
15:55	68	19	35	48	230	haze	2.5
16:07	68	19	38	54	230	haze	1.75
17:57	64	20	33	43	210	haze	2
18:08	64	20	35	48	210	haze	1.75
18:28	63	22	33	43	220	haze	2
18:42	63	24	35	44	220	haze	2.5
18:48	63	24	35	47	210	haze	3
18:49	63	24	32	47	220	haze	3
18:55	61	23	38	47	220	haze	4
19:05	61	25	37	50	210	haze	4
19:19	61	23	32	53	210	haze	4
19:35	59	25	29	44	220	haze	3
19:38	59	25	27	44	220	haze	2.5
19:49	59	25	27	36	230	haze	2.5
19:55	59	26	21	36	230	haze	2.5
20:06	59	27	23	29	230	haze	3
20:09	57	28	21	29	230	haze	3
20:30	57	28	20	25	230	haze	4
20:43	57	28	17		240	haze	4
20:48	55	33	17		230	haze	5
20:55	56	31	21	27	230	haze	5
21:55	54	33	18		220		9
22:07	54	35	17	21	210		9
22:55	52	40	20		220		10

Table 13: Weather observations for Las Vegas, New Mexico, on March 18, 2012 (Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 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	43	28	21		200		10
1:53	44	28	21		210		10
2:53	47	27	21		210		10
3:53	45	32	16		190		10
4:53	47	33	17		200		10
5:53	47	33	20		190		10
6:53	47	35	15		200		10
7:53	48	34	14		190		10
8:53	50	33	13		190		10
9:53	52	32	20	27	190		10
10:53	55	27	29	35	190		10
11:53	61	17	44	56	190		10
12:53	63	15	48	68	200		10
13:53	61	16	48	64	200		10
14:53	59	20	45	60	210	haze	6
15:53	57	22	53	64	210	haze	3
16:33	55	22	47	62	200	haze	6
16:53	54	24	41	56	210	haze	6
17:53	51	24	47	59	220	haze	6
18:53	42	53	23	27	230		10
19:53	38	59	20		230		10
20:53	36	67	22	26	240		10
21:53	35	66	17	27	230		10
22:53	43	28	21		200		10
23:53	34	61	17		240		10

Table 14: Weather observations for Los Alamos, New Mexico, on March 18, 2012 (Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
8:55	48	29	12	21	150		10
9:15	50	27	16	31	170		10
9:35	52	26	29	48	170		10
9:55	52	26	35	47	190		10
10:15	52	26	27	48	190		10
10:35	52	22	25	52	180		10
10:55	52	22	31	46	170		7
11:15	52	20	33	51	180	haze	5
11:35	52	22	32	46	170	haze	5
11:55	52	22	36	51	180	haze	5
12:15	54	20	25	62	190	haze	4
12:35	54	20	32	50	190	haze	5
12:55	55	18	50	63	180	haze	4
13:15	54	20	31	53	180	haze	5
13:35	50	29	40	59	190	haze	5
13:55	50	32	38	51	190	haze	5
14:15	50	34	28	48	180	haze	5
14:35	52	32	30	52	180	haze	5
14:55	52	30	37	48	190		7
15:15	52	28	25	45	170		10
15:35	46	46	39	63	200	mod drizzle	5
15:55	46	46	29	45	220		10
16:15	43	61	16	29	230		10
16:35	45	49	20	30	220		10
16:55	43	45	14	25	210		10
17:15	43	49	15	27	210		10
17:35	37	81	18	39	190	lt snow	2
17:55	36	80	7		200	lt snow	4

Table 15: Weather observations for Raton, New Mexico, on March 18, 2012
(Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 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	30	0				10
1:53	41	33	7		270		10
2:53	40	37	6		180		10
3:53	40	37	7		240		10
4:53	41	36	8		240		10
5:53	39	44	8		260		10
6:53	44	38	7		250		10
7:53	52	29	16		200		10
8:53	58	25	25	33	180		10
9:53	60	21	36	47	210		10
10:53	59	22	31	50	210		10
11:53	62	20	38	51	190		10
12:53	64	19	41	53	190		10
13:53	60	23	41	50	180		10
14:20	64	15	45	58	200	haze	1.75
14:30	64	15	50	62	190	haze	1.75
14:46	64	15	51	67	210	haze	0.75
14:53	66	14	47	63	200	haze	1
15:06	66	15	44	62	210	haze	1.5
15:26	64	16	54	64	200	haze	2.5
15:35	63	17	47	64	190	haze	1.5
15:53	63	17	45	61	200	haze	2.5
16:11	63	17	46	60	200	haze	1.5
16:53	61	20	46	59	200	haze	1.25
17:35	57	21	40	52	210	haze	2.5
17:46	57	21	39	55	210	haze	3
17:50	57	21	38	50	200	haze	2.5
17:53	57	21	36	50	200	haze	2.5
18:29	55	21	40	54	210	haze	3
18:53	54	25	35	44	230		7
19:53	50	34	23	44	230		10
20:07	46	46	14	23	260		10
20:53	45	45	14		200		10
21:53	45	42	13		250		10
22:53	42	41	14		250		10
23:53	40	44	18		250		10

Table 16: Weather observations for Santa Fe, New Mexico, on March 18, 2012 (Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 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	49	21	18		140		10
1:53	47	24	15		150		10
2:53	45	26	9		130		10
3:53	45	28	10		130		10
4:53	46	30	15		140		10
5:53	46	31	13		140		10
6:53	48	31	15		160		10
7:53	47	33	13		160		10
8:53	52	29	21		160		10
9:53	57	24	17	29	160		10
10:53	60	18	31	45	210		10
11:53	60	18	37	48	200		10
12:53	64	16	33	52	210		10
13:53	59	25	29	44	230		10
14:15	57	26	31	48	220		10
14:53	59	23	24	47	190		10
15:53	54	26	32	45	240		10
16:53	46	45	24	36	230		10
17:15	39	81	27	40	220	lt rain	10
17:39	37	87	21	28	250		10
17:53	37	85	14		260		10
18:53	38	76	15		250		10
19:42	34	86	12		230	lt snow; fog	2
19:51	34	86	7		240	lt snow	9
19:53	33	92	8		220		9
20:53	34	92	0				10
21:45	34	80	9		220	lt snow	5
21:53	33	81	7		220	lt snow	5
22:00	32	86	0			lt snow; fog	6
22:53	33	85	4		240	lt snow	10
23:53	33	72	9		250		10

Table 17: Weather observations for Taos, New Mexico, on March 18, 2012
(Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
7:55	46	31	7		150		10
8:15	52	28	14		200		10
8:35	52	28	15	18	210		10
8:55	54	24	23	33	210		10
9:15	54	24	25	38	210		10
9:35	54	22	25	43	210		10
9:55	54	24	28	41	200		10
10:15	55	22	31	43	220		10
10:35	55	22	31	43	210		10
10:55	57	21	35	48	200		10
11:15	55	24	30	43	220		10
11:35	54	28	32	43	200		10
11:55	54	28	30	37	190		10
12:15	52	28	30	45	210		10
12:35	54	28	29	41	190		10
12:55	54	26	28	36	220		10
13:15	54	26	25	37	210		10
13:35	54	26	30	44	190		10
13:55			27	47	190		8
14:15			25	45	200		7
14:35	55	28	36	44	230		7
14:55	55	30	32	46	220		4
15:15	55	30	33	39	220		7
15:35	55	28	28	40	220		8
15:55	48	37	36	77	210		5
16:15	46	39	32	50	250		5
16:35	41	56	21	32	270		10
16:55	36	80	17	29	270		8
17:15	36	80	8		260		10
17:35	37	70	10		250		10
17:55	36	69	14		220		10

Table 18: Weather observations for Tucumcari, New Mexico, on March 18, 2012 (Source: http://www.met.utah.edu/mesowest/)

Time MST March 18, 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	61	36	17		200		10
1:53	59	55	20		200		10
2:53	54	64	15		210		10
3:53	54	69	4		280		10
4:53	54	80	16		210		8
5:53	52	86	7		190		7
6:53	56	80	15	18	210	haze	6
7:53	63	60	20	28	210		9
8:53	68	40	22		200		10
9:53	74	17	21	31	200		10
10:53	77	12	36	44	210		10
11:53	75	12	35	50	200		10
12:53	75	13	38	47	190		10
13:53	76	12	39	47	200		10
14:53	77	11	41	48	200		10
15:53	76	11	35	47	210		10
16:53	75	11	33	47	200		9
17:53	73	12	30	40	240		8
18:29	70	17	35	43	220	haze	2.5
18:43	70	16	27	44	230	haze	3
18:53	69	17	30	43	230	haze	4
19:05	70	16	44	54	230	haze	4
19:53	66	17	29	43	220	haze	4
20:53	64	19	24	38	220	haze	5
21:53	62	22	23	32	240	haze	4
22:04	61	23	30	38	250	haze	4
22:27	61	23	28	41	250	haze	5
22:53	58	28	18	30	260		10
23:53	55	32	21	25	270		10

Webcam imagery provides visual confirmation of the dust storm that occurred on March 18, 2012. The web cam image (Figure 15) taken at 6:04 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. At the time this image was captured in Eads, nearby Lamar was reporting a sustained wind of 28-31 mph with wind gusts to 40-44 mph. Haze was also observed, with obscured visibility ranging from 4 to 8 miles. For comparison purposes a 2nd web cam image (Figure 16) is included from Eads at approximately the same time of day (6:07 PM MST), but from two days earlier (March 16, 2012) when the wind was generally light (sustained at 0-9 mph) and visibility was considered good (10 statute miles).

Figure 15: Eads, Colorado webcam image at 6:04 PM MST March 18, 2012. (Source: http://www.wunderground.com/webcams/kcpnews/1/show.html#cal)

Figure 16: Eads, Colorado webcam image at 6:07 PM MST March 16, 2012. (Source: http://www.wunderground.com/webcams/kcpnews/1/show.html#cal)

Dust can also be easily identified from web camera imagery across New Mexico. Figure 17 through Figure 19 show a view of Albuquerque from Sandia Crest (10,678 ft. above MSL) at 8:41, 9:11 and 10:11 AM MST, respectively.

Figure 17: Sandia Crest, New Mexico webcam image at 8:41 AM MST March 18, 2012. (Source: http://amos.cse.wustl.edu/camera?id=17708#20140916_164203)

Figure 18: Sandia Crest, New Mexico webcam image at 9:11 AM MST March 18, 2012. (Source: http://amos.cse.wustl.edu/camera?id=17708#20140916_164203)

Figure 19: Sandia Crest, New Mexico webcam image at 10:11 AM MST March 18, 2012. (Source: http://amos.cse.wustl.edu/camera?id=17708#20140916_164203)

Web cameras farther north in New Mexico also show dust sweeping through Raton. The images in Figure 20 through Figure 22 were taken at the Holiday Inn Express located about 3 miles south of downtown Raton at 12:58, 2:28 and 3:28 PM MST, respectively.

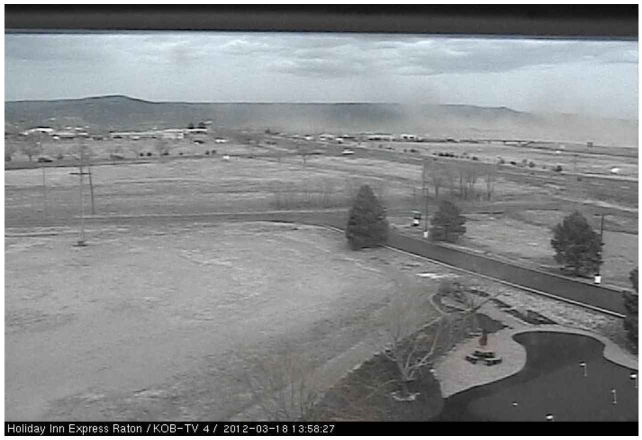


Figure 20: Raton, New Mexico webcam image at 12:58 PM MST March 18, 2012. (Source: http://amos.cse.wustl.edu/camera?id=17695#20130617_195922)

Figure 21: Raton, New Mexico webcam image at 2:28 PM MST March 18, 2012. (Source: http://amos.cse.wustl.edu/camera?id=17695#20130617_195922)

Figure 22: Raton, New Mexico webcam image at 3:28 PM MST March 18, 2012. (Source: http://amos.cse.wustl.edu/camera?id=17695#20130617_195922)

Figure 23 shows the MODIS (Moderate Resolution Imaging Spectroradiometer) Terra satellite image zoomed on White Sands National Monument at 10:38 AM MST (1738Z) on March 18, 2012. Circled in red are what appear to be thin plumes of dust moving northeastward off the northern edge of the White Sands area. For comparison purposes another MODIS image of White Sands National Monument (Figure 24) is included which captures conditions during a period of calmer weather. This image was taken at 12:40 PM MST on March 14, 2012 and shows no signs of the suspected dust plumes that are visible in Figure 23 .

Local surface observations support the argument that Figure 23 does indeed show plumes of dust moving northeastward off the White Sands area. In nearby Alamogordo (located just a few miles to the east of White Sands and labeled on Figure 23), an observation of sustained south-southwesterly winds of 31 mph, gusts to 40 mph and visibility reduced to 7 miles was recorded just three minutes before the MODIS image was captured (Table, 10:35 AM MST). In contrast, the weather observation for Alamogordo for the “clean” MODIS image of Figure 24 reveals a sustained south-southeasterly wind of only 7 mph with no stronger gusts.

Another tool used to detect dust in the atmosphere is the GASP (GOES Aerosol Smoke Product) Aerosol Optical Depth image (see the following link for additional information on GASP: http://www.star.nesdis.noaa.gov/smcd/emb/aerosols/products_geo.php). The GASP WEST product at 10:15 AM MST (1715Z), March 18, 2012 shown on Figure 25 shows indications of elevated aerosol levels in central parts of New Mexico with AOD values of 0.2 – 0.4. By taking those elevated AOD pixels and overlaying them on a Google Earth map, we can see the area impacted is in close proximity to Albuquerque and also southward in the direction of White Sands National Monument. To confirm suspicions that these elevated AOD values are indeed dust, one simply need to look at surface weather observations in Albuquerque at the approximate time of the GASP image. As suspected, at 10:07 AM MST, March 18th, 2012 (eight minutes before the GASP image) Albuquerque reported blowing dust and visibility restricted to ¾ of a mile (Table 8).

MODIS and GASP satellite imagery reveal that a dust storm was taking place in New Mexico on the same day that Alamosa and Lamar in southern Colorado reported an exceedance of the twenty-four hour PM_{10} standard. The drought-stricken soils of New Mexico were a likely contributor to the blowing dust in Alamosa and Lamar which produced the PM_{10} exceedances.

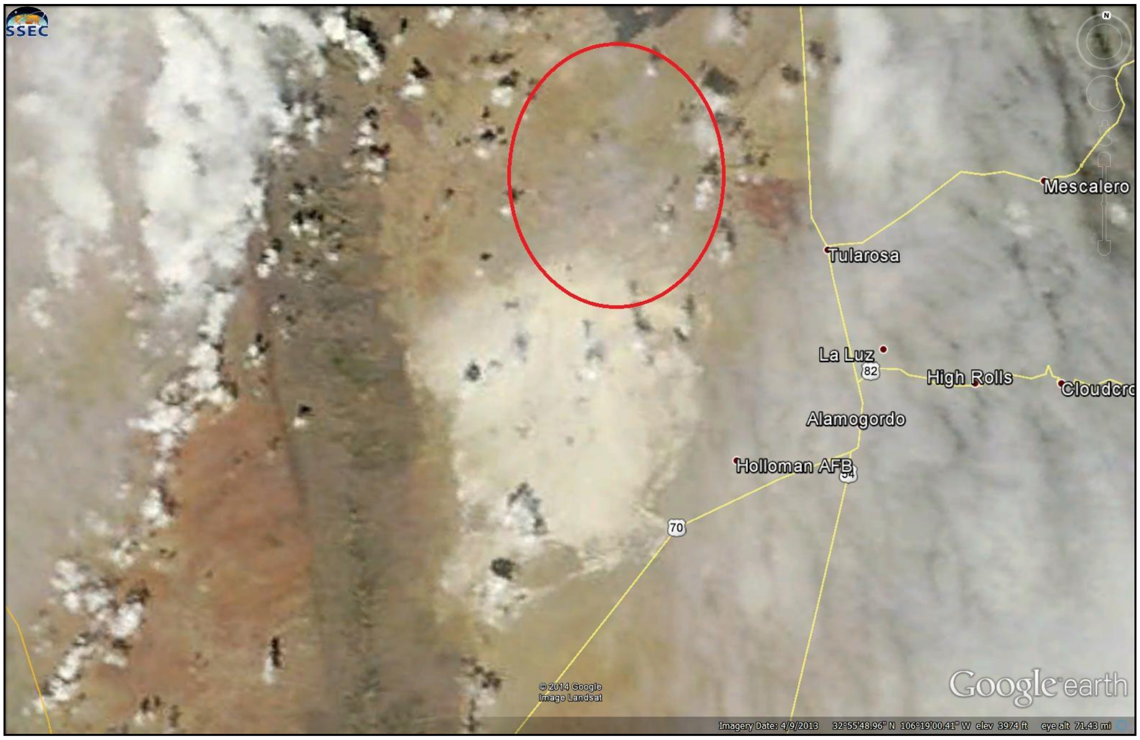
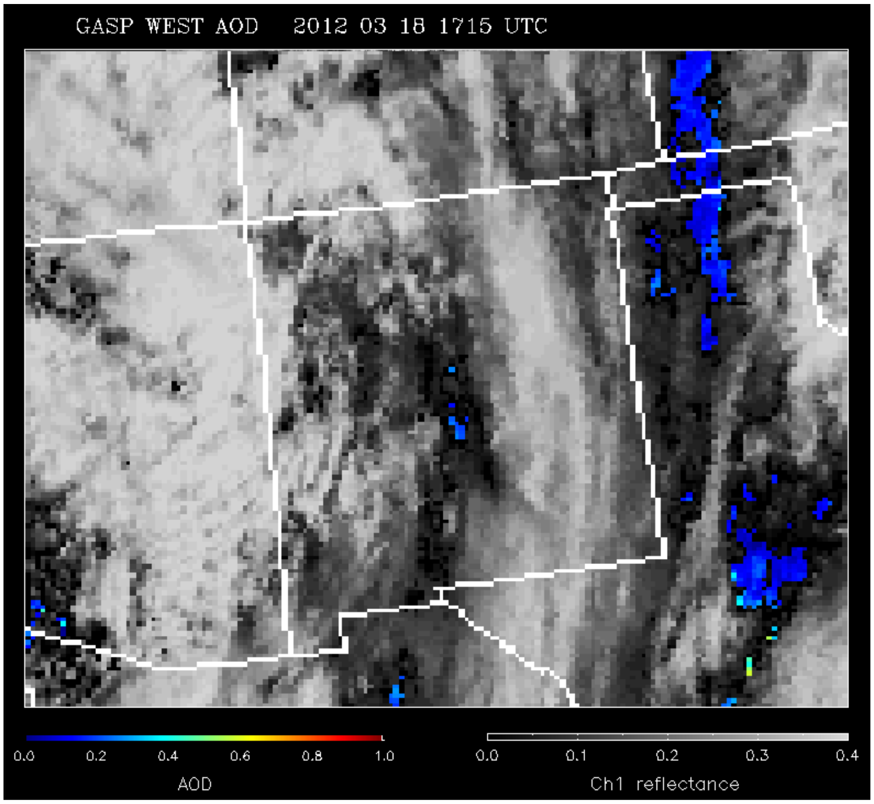


Figure 23: MODIS Terra satellite image of White Sands National Monument at approximately 10:38 AM MST (1738Z) on March 18, 2012.
(Source: http://ge.ssec.wisc.edu/modis-today/index.php).

Figure 24: MODIS Aqua satellite image of White Sands National Monument at approximately 12:40 PM MST (1940Z) on March 14, 2012.
(Source: http://ge.ssec.wisc.edu/modis-today/index.php).



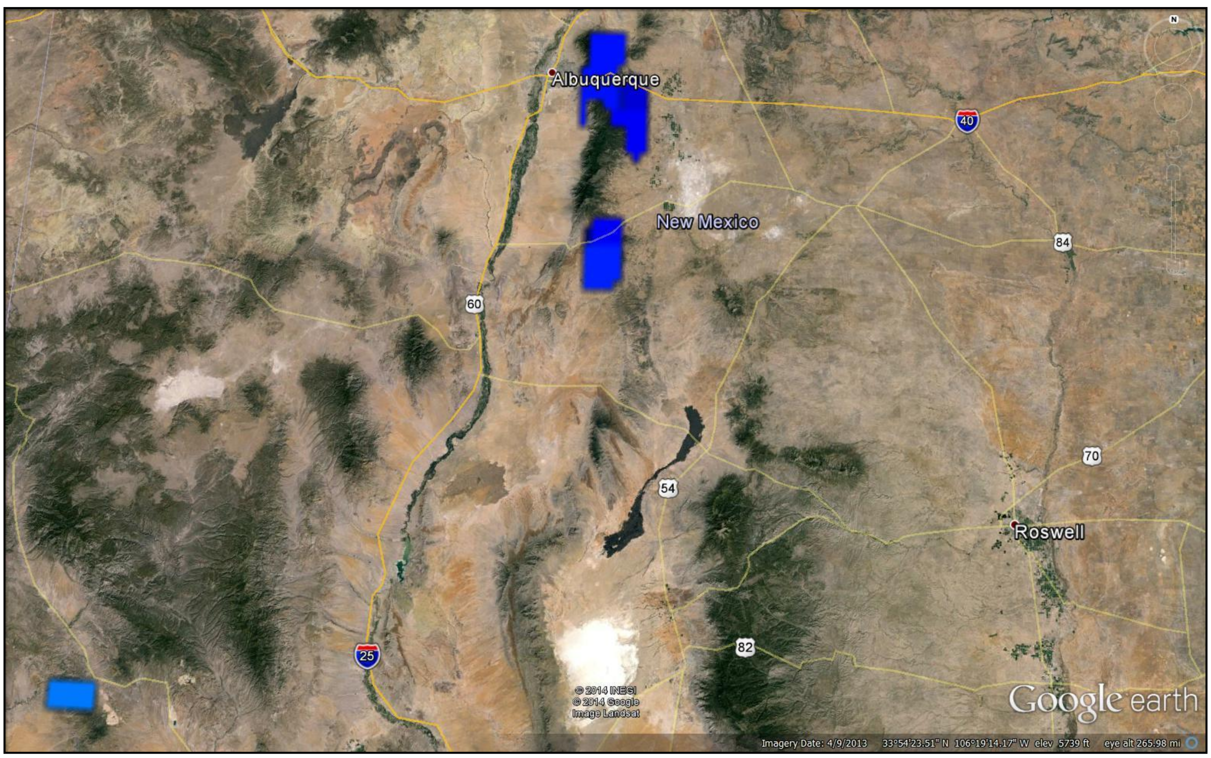


Figure 25: GASP West Aerosol Optical Depth image at 10:15 AM MST (1715Z) March 18, 2012 and Map overlay.
(Source: http://www.star.nesdis.noaa.gov/smcd/spb/aq/index.php?product_id=2)

The web cameras along with MODIS and GASP imagery from New Mexico all lend support to the argument that the dust storm of March 18, 2012 was a regional event that was not reasonably controllable or preventable. The hallmarks of a regional dust transport event are strong winds present at the surface and aloft, combined with deep atmospheric mixing. Surface observations from Table 1 through Table 18 have already provided ample evidence that strong surface winds were in place over the region. By viewing upper-air maps we can also establish that the winds aloft were very strong and atmospheric mixing was sufficiently deep during the dust event of March 18, 2012.

Figure 26 shows a detailed view of the 700 mb trough via the NARR (North American Regional Reanalysis) at 11 AM MST, March 18, 2012. Embedded in the trough are a number of well-defined shortwaves. One of those shortwaves can be observed in southwest New Mexico with an area of strong 40-50 knot winds located just to the northeast of this shortwave (circled in red). It should be noted that this band of high winds was located directly upwind from the Alamosa monitor, approximately over Albuquerque, New Mexico.

Concurrently, a cold front was moving into western New Mexico (Figure 4). This approaching cold front effectively destabilized the atmosphere and produced deep mixing. Figure 27 shows the height of the top of the mixed layer in kilometers above MSL at 11 AM MST, March 18, 2012. We can see that deep mixing of 5-7km was occurring over western New Mexico in advance of the cold front, including over Albuquerque.

Referring back to surface observations at 11 AM MST, March 18, 2012, in the general vicinity of the strong winds aloft and deep mixing, Albuquerque reported sustained winds of 44 mph, gusts to 66 mph with blowing dust and visibility reduced to ¾ of a mile (Table 8, 10:59 AM MST). Meanwhile in nearby Belen the winds were sustained at 36mph, gusts to 46 mph with haze and the visibility down to 2 miles (Table 9, 10:55 MST). When blowing dust occurs with surface winds of this magnitude and then combined with strong winds aloft and deep mixing, dust can be suspended for many hours and transported long distances via Aeolian processes (Lancaster, 2009).

In order to definitively attribute at least a portion of the dust deposition in Alamosa to long-range transport from New Mexico, a NOAA HYSPLIT backward trajectory analysis (Draxler and Rolph, 2012) was conducted (Figure 28). The analysis includes 6-hour duration back trajectories from Alamosa initializing at 17Z (10 AM MST) and ending at 00Z (5 PM MST). This encompasses the time period when Alamosa was reporting haze and reduced visibility observations (see the following link for more information on HYSPLIT from the NOAA Air Resources Laboratory: http://www.arl.noaa.gov/HYSPLIT_info.php). The trajectory analysis clearly shows the transport of air from the same part of New Mexico that was experiencing high surface winds, strong winds aloft, deep atmospheric mixing, and reports of blowing dust and haze.

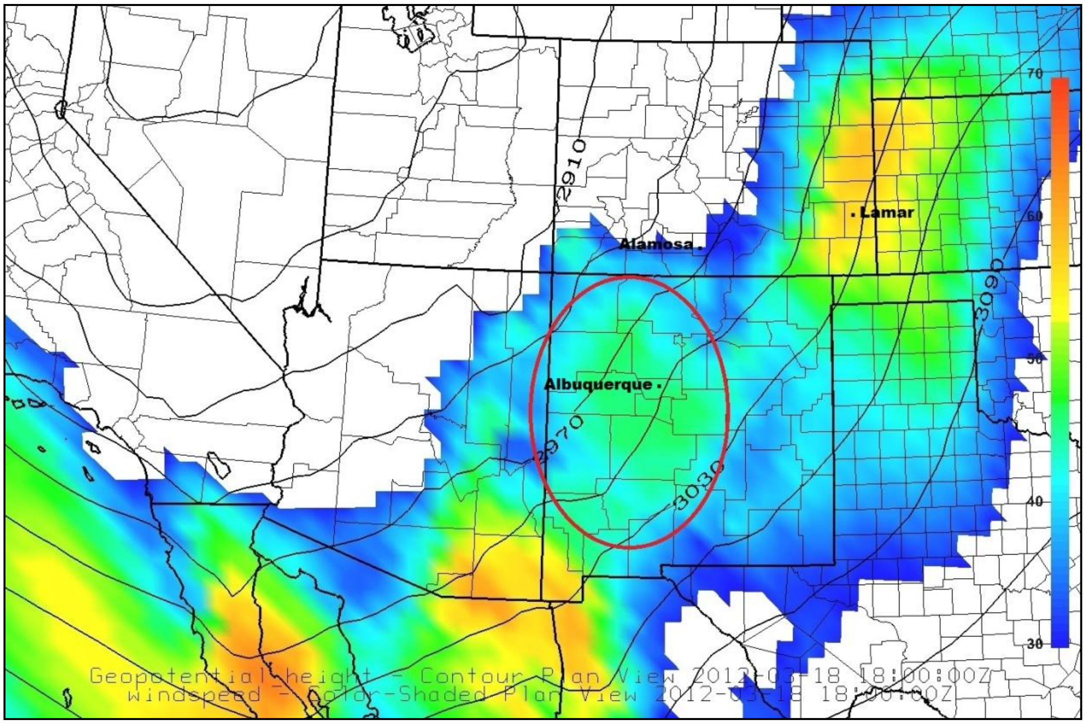


Figure 26: NARR 700 mb analysis for 18Z March 18, 2012, or 11 AM MST March 18, 2012 showing wind speeds in knots. Only speeds above 30 knots are shown.
(Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

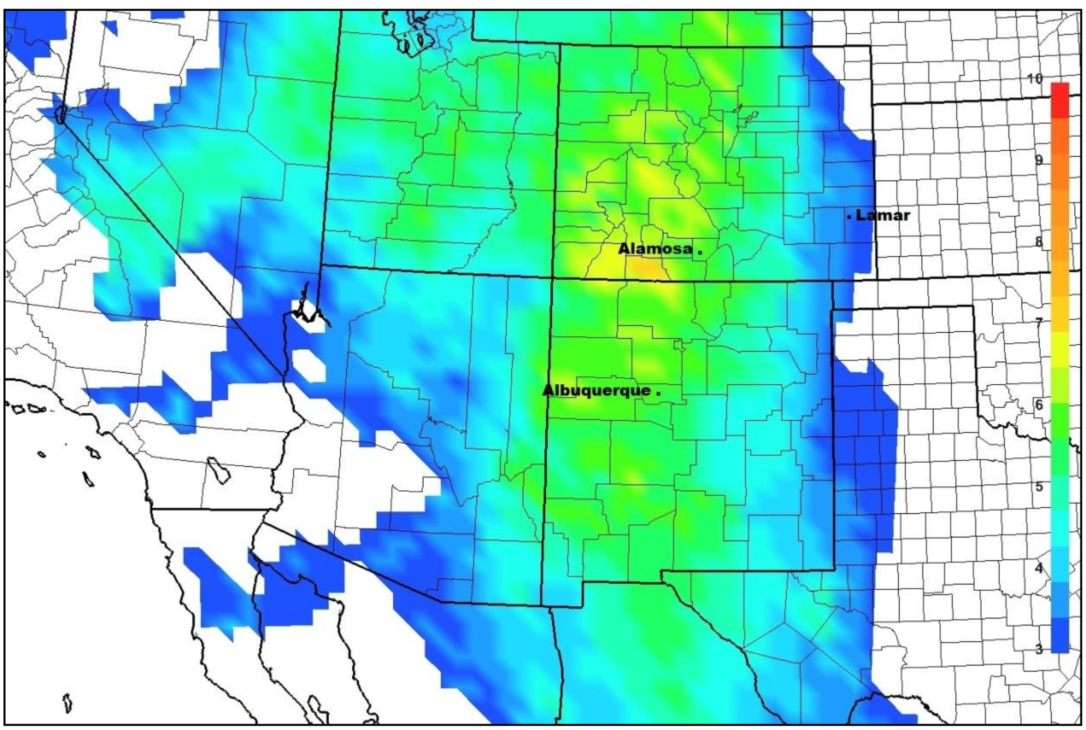


Figure 27: Height of the mixed layer in kilometers above mean sea level from the NARR at 18Z March 18, 2012, or 11 AM MST March 18, 2012. Only mixing heights above 3 kilometers are shown.
(Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

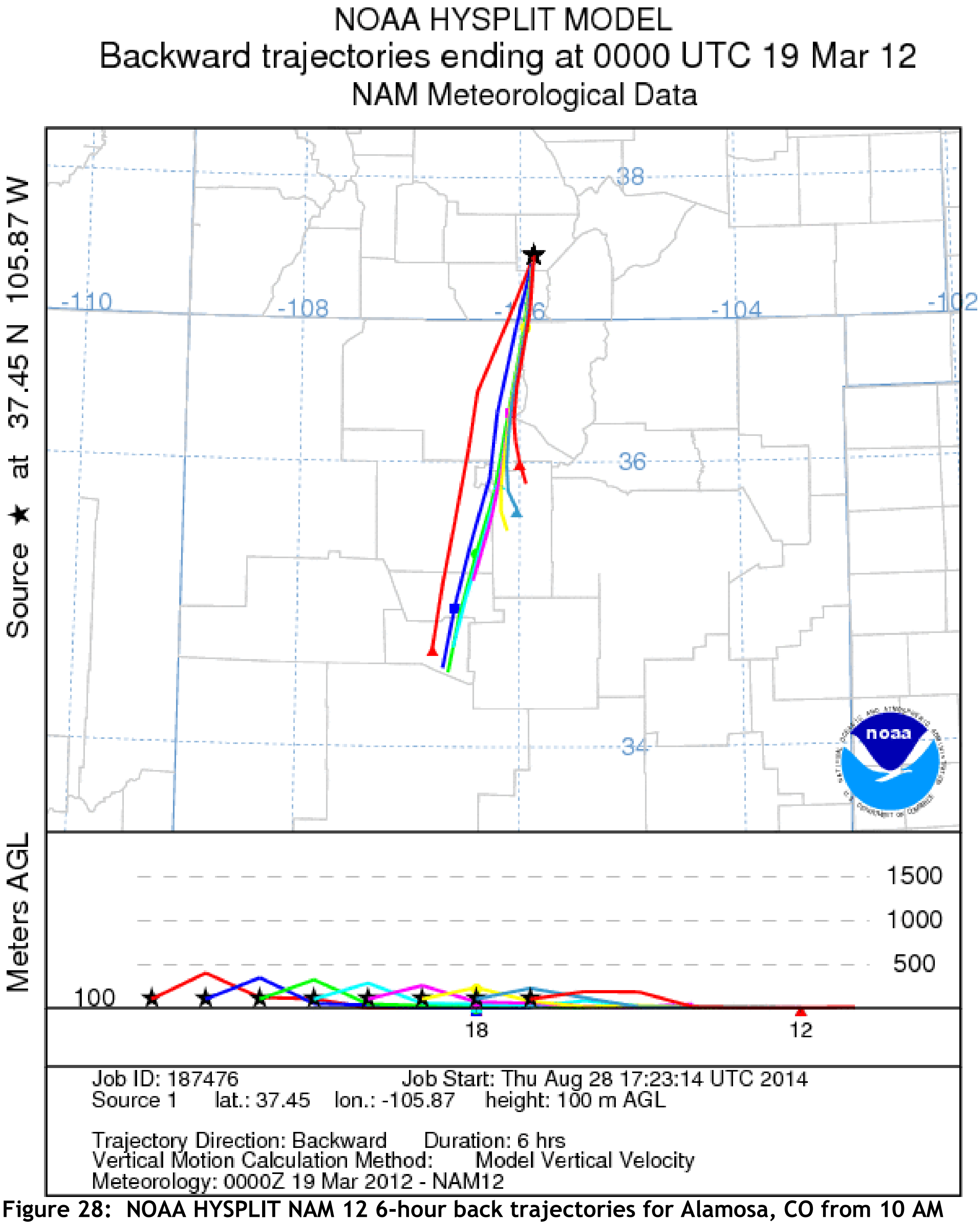


Figure 28: NOAA HYSPLIT NAM 12 6-hour back trajectories for Alamosa, CO from 10 AM MST (17Z) March 18, 2012, to 5 PM MST (0Z March 19) March 18, 2012.
(Source: http://ready.arl.noaa.gov/HYSPLIT.php)

The conditions that created blowing dust in Alamosa during the late morning and afternoon hours of March 18, 2012 produced similar results for Lamar later in the day. Figure 29 shows the top of the mixed layer at 2 PM MST. Once again we notice that deep mixing was taking place over New Mexico, reaching 6-8km above MSL across the northern half of the state. With this very deep mixing, a significant amount of dust could realistically have been suspended to the 500 mb level (about 6 km above MSL). The winds at the 500 mb level were exceedingly strong at 2 PM MST, approaching 100 knots across large portions of New Mexico (Figure 30). Three hours later at 5 PM MST, the 500 mb jet streak would have been directing any suspended particulates at that level directly towards Lamar (Figure 31). The same can be said for conditions lower in the atmosphere at 5 PM MST with 700 mb transport leading from New Mexico into southeast Colorado (Figure 32).

The NOAA HYSPLIT back trajectory analysis for Lamar confirms that at least a portion of the air mass over southeast Colorado during the afternoon and evening of March 18, 2012 was transported from northeast New Mexico. Prior research by CDPHE has shown that northeast New Mexico is a known source region for blowing dust events in Lamar (see Blowing Dust Climatologies available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2). Webcam imagery from Raton (Figure 20 through Figure 22) has already confirmed that a dust storm was taking place in this part of northeast New Mexico during the early and mid afternoon hours of March 18, 2012. Additionally, surface observations from across the region in Clayton (Table 10), Las Vegas (Table 13) and Tucumcari (Table 18) also show several hours of high winds, haze and reduced visibilities.

Lamar also experienced a brief secondary increase in wind speeds with a decrease in visibility during the evening hours of March 18, 2012. This re-intensification of the wind likely occurred due to strong winds aloft being mixing down to the surface. At 8:53 PM MST (Table 2) the wind abruptly increased again to 35 mph at the surface with gusts to 45 mph and visibility dropping to 4 miles. This occurred less than an hour after Figure 34 shows a 700 mb jet streak directly over Lamar. Additionally, Figure 35 reveals that mixing remained fairly deep at 4-6 km. Mixing to this degree would have been more than sufficient to mix down the strong winds at 700 mb (about 3 km above MSL) and provide a temporary increase in the wind speed despite the loss of diurnal heating.

The synoptic weather conditions on March 18, 2012 over New Mexico and southern parts of Colorado were conducive for widespread strong gusty winds and the long range transport of blowing dust.

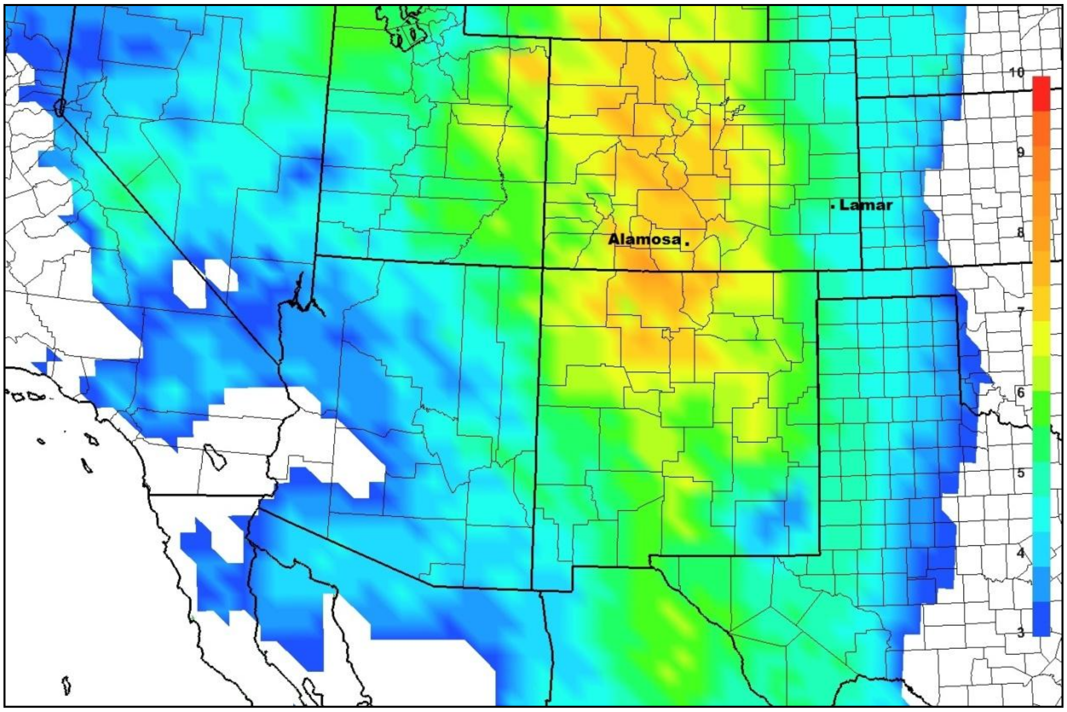


Figure 29: Height of the mixed layer in kilometers above mean sea level from the NARR at 21Z March 18, 2012, or 2 PM MST March 18, 2012. Only heights above 3 kilometers are plotted.
(Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

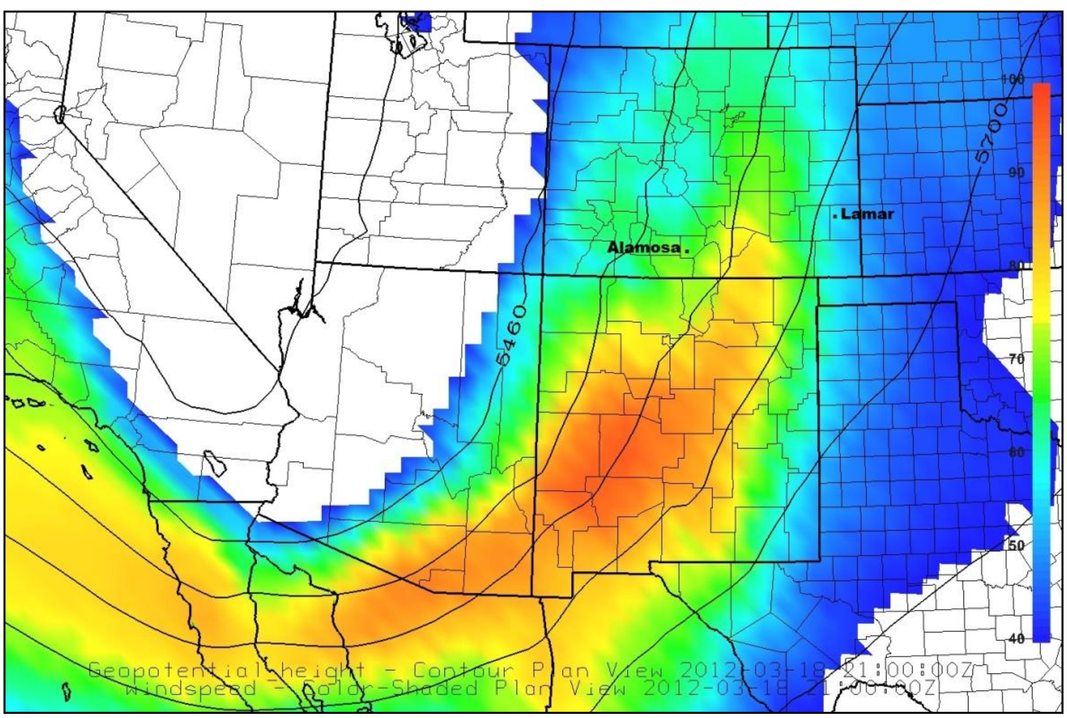


Figure 30: NARR 500 mb analysis for 21Z March 18, 2012, or 2 PM MST March 18, 2012 showing wind speeds in knots. Only speeds above 40 knots are shown.
(Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

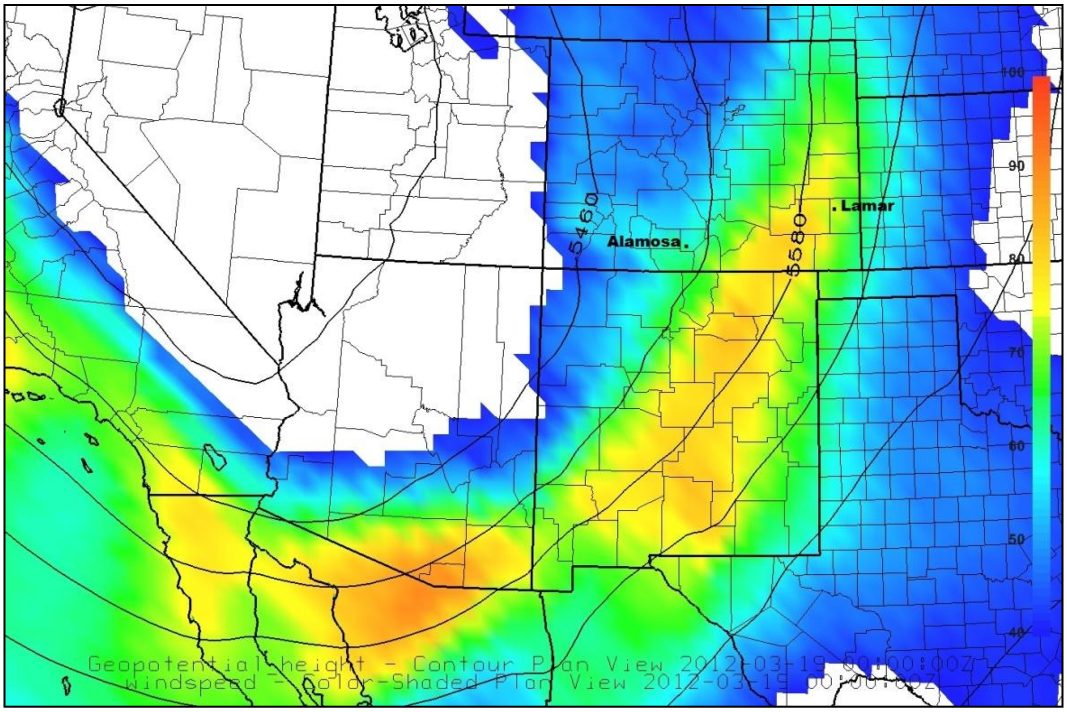


Figure 31: NARR 500 mb analysis for 0Z March 19, 2012, or 5 PM MST March 18, 2012 showing wind speeds in knots. Only speeds above 40 knots are shown. (Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

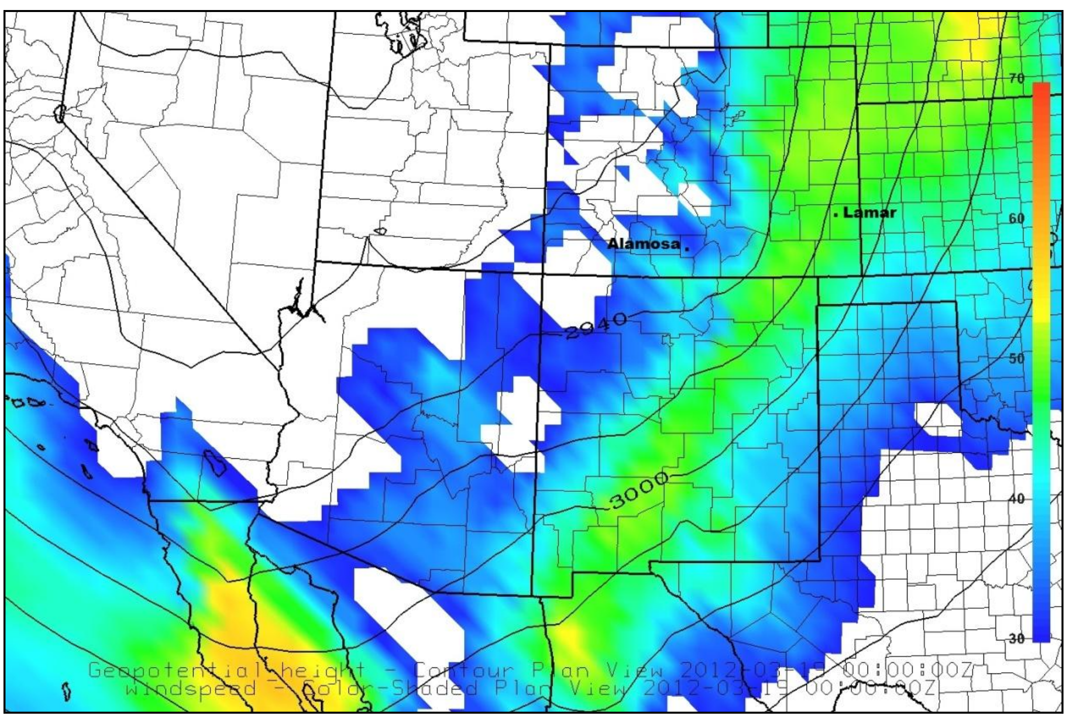


Figure 32: NARR 700 mb analysis for 0Z March 19, 2012, or 5 PM MST March 18, 2012 showing wind speeds in knots. Only speeds above 30 knots are shown. (Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

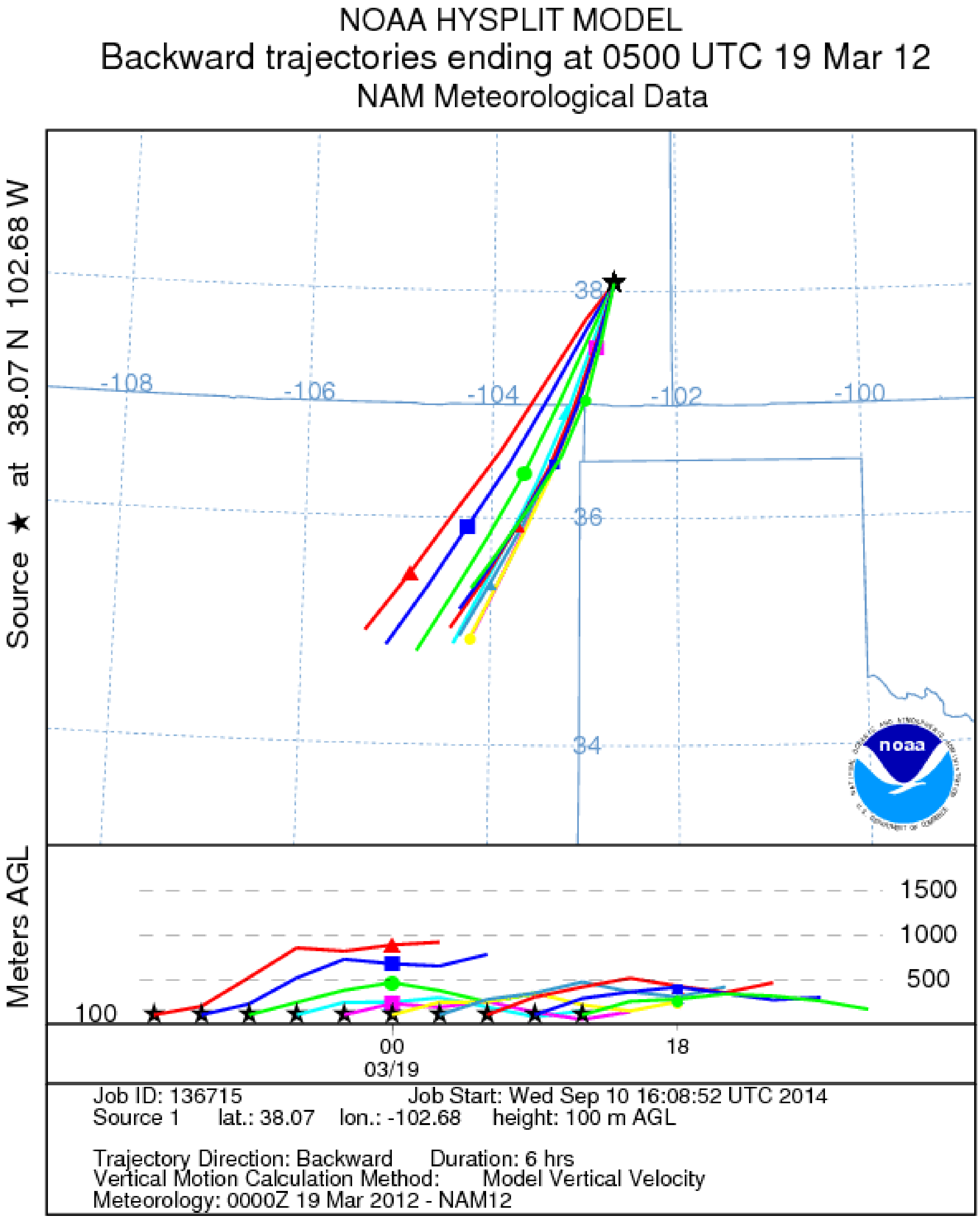


Figure 33: NOAA HYSPLIT NAM 12 6-hour back trajectories for Lamar, CO from 1 PM MST (20Z) March 18, 2012, to 10 PM MST (5Z March 19) March 18, 2012.
(Source: http://ready.arl.noaa.gov/HYSPLIT.php)

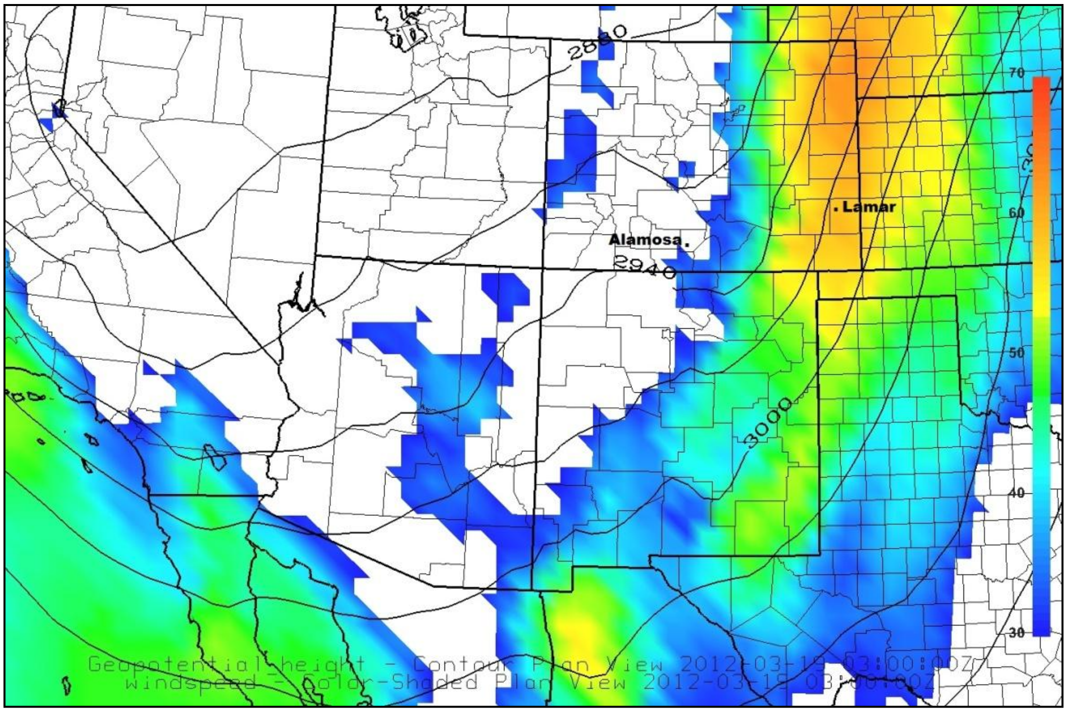


Figure 34: NARR 700 mb analysis for 3Z March 19, 2012, or 8 PM MST March 18, 2012 showing wind speeds in knots. Only speeds above 30 knots are shown.
(Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

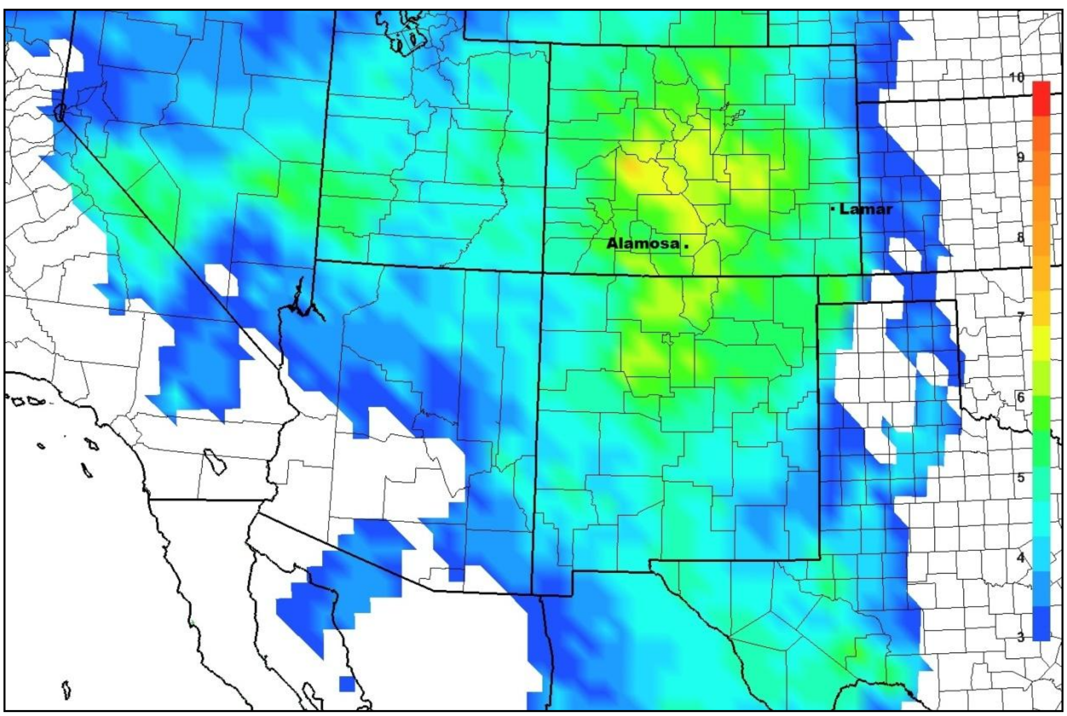


Figure 35: Height of the mixed layer in kilometers above mean sea level from the NARR at 3Z March 19, 2012, or 8 PM MST March 18, 2012. Only heights above 3 kilometers are plotted.
(Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

The Pueblo National Weather Service (NWS) forecast office issues weather information and alerts for south-central and southeast Colorado, including Alamosa and Lamar. Appendix A provides High Wind Warnings and Area Forecast Discussions from the Pueblo NWS on March 18, 2012. The highlighted text from this product clearly shows that the NWS anticipated and observed blowing dust throughout the forecast area. Additionally, CDPHE issued a Blowing Dust Advisory for eastern Colorado on March 18, 2012. This advisory can also be found in Appendix A.

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 at 0015Z (5:15 PM MST) March 19, 2012. This narrative can also be found in Appendix A and reveals that NOAA believed blowing dust was very likely occurring in eastern New Mexico and Colorado during the afternoon of March 18, 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 south-central and southeast Colorado along with eastern New Mexico on March 18, 2012.

Figure 36 shows the output for blowing dust from the Navy Aerosol Analysis and Prediction System (NAAPS) Global Aerosol Model for 5 PM MST on March 18, 2012. The NAAPS system models blowing dust emissions and transport based on soil moisture content, soil erodibility factors and a variety of meteorological factors known to be conducive to 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 36 shows an area of highly elevated surface dust concentrations over much of New Mexico and southeast Colorado. The upper left panel also reveals above normal Total Optical Depth values attributed to dust for the same geographic area.

Forecast products from the Navy Aerosol Analysis and Prediction System model provide supporting evidence for a regional blowing dust event on March 18, 2012.

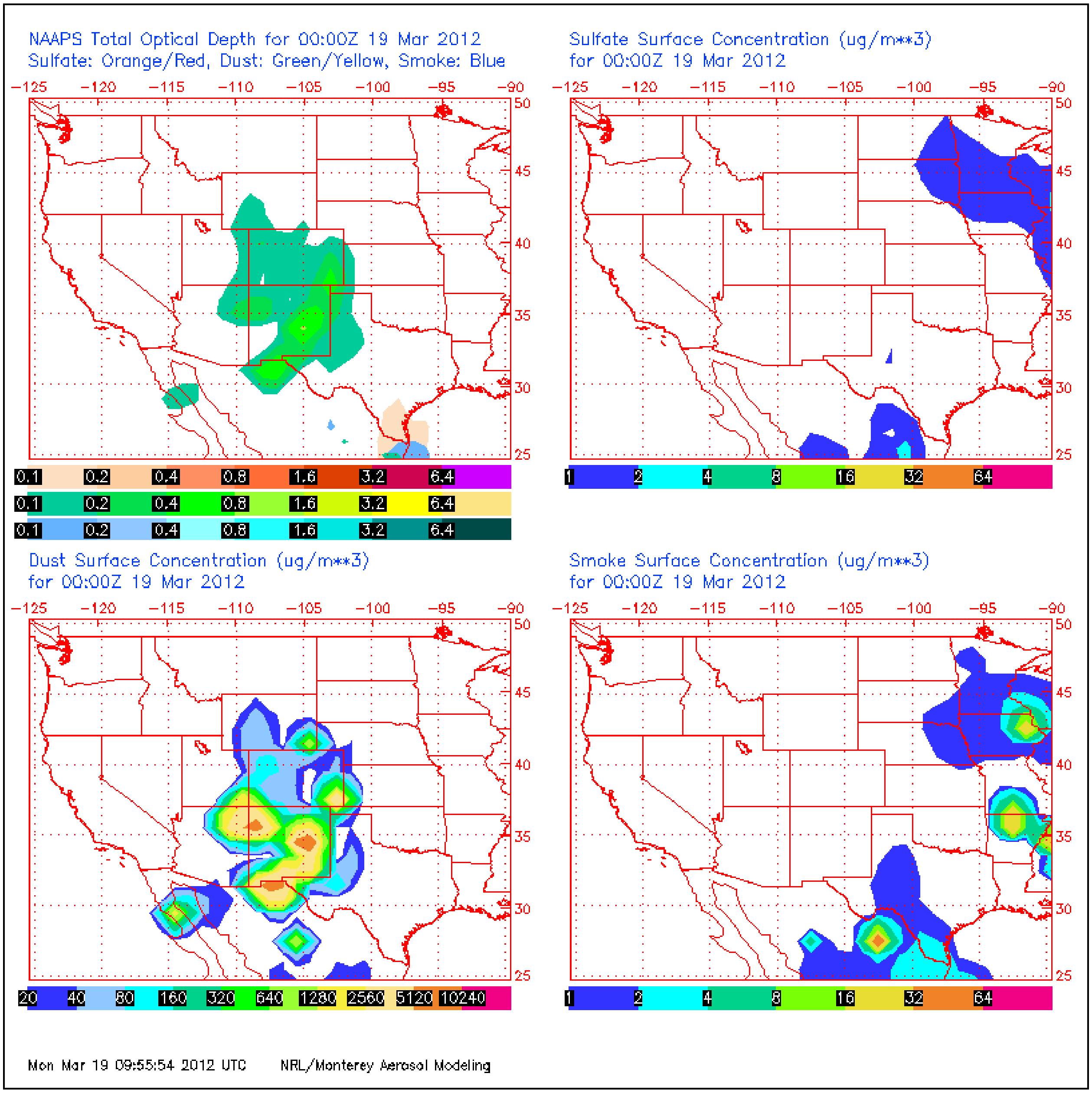


Figure 36: NAAPS forecasted dust concentrations for 5 PM MST March 18 (00Z March 19), 2012.
(Source: http://www.nrlmry.navy.mil/aerosol-bin/aerosol/display_directory_all?DIR=/web/aerosol/public_html/globaer/ops_01/wus/)

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 for the southwest United States, including southern Colorado and all of New Mexico, were calculated for 11 AM and 3 PM MST March 18, 2012 using the 12 km NAM

(North American Mesoscale Model). These friction velocities are presented in Figure 37 and Figure 38, respectively. According to data presented by 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 m/s range. In Figure 37, the area immediately surrounding Alamosa show friction velocities of less than 1.0 m/s despite the fact that high winds and haze were occurring at that time (Table 1, 10:52 AM MST). However, to the south in New Mexico values were much higher ranging from 1.0 – 1.5 m/s. These higher friction velocities well to the south of Alamosa point to long-range transport of dust, hence a regional event.

Figure 38 shows that friction velocities increased in southeast Colorado, with values around 1.0 m/s around the Lamar area. Therefore it is reasonable to assume that undisturbed soils surrounding Lamar were susceptible to blowing dust at 2 PM MST on March 18, 2012. Additionally, frictional velocity values were even higher upwind from Lamar across eastern New Mexico. Once again, widespread velocities approaching 1.5 m/s can be observed. Note that this is the same part of New Mexico where 30-day precipitation values were below 0.5 inches (Figure 12) and where severe to extreme drought conditions were being experienced (Figure 13). Blowing dust will typically only occur where friction velocities are high and soils are dry. This is exactly the pairing of factors that was present for south-central and southeast Colorado along with wide areas of New Mexico on March 18, 2012.

The elevated friction velocities shown in Figure 37 and Figure 38, the data on soil moisture conditions presented elsewhere in this report and the prevalence of winds above blowing dust thresholds prove that this dust storm was a natural, regional event that was not reasonably controllable or preventable.

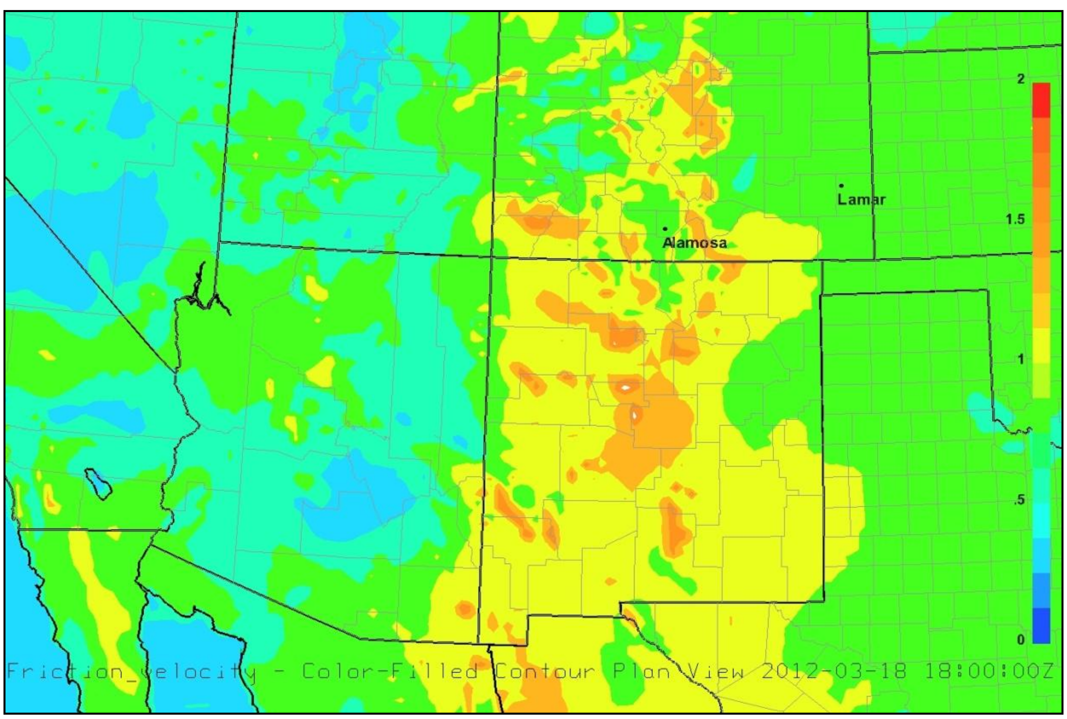


Figure 37: 12 km NAM friction velocities in meters/second at 11 AM MST (18Z) March 18, 2012.
(Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

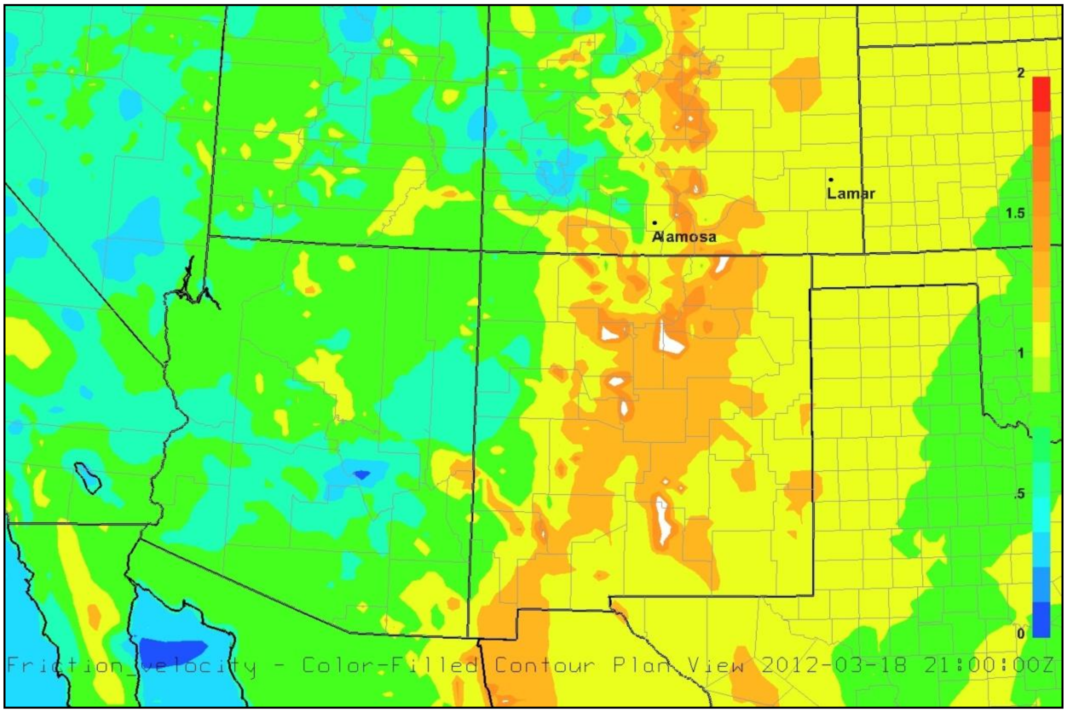


Figure 38: 12 km NAM friction velocities in meters/second at 2 PM MST (21Z) March 18, 2012.
(Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

3.0 Evidence-Ambient Air Monitoring Data and Statistics

On March 18, 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 southern Colorado and New Mexico affecting PM_{10} samples across a broad geographical area. During this event samples in excess of 150 $\mu g/m^3$ were recorded at Alamosa-Adams State College (Alamosa ASC, 324 $\mu g/m^3$), Alamosa-Municipal Building (Alamosa Muni, 23 $\mu g/m^{3)}$, Lamar-Power Plant (Lamar Power, 220 $\mu g/m^3$) and Lamar-Municipal Building (Lamar Muni, 242 $\mu g/m^3$). An elevated sample was recorded at the Pagosa Springs monitoring site (Pagosa, 65 $\mu g/m^3$). No other sites/samples were affected by this event. The elevated PM_{10} readings resulted from blowing dust associated with strong, gusty winds in lead of the cold front.

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

This evaluation of PM_{10} monitoring data for sites affected by the March 18, 2012, event was made using valid samples from PM_{10} samplers in Alamosa and Lamar from 2007 through 2012, APCD has been monitoring PM_{10} concentrations in these areas since 1985. The overall data summary for the affected sites is presented in Table 19, with all data values being presented in $\mu g/m^3$:

Table 19: March 18, 2012, Event Data Summary

Evaluation	*Alamosa ASC*	*Alamosa Muni*	*Lamar Power*	*Lamar Muni*
3/18/2012	**324**	**237**	**220**	**242**
Mean	29.6	23.2	27.9	21.7
Median	24	20	24	19
Mode	20	16	23	15
St. Dev.	28.51	17.94	21.13	15.26
Var.	812.59	322.02	446.38	232.75
Minimum	1	2	3	1
Maximum	635	349	367	242
Count	1839	2048	2181	2114

The approximate percentile values for various criteria were calculated and are displayed in Table 20. All percentile calculations presented in this table were made using the entire dataset, including known high wind events. There is no difference between the two datasets for any site (with and without high wind events) in regards to percentile calculations. Percentile calculations for the entire dataset (‘Overall’), for samples taken in any March (‘Any March’) and for 2012 for all sites affected by the event are presented in Table 20.

Table 20: March 18, 2012 Site Percentile (All Affected Sites)

Evaluation	*Alamosa ASC*	*Alamosa Muni*	*Lamar Power*	*Lamar Muni*
2/23/2012	**324**	**237**	**220**	**242**
Overall	99.8%	99.8%	100.0%	Max
Any March	Max	Max	Max	Max
2012	99.8%	99.7%	Max	Max

The percentile calculations in Table 20 demonstrate the extreme nature of these samples as compared with each dataset. Although the Pagosa Springs sample is not in excess of 150 µg/m^3 it is still the 95th percentile sample recorded among all March samples from 2007 through 2012 and exceeds the 98th percentile value of all samples in 2012. That all samples from affected sites 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 the four sites are further summarized by month. 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 from these periods (winter and spring) that are generally lower than other months of the year. This time frame (winter and 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 March (all samples in any March from 2007-2012) and for 2012 for all four sites are presented in Table 21:

Table 21: March 18, 2012 PM_{10} Evaluation by Month and Year

Evaluation	*Alamosa ASC*		*Alamosa Muni*		*Lamar Power*		*Lamar Muni*	
	March	All 2012	March	All 2012	March	All 2012	March	All 2012
Mean	23.1	26.9	30.3	32.3	30.9	28.1	24.5	24.6
Median	16	20	23	25	25	24	20	20
Mode	14	13	24	18	18	27	15	17
St. Dev.	29.30	32.98	27.91	28.59	27.17	23.08	24.83	21.45
Var.	858.76	1087.80	779.22	817.30	738.03	532.66	616.37	460.07
Minimum	3	5	6	6	3	3	2	3
Maximum	324	389	237	239	220	220	242	242
Count	165	357	155	314	186	361	179	364

Alamosa ASC – 08-0039-0001

The PM_{10} sample on March 18, 2012, at Alamosa ASC of 324 µg/m^3 is the largest sample recorded among all March samples from 2007 through 2012, is the 2nd 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 4th largest sample in the entire data set. All three samples greater than the event sample are associated with a high wind event. There are 1,839 samples in the Alamosa ASC dataset. The sample of March 18, 2012 clearly exceeds the typical samples for this site.

Figure 39 to Figure 42 graphically characterize the Alamosa ASC PM_{10} data. The first, Figure 39, 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 1,839 samples in this data set, less than 1% are greater than 100 µg/m^3.

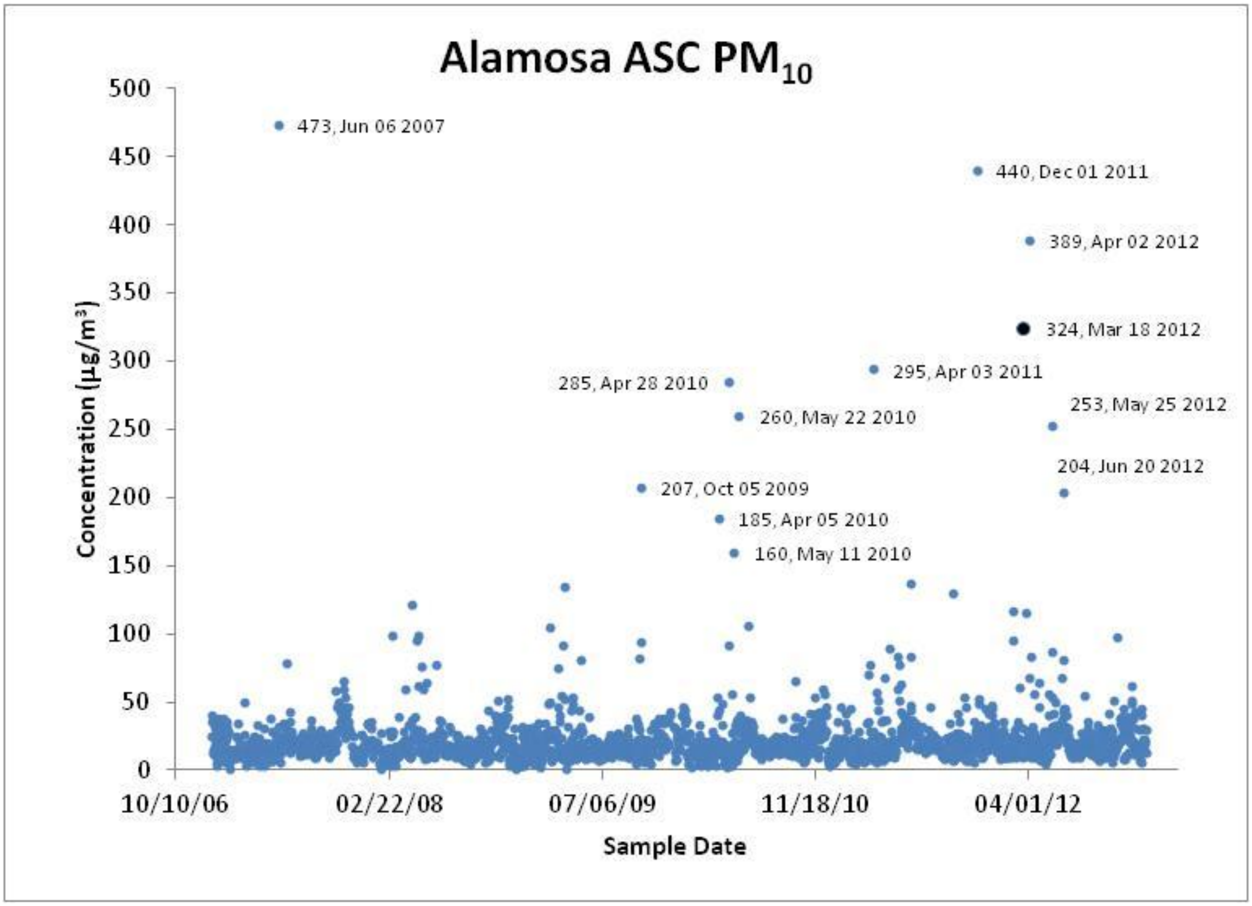


Figure 39: Alamosa ASC PM_{10} Time Series, 2007-2012

Figure 40 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 80% 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 March 18, 2012, exceeds what is typical for this site.

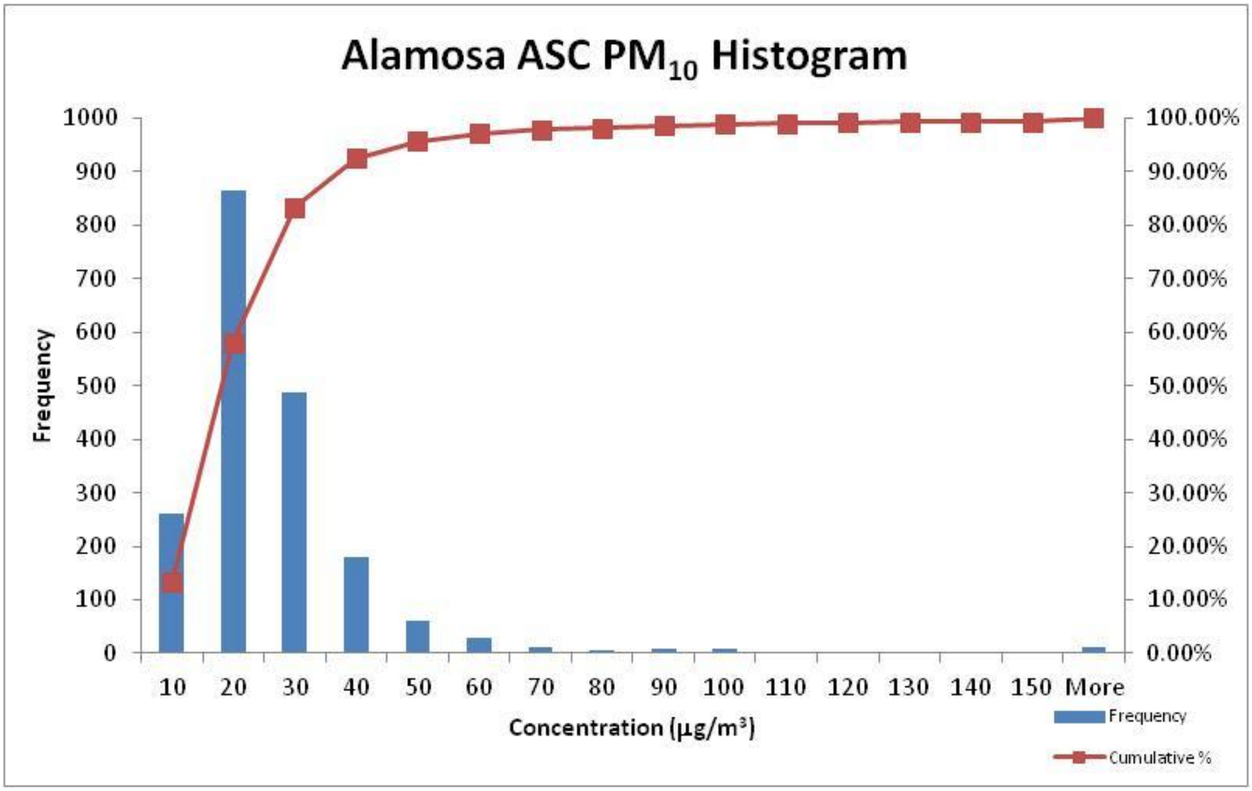


Figure 40: Alamosa ASC PM_{10} Histogram, 2007-2012

The monthly box-whisker plot in Figure 41 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 March 18, 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.

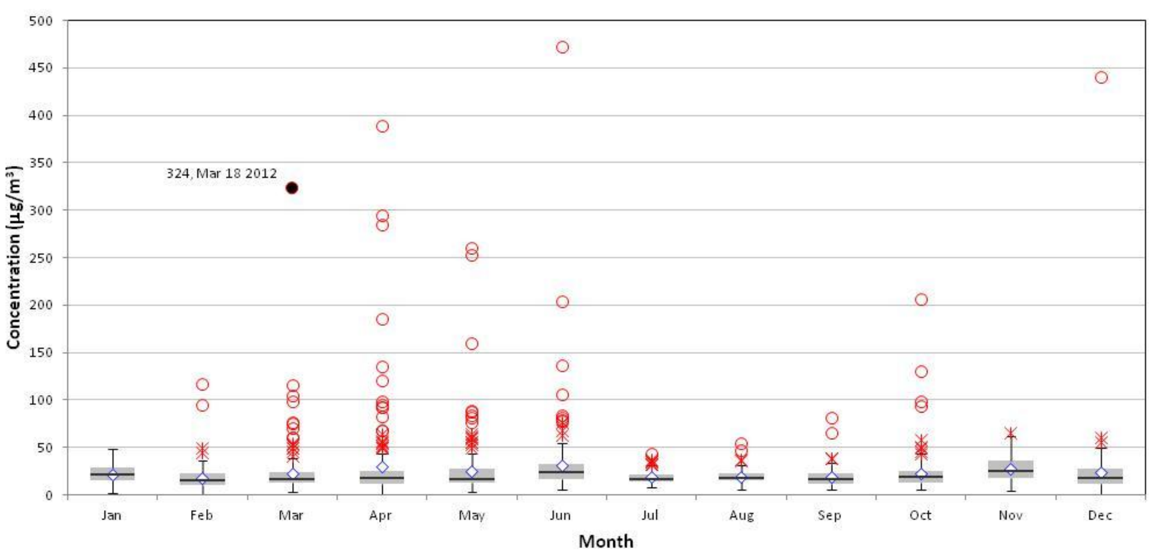


Figure 41: Alamosa ASC PM_{10} Box-Whisker Plot, 2007-2012

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 March 18, 2012.

The presence of the extreme values distorts the graph, losing definition and distorting information presented across the small portion of 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 42. This expanded plot demonstrates that March 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 due to a small number of extreme samples.

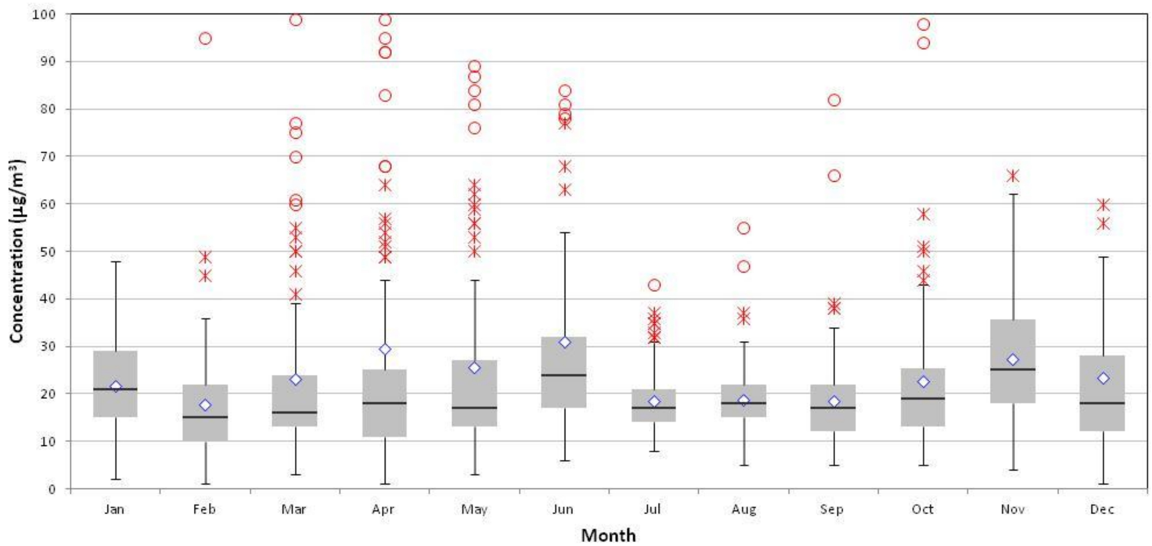


Figure 42: Alamosa ASC PM_{10} Box-Whisker Plot, Reduced Scale, 2007-2012

Note the degree to which the data in the months of fall through spring, beginning in October and extending through May, are skewed. The March mean (23.1 μg/m^3) is greater than the March median value (16 μg/m^3) and is greater than 74% of all samples in any March. 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 42 suggests that typical, day to day PM_{10} concentrations exposures for the month of June and November are highest among all months. The sample of March 18, 2012, clearly exceeds the typical data at this site.

Alamosa Muni – 08-003-0003

The PM_{10} sample on March 18, 2012, at Alamosa Muni of 237 μg/m^3 is the largest sample recorded among all March samples from 2007 through 2012, is the 2nd largest sample of all

2012 data, and is greater than the 99th percentile value (115 µg/m^3) for the entire dataset. Overall, this sample is the 5th largest sample in the entire data set. All four samples greater than the event sample are associated with a high wind event. There are 2,048 samples in the Alamosa Muni dataset. The sample of March 18, 2012 clearly exceeds the typical samples for this site.

Figure 43 to Figure 46 graphically characterize the Alamosa Muni PM_{10} data. The first, Figure 43, is a simple time series; every sample in this dataset (2007 – 2012) greater than 150 µg/m^3 is identified. Note the overwhelming mass of samples occupying the lower end of the graph. Of the 2,048 samples in this data set, less than 1% are greater than 115 µg/m^3.

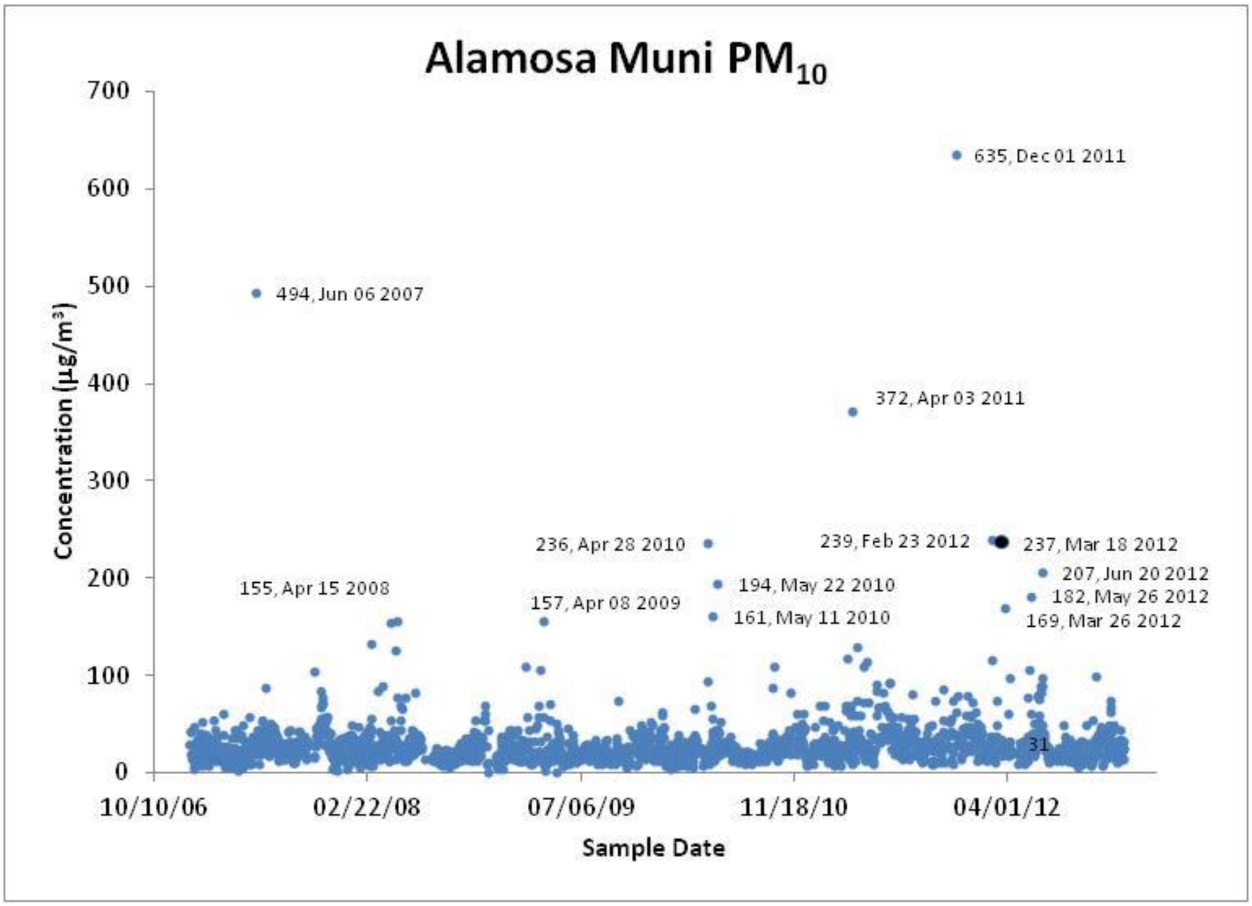


Figure 43: Alamosa Muni PM10 Time Series, 2007-2012

Figure 44 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 33 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 March 18, 2012, exceeds what is typical for this site.

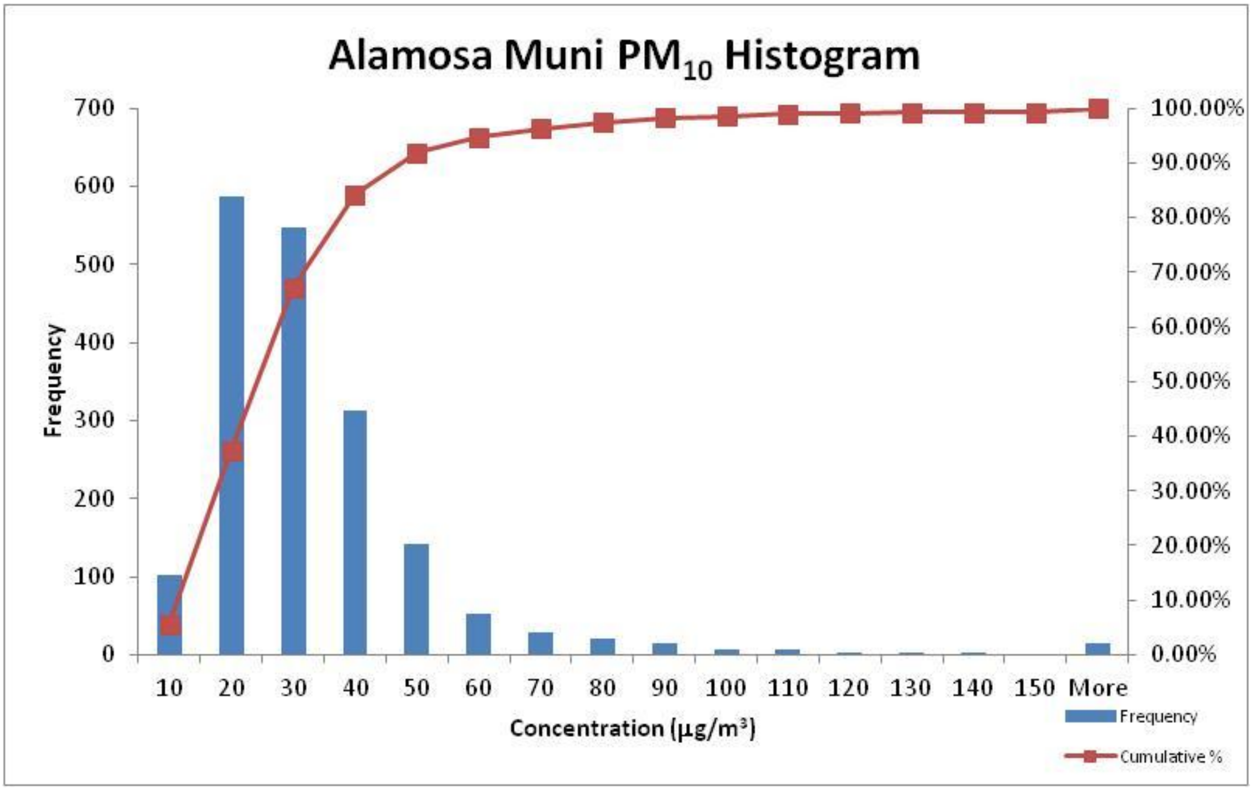


Figure 44: Alamosa Muni PM_{10} Histogram, 2007-2012

The monthly box-whisker plot in Figure 45 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 March 18, 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.

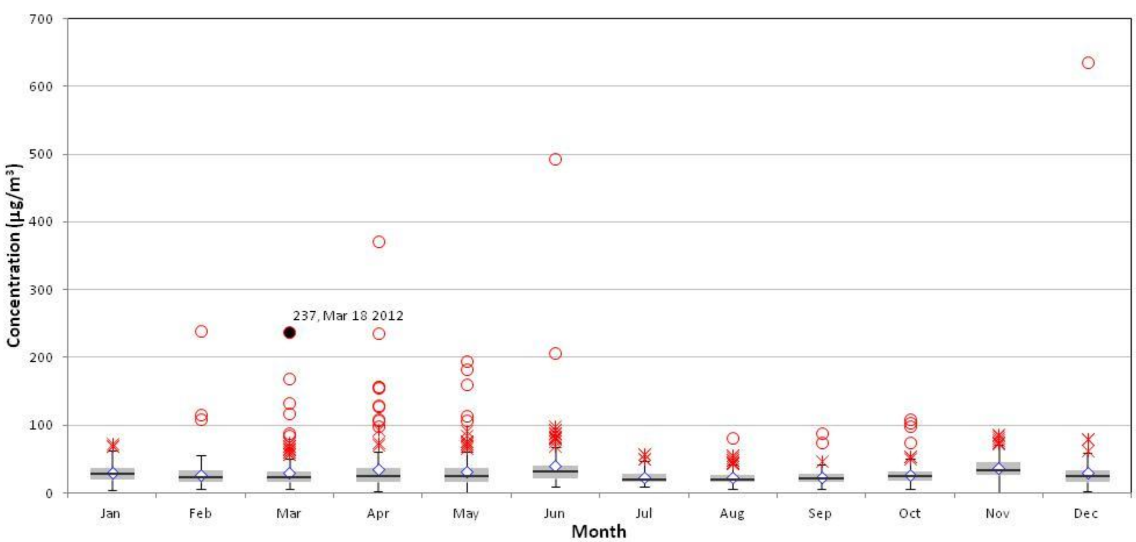


Figure 45: Alamosa Muni PM10 Box-Whisker Plot, 2007-2012

The presence of the extreme values distorts the graph, losing definition and distorting information presented across the small portion of 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 46. This expanded plot demonstrates that March 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 due to a small number of extreme samples.

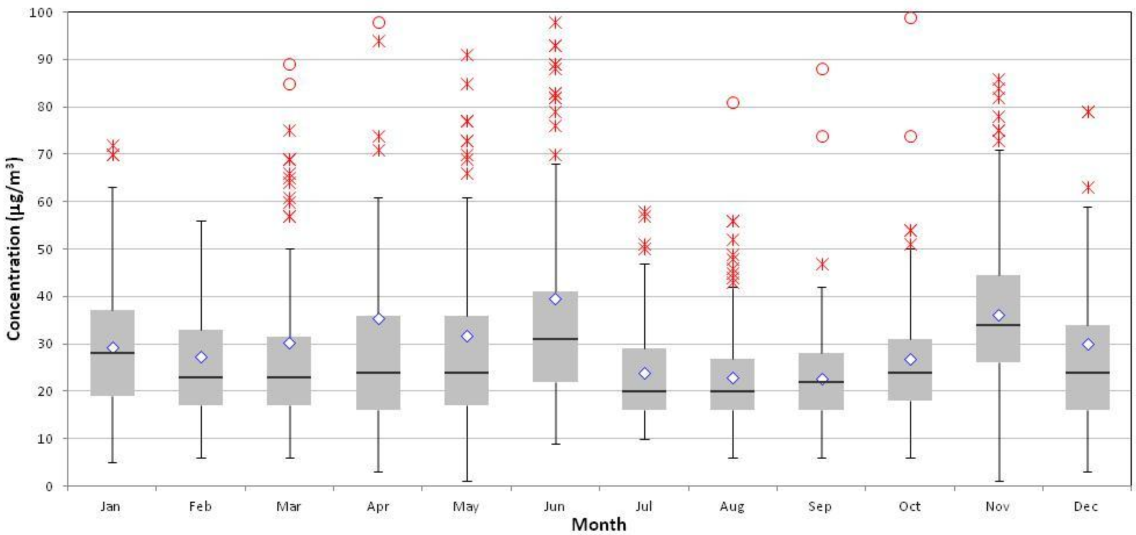


Figure 46: Alamosa Muni PM10 Box-Whisker Plot, Reduced Scale, 2007-2012

Note the degree to which the data in the months of fall through spring, beginning in October and extending through June, are skewed. The March mean (30.2 µg/m^3) is greater than the March median value (23 µg/m^3) and is greater than 72% of all samples in any March. 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 46 suggests that typical, day to day PM_{10} concentrations exposures for the month of June and November are highest among all months. The sample of March 18, 2012, clearly exceeds the typical data at this site.

Lamar Power Plant – 08-099-0001

The PM_{10} sample on March 18, 2012, at Lamar Power of 220 µg/m^3 is the largest sample recorded among all March samples from 2007 through 2012, is the 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 4th largest sample in the entire data set. All three samples greater than the event sample are associated with a high wind event. There are 2,181 samples in the Lamar Power dataset. The sample of March 18, 2012 clearly exceeds the typical samples for this site.

Figure 47 to Figure 50 graphically characterize the Lamar Power PM_{10} data. The first, Figure 47, 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.

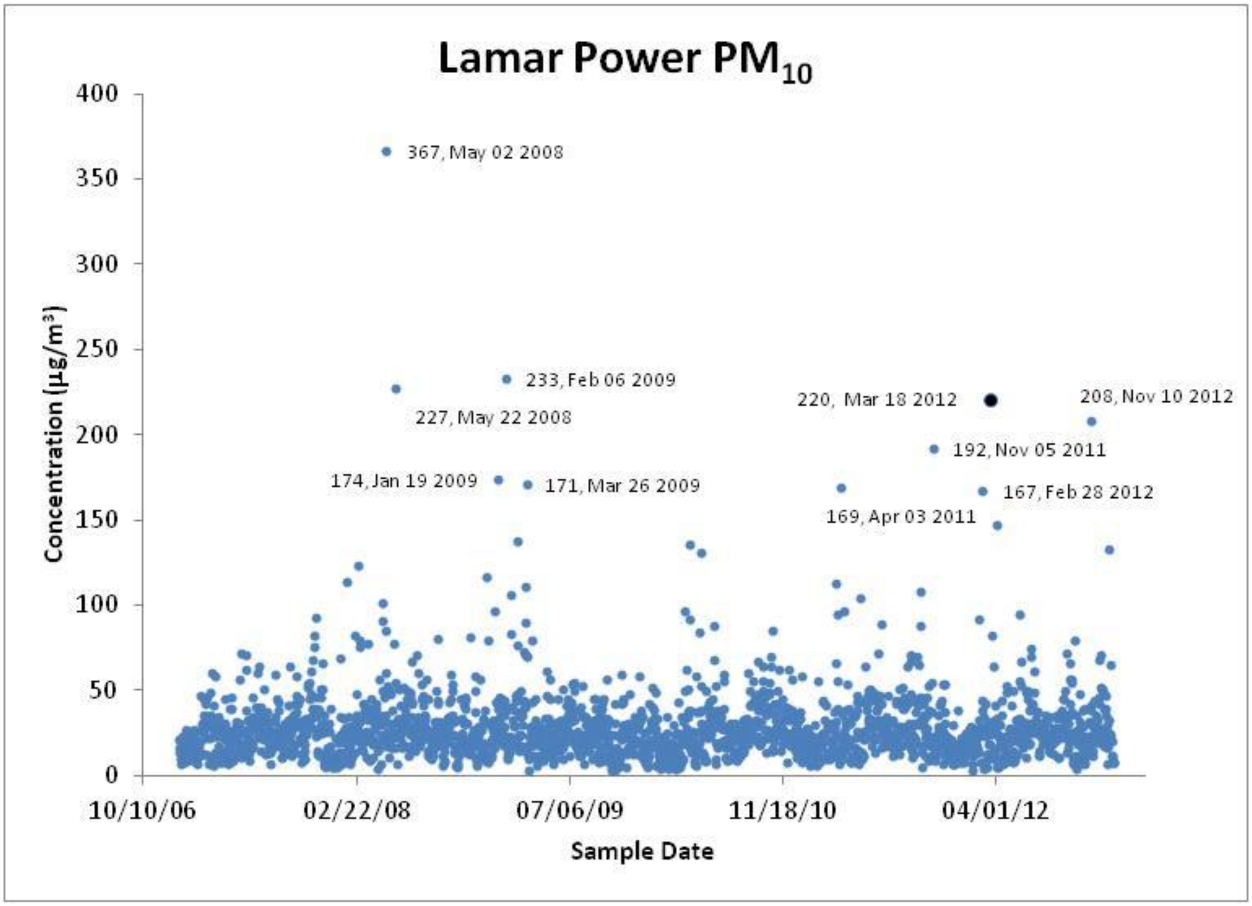


Figure 47: Lamar Power PM_{10} Time Series, 2007-2012

Figure 48, 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 March 18, 2012, exceeds what is typical for this site.

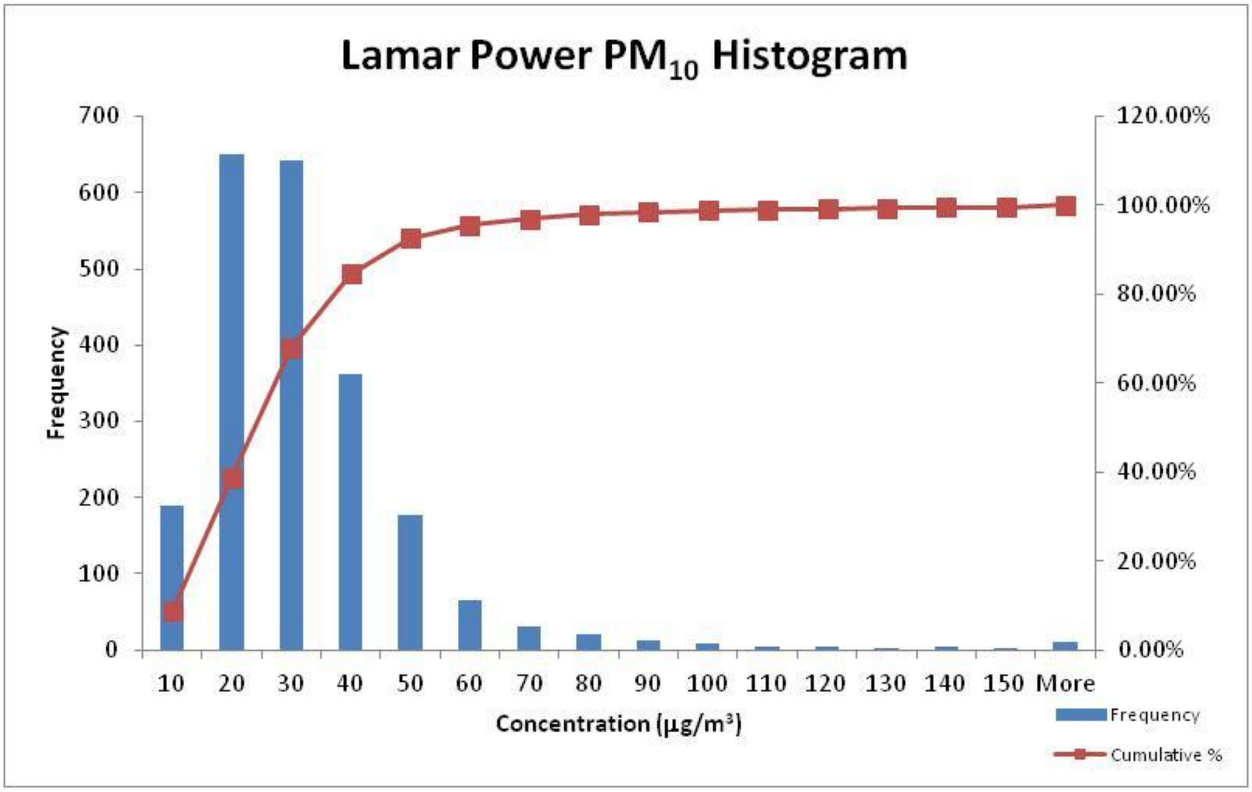


Figure 48: Lamar Power PM_{10} Histogram

The monthly box-whisker plot in Figure 49 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 March 18, 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.

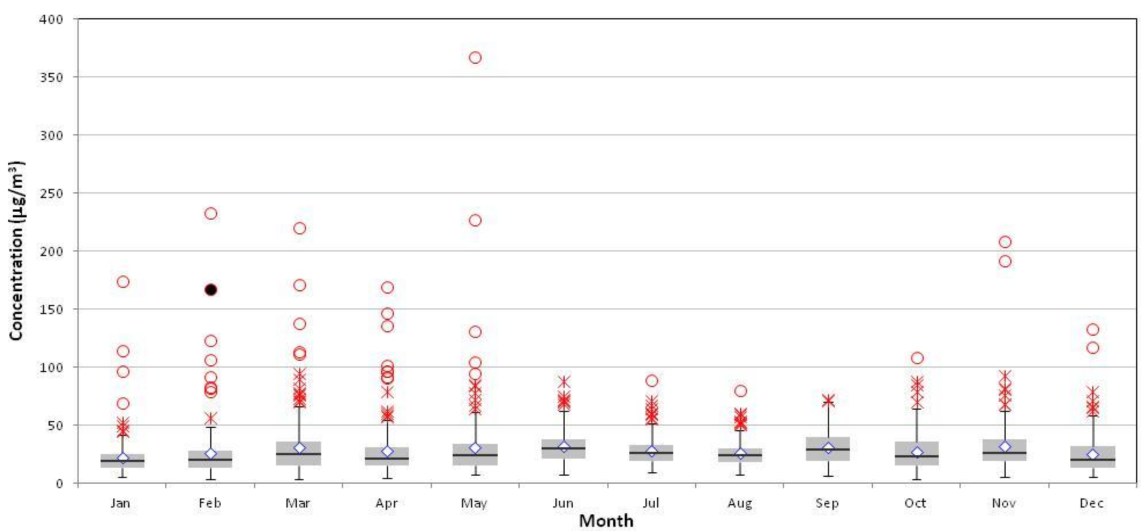


Figure 49: Lamar Power PM_{10} Box-Whisker Plot, 2007-2012

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 50. This expanded plot demonstrates that March 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.

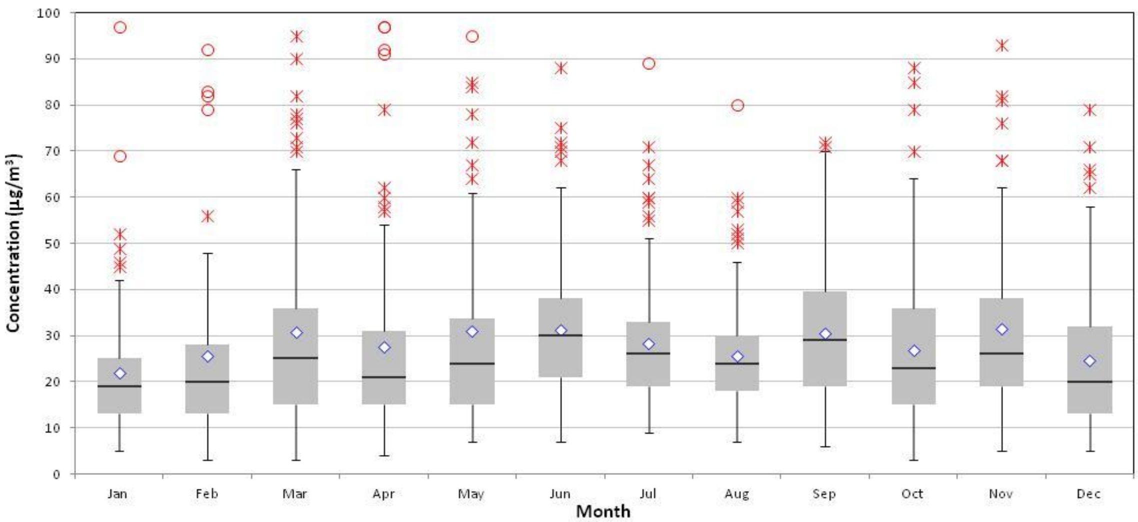


Figure 50: Lamar Power PM_{10} Box-Whisker Plot, Reduced Scale, 2007-2012

Note the degree to which the data in the months of fall through spring, beginning in October and extending through May, are skewed. The March mean (23.5 µg/m^3) is greater than the March median value (20 µg/m^3) and is greater than the 65% of all samples in any March. 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 42 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 March 18, 2012, clearly exceeds the typical data at this site.

Lamar Muni – 08-099-0002

The PM_{10} sample on March 18, 2012, at Lamar Muni of 242 µg/m^3 is the largest sample recorded among all March samples from 2007 through 2012, is the largest sample of all 2012 data, and is the largest sample in the dataset. There are 2,114 samples in the Lamar Power dataset. The sample of March 18, 2012 clearly exceeds the typical samples for this site.

Figure 51 to Figure 54 graphically characterize the Lamar Muni PM_{10} data. The first, Figure 51, 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.

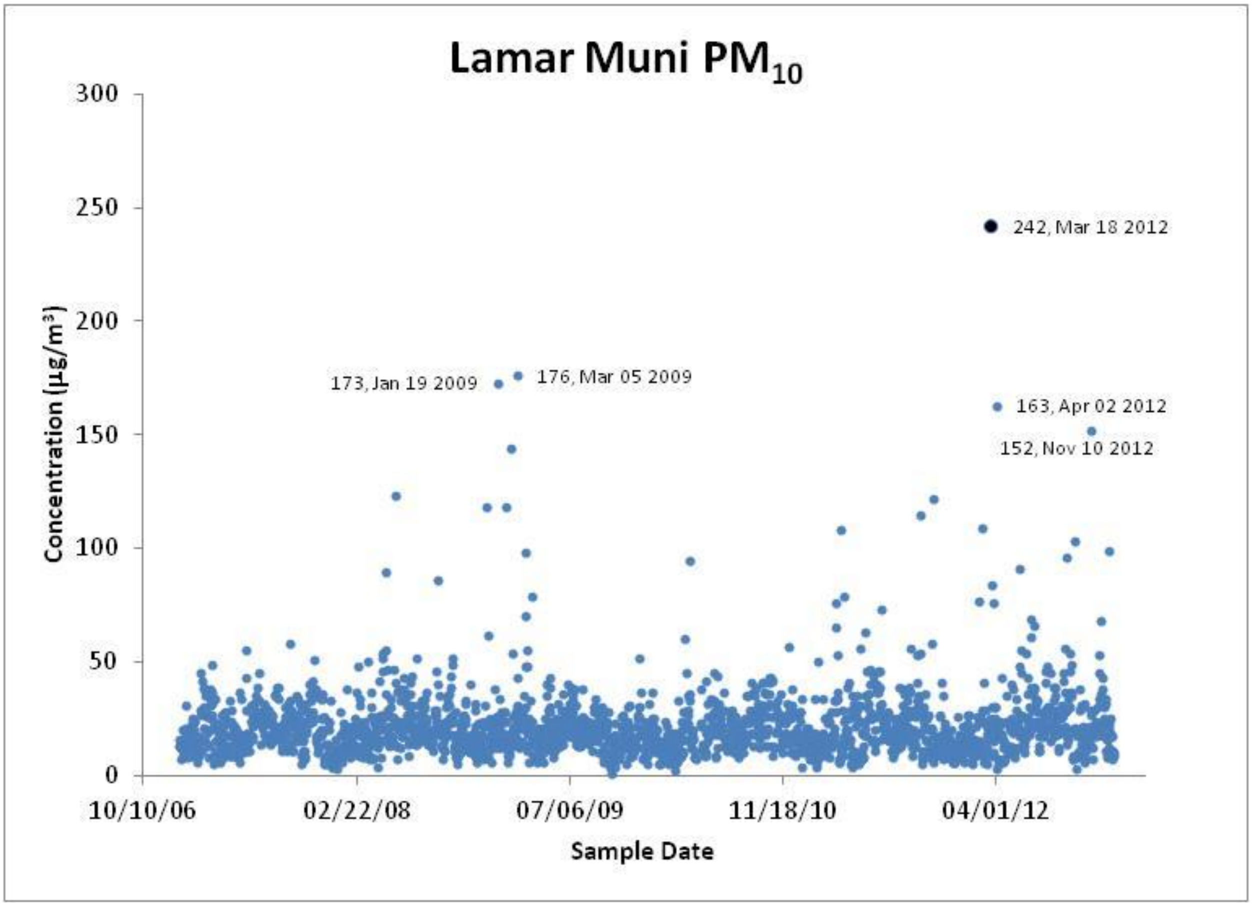


Figure 51: Lamar Muni PM_{10} Time Series

Figure 52 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 March 18, 2012, exceeds what is typical for this site.

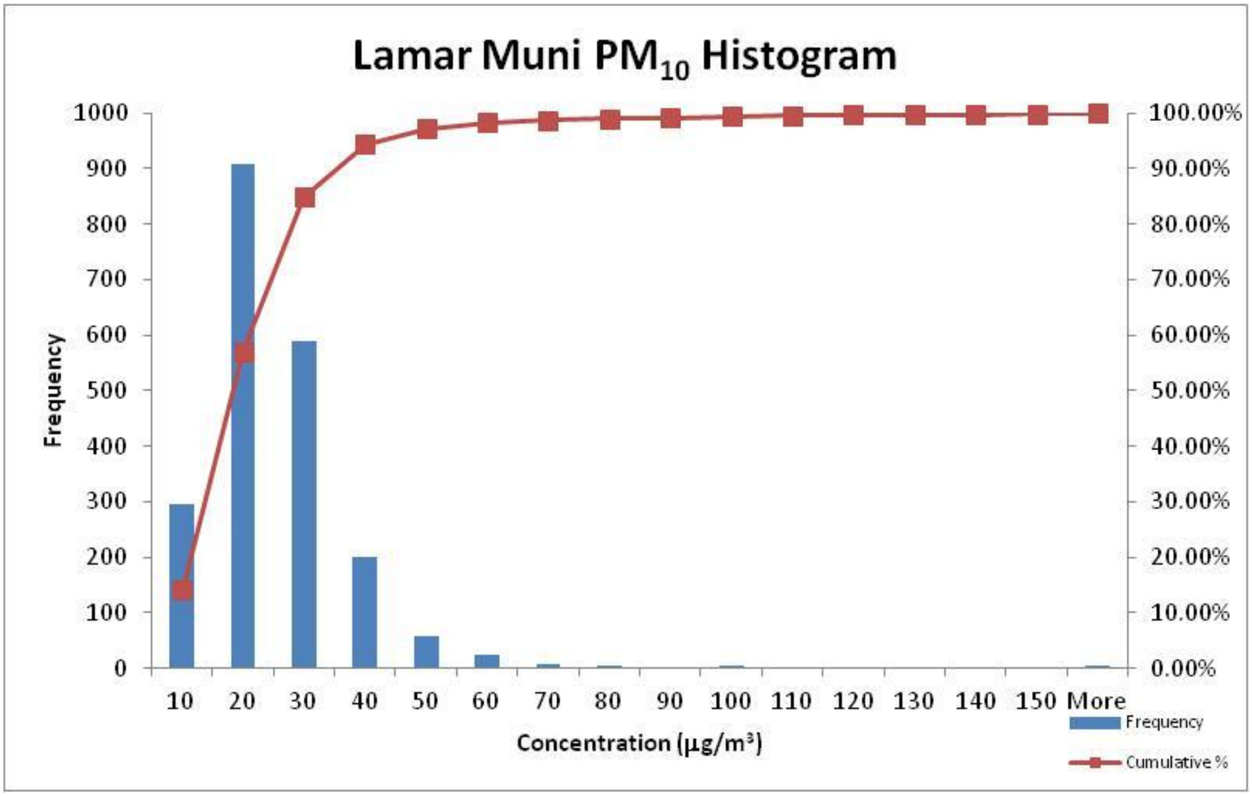


Figure 52: Lamar Muni PM_{10} Histogram, 2007-2012

The monthly box-whisker plot in Figure 53 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 March 18, 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.

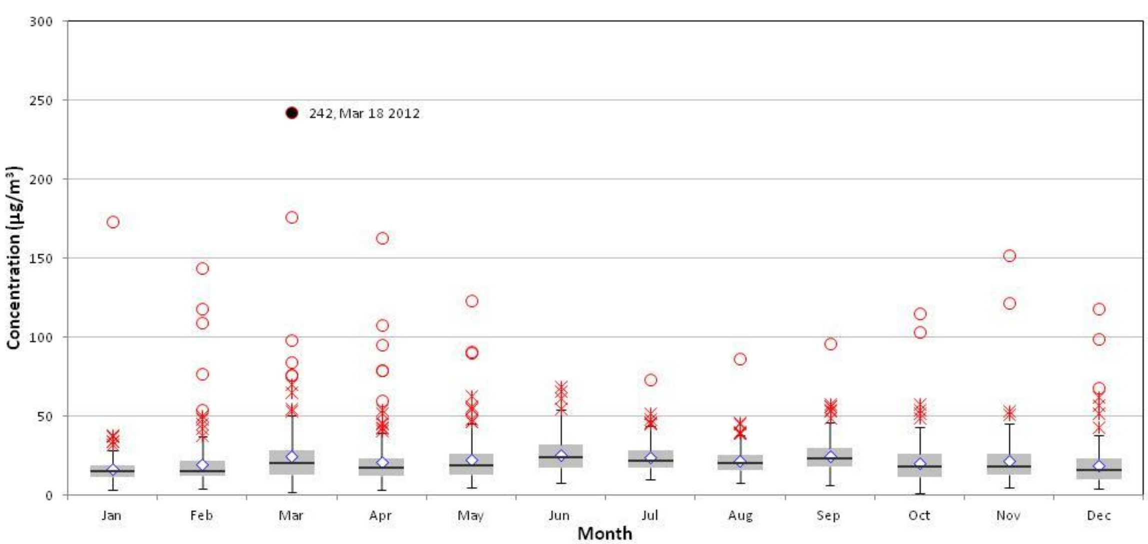


Figure 53: Lamar Muni PM_{10} Box-Whisker Plot, 2007-2012

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 54. This expanded plot demonstrates that March 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.

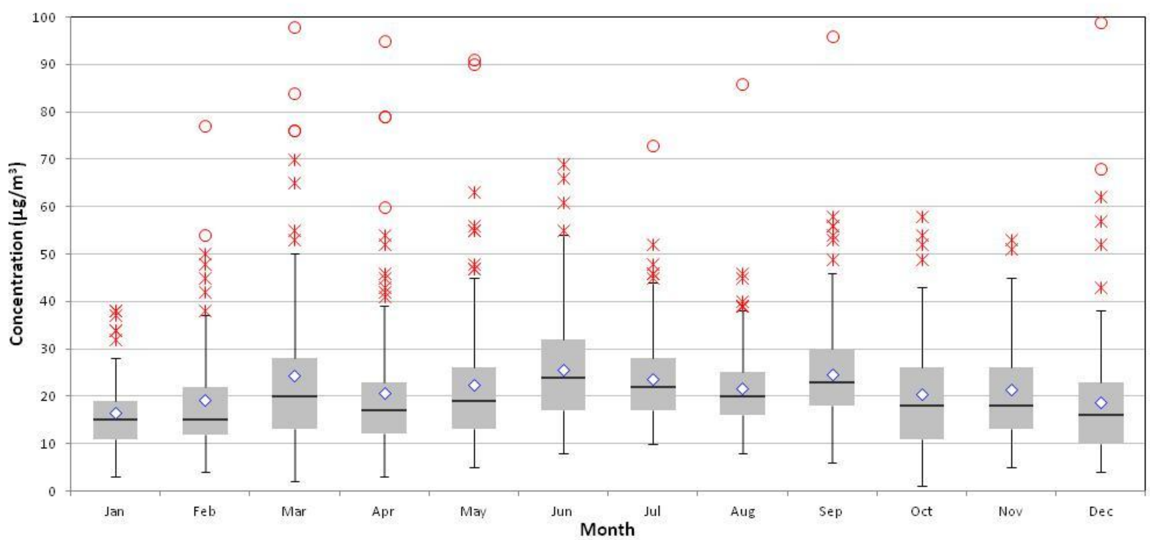


Figure 54: Lamar Muni PM_{10} Box-Whisker Plot, Reduced Scale, 2007-2012

Note the degree to which the data in the months of fall through spring, beginning in October/November and extending through May, are skewed. The March mean (24.5 µg/m^3) is greater than the March median value (20 µg/m^3) and is greater than the 66% of all samples in any March. 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 54 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 March 18, 2012, clearly exceeds the typical data at this site.

3.2 Wind Speed Correlations

Wind speeds in southeast Colorado increased early in the morning March 18, 2012 and stayed elevated throughout the day, gusting to speeds in excess of 50 mph. The four charts in Figure 55 display wind speed (mph) as a function of date from meteorological sites within the affected areas for a number of days before and after the event.

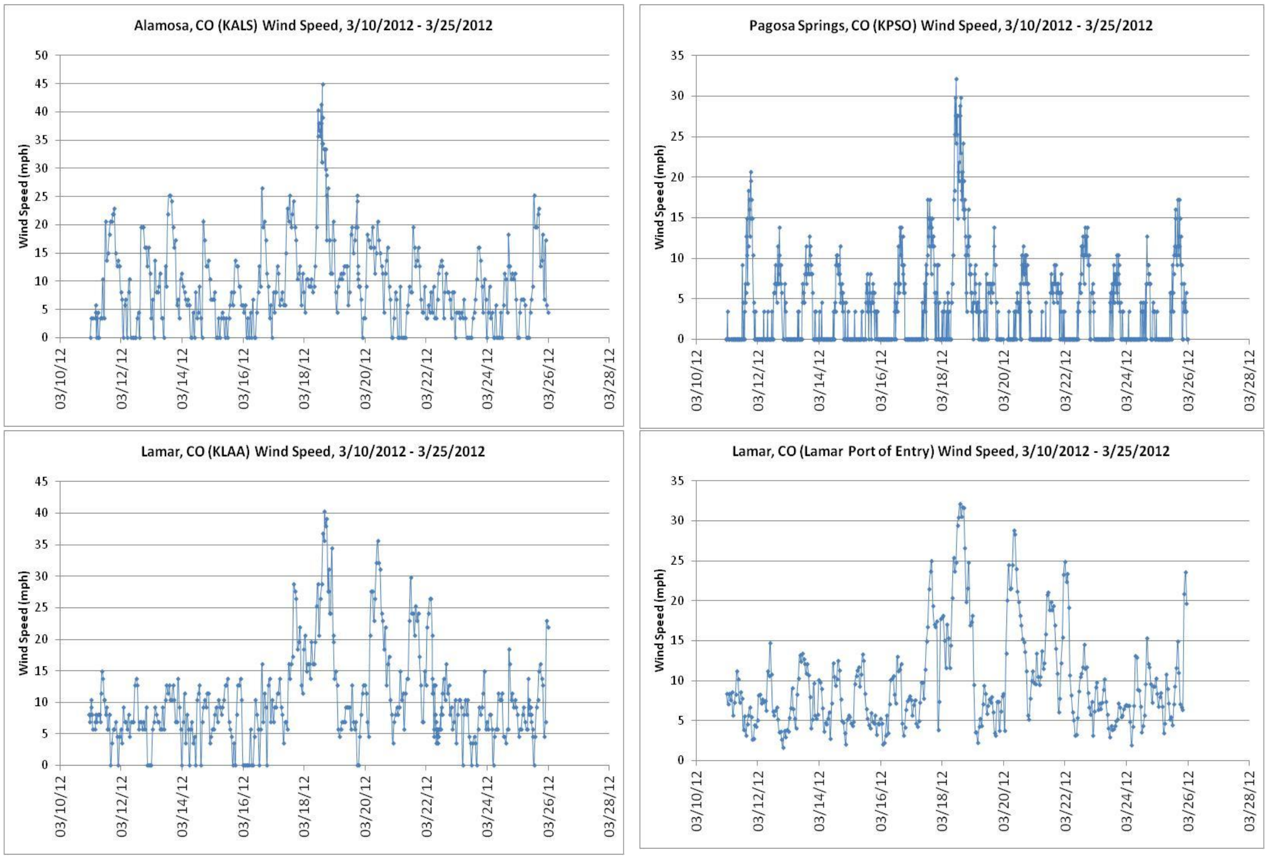


Figure 55: Wind Speed (mph) Affected Sites, 03/10/2012 – 03/25/2012

Figure 56 plots PM_{10} concentrations from the affected sites for the period for seven days prior to and following the sample(s) of March 18, 2012.

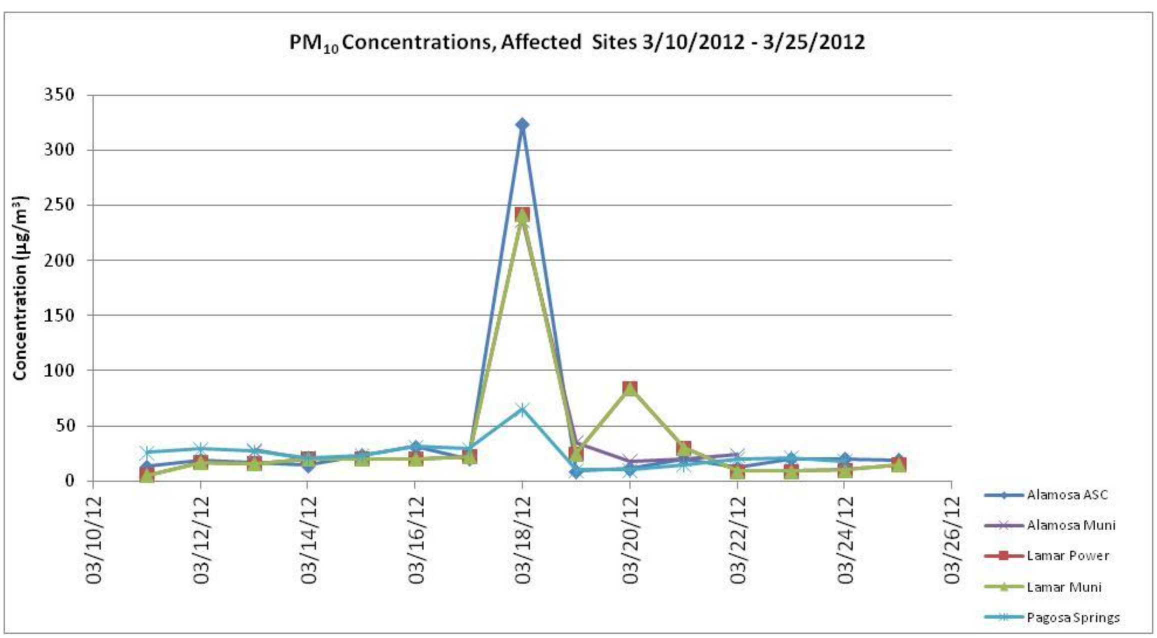


Figure 56: PM_{10} Concentrations, Affected Sites, 03/10/2012 – 03/25/2012

Figure 56 mimics the plots for wind speed, suggesting an association between the regional high winds and PM_{10} concentrations at the affected sites. Although the samples were affected to differing degrees by the event (possibly reflecting the variation in contribution from local sources) 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 and Alamosa on March 18, 2012.

3.3 Percentiles

Monthly percentile plots in Figure 57 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.

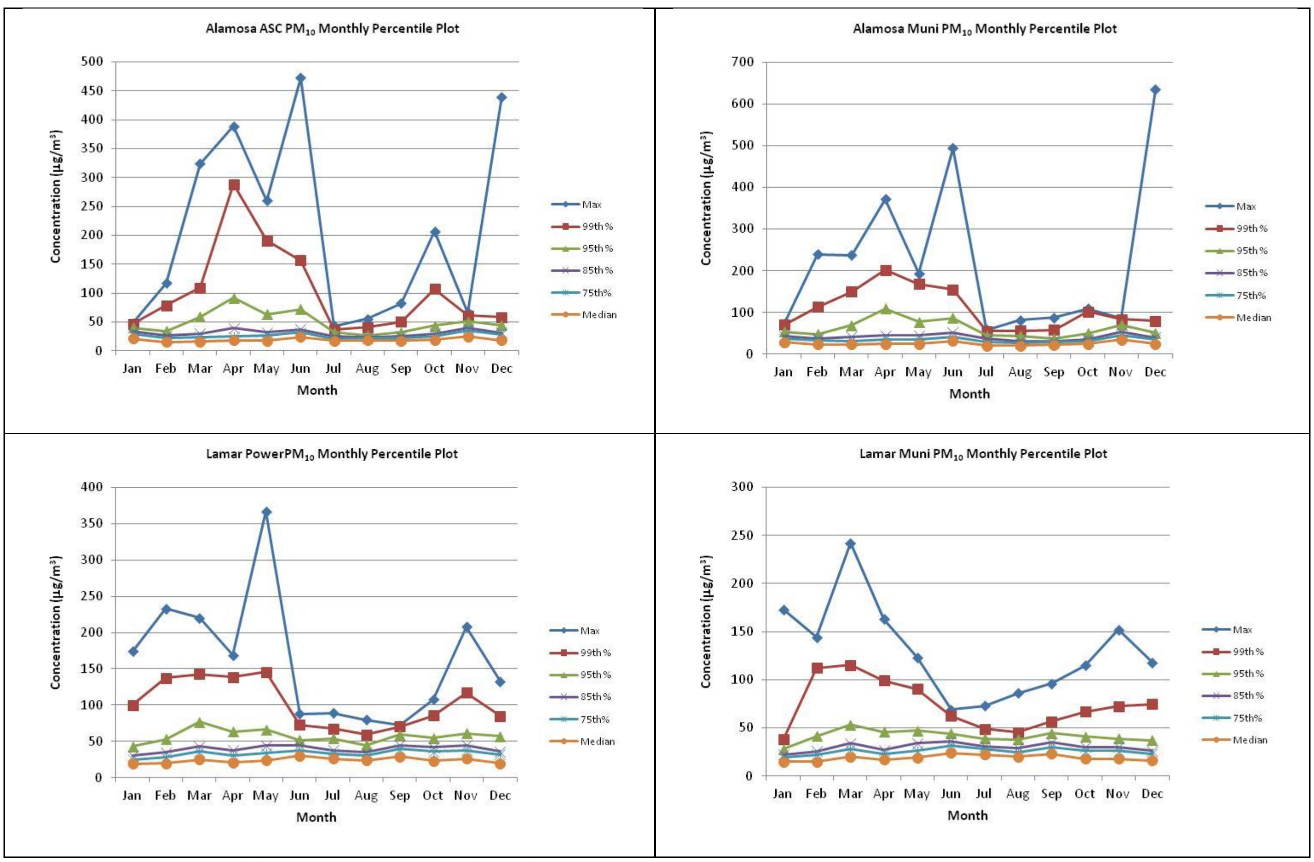


Figure 57: Monthly PM_{10} Percentile Plots

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 sets of concern

(Alamosa ASC, Alamosa Muni, Lamar Power, and Lamar Muni) a conservative estimate of the percentile value that is reflective of typical, day to day variation is the 75th percentile value. Nearly all of the variation in the monthly 75th percentile values of these four data sets can be explained by the variation in monthly medians; for these four sites the correlation between the median and monthly 75th percentile values vary from an r^2 = 0.85 (Lamar Power) to an r^2 = 0.95 (Alamosa Muni). A reasonable estimate of the contribution to the event from local sources for these data sets may be the monthly 85th percentile values; for these three sites the correlation between the median and the monthly 85th percentile values vary from an r^2 = 0.69 Alamosa ASC) to an r^2 = 0.87 (Lamar Muni). The portion of the sample concentration remaining from these monthly percentile values would be the sample contribution due to the event.

Table 22 identifies various percentile values that are representative of the maximum contribution due to local sources for each site from all April data for both sample dates. In Table 22 the range estimate in the 'Est. Conc. Above Typical' column is derived using the difference between the actual sample value and the 85th percentile as the minimum (reasonable) event contribution estimate and the difference between the actual sample value and the 75th percentile as the maximum (conservative) event contribution estimate. This column represents the range of estimated contribution to the March 18, 2012 sample at the sites listed in the table from the high wind event.

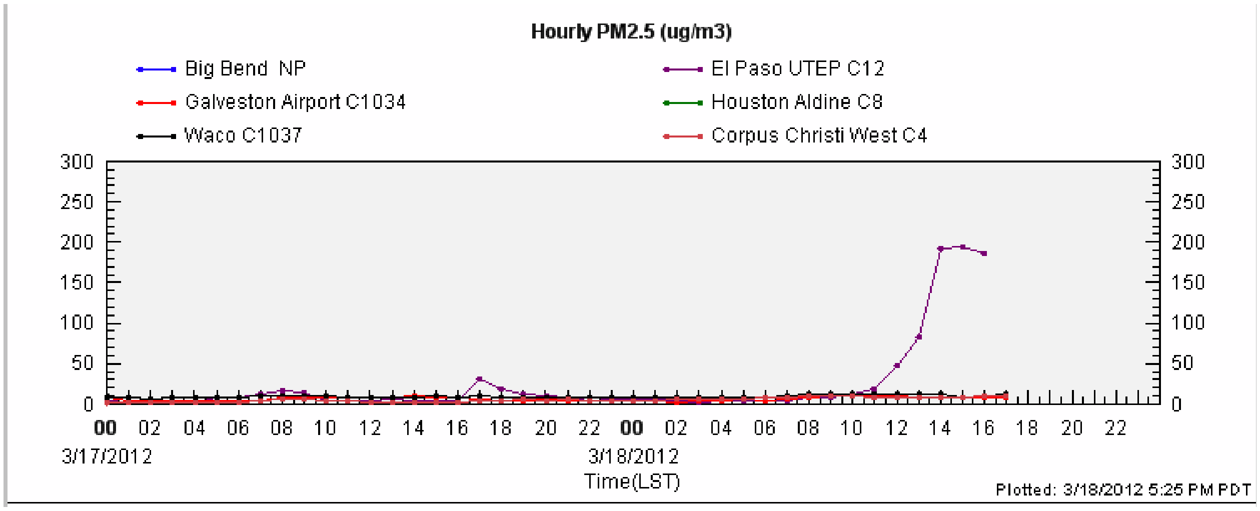
Table 22: Estimated Maximum Event PM_{10} Contribution – Affected Sites

Site	Event Day Concentration (µg/m³)	March Median (µg/m³)	March Average (µg/m³)	March 75th % (µg/m3)	March 85th % (µg/m3)	Est. Conc. Above Typical (µg/m³)
Alamosa ASC	324	16	23.1	24	29.4	**204 - 300**
Alamosa Muni	237	23	30.2	31.5	41.7	**195 - 205**
Lamar Power	220	25	30.8	36	43.3	**177 - 184**
Lamar Muni	242	20	24.5	28	34	**208 - 214**

Clearly, there would have been no exceedance on March 18, 2012, but for the additional contribution to the PM_{10} samples provided by the event.

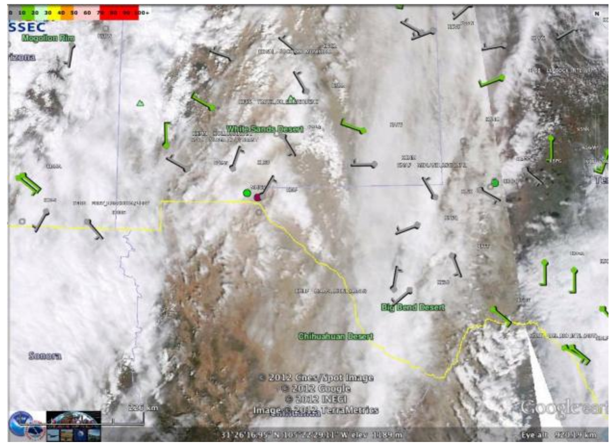
4.0 News and Credible Evidence

In a band from Mexico up through West Texas and into Colorado, NOAA issued a high wind warning this afternoon. El Paso appears to be badly hit as it has nearly 200µg m^{-3} $PM_{2.5}$ (see the AIRNOWTech concentrations below).



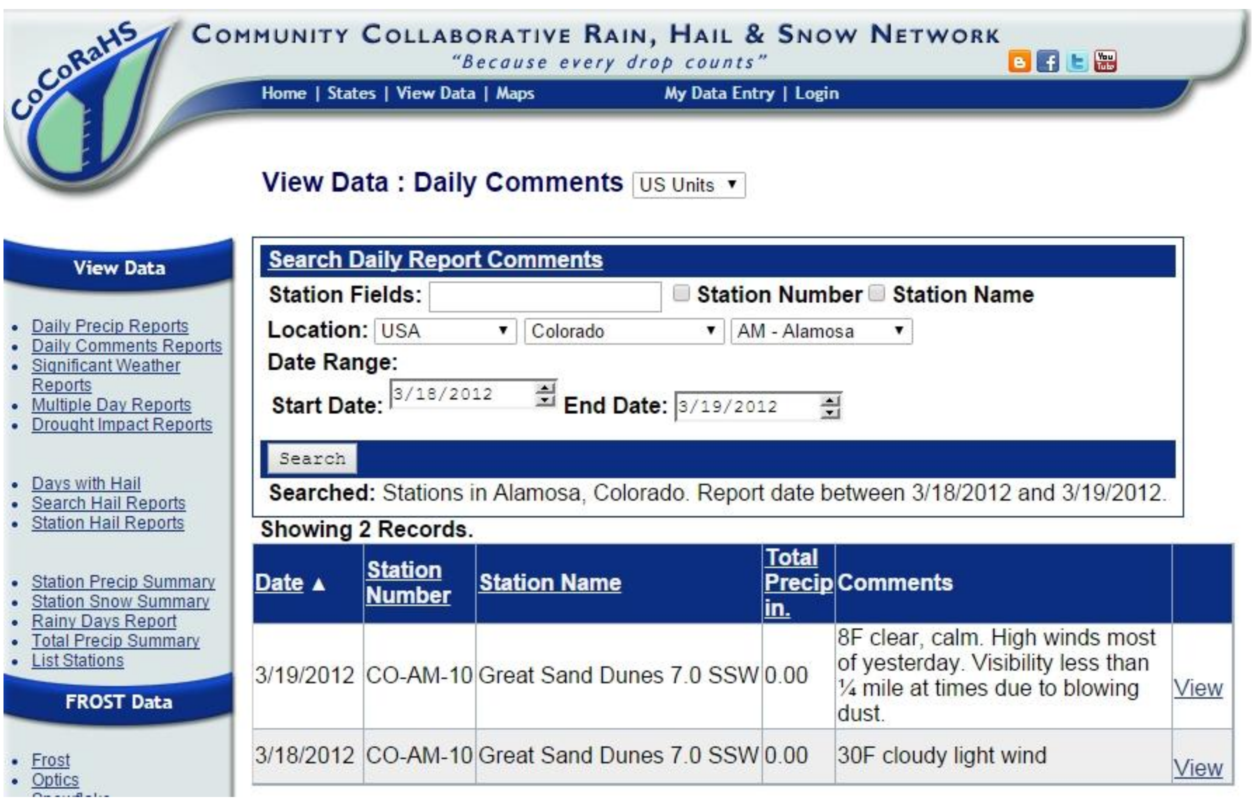
The webcams in the area don't help much because they are totally occluded. On the left is the Chelsea School webcam and the right shows the one on Ranger Peak. Neither helps much.


KFOX14TV has a story on a major fire which has blown up in the high winds (LOL that the story says the winds are 20 feet high) so it is not clear if this is smoke or dust. New Mexico Dept. of Transportation had closed I-10 and people in El Paso are being requested to stay off the roads as there is no visibility at all. The latter report says that the dust was extensive in the area. The MODIS image doesn't show the dust under the clouds and the MADIS winds (superimposed) don't show the front that went through.



Posted by Ray Hoff at [8:37 PM](#) | [Comments (0)](#)

Retrieved from: http://alg.umbc.edu/usaq/archives/2012_03.html



COMMUNITY COLLABORATIVE RAIN, HAIL & SNOW NETWORK

"Because every drop counts"

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- Station Snow Summary
- Rainy Days Report
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FROST Data

- Frost
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Search Daily Report Comments

Station Fields: ☐ **Station Number** ☐ **Station Name**

Location: USA | Colorado | AM - Alamosa

Date Range:

Start Date: 3/18/2012 **End Date:** 3/19/2012

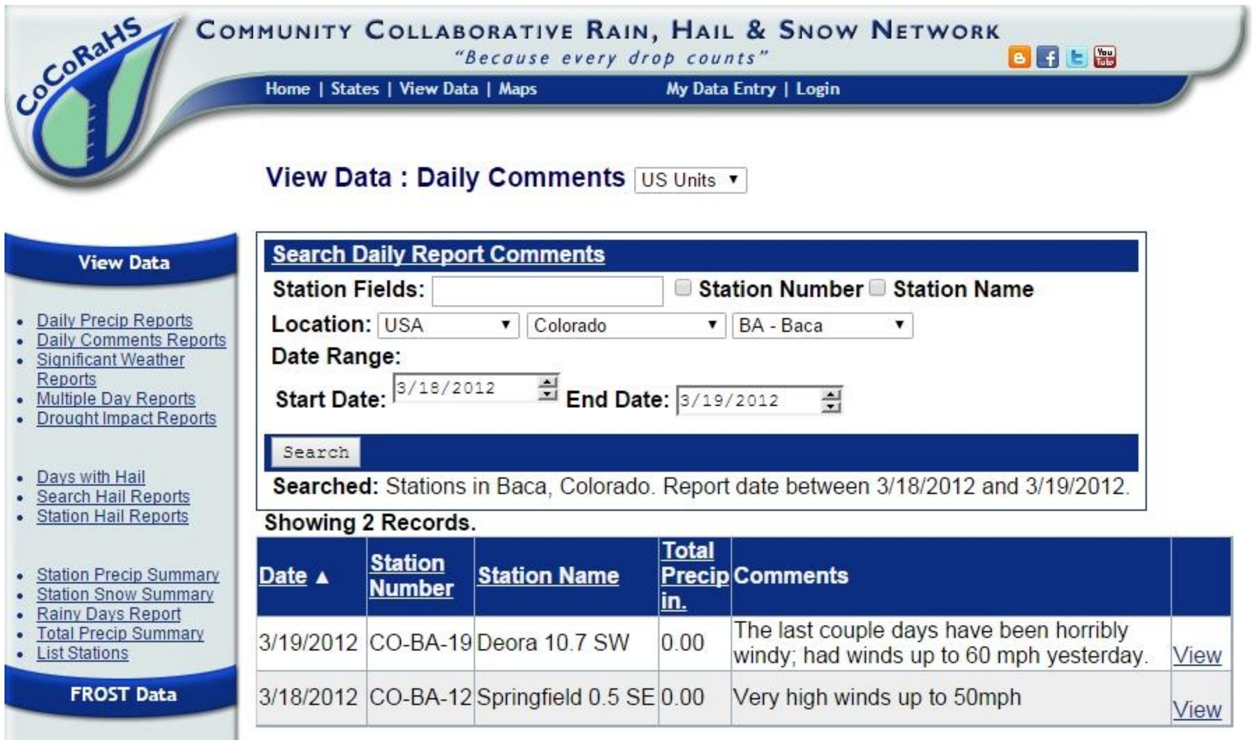
Search

Searched: Stations in Alamosa, Colorado. Report date between 3/18/2012 and 3/19/2012.

Showing 2 Records.

Date ▲	Station Number	Station Name	Total Precip in.	Comments	
3/19/2012	CO-AM-10	Great Sand Dunes 7.0 SSW	0.00	8F clear, calm. High winds most of yesterday. Visibility less than ¼ mile at times due to blowing dust.	View
3/18/2012	CO-AM-10	Great Sand Dunes 7.0 SSW	0.00	30F cloudy light wind	View

Retrieved from: http://www.cocorahs.org/ViewData/ListDailyComments.aspx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View Data : Daily Comments US Units

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- Daily Precip Reports
- Daily Comments Reports
- Significant Weather Reports
- Multiple Day Reports
- Drought Impact Reports

- Days with Hail
- Search Hail Reports
- Station Hail Reports

- Station Precip Summary
- Station Snow Summary
- Rainy Days Report
- Total Precip Summary
- List Stations

FROST Data

Search Daily Report Comments
Station Fields: Station Number Station Name
Location: USA Colorado BA - Baca
Date Range:
Start Date: 3/18/2012 End Date: 3/19/2012
Search
Searched: Stations in Baca, Colorado. Report date between 3/18/2012 and 3/19/2012.
Showing 2 Records.

Date ▲	Station Number	Station Name	Total Precip in.	Comments	
3/19/2012	CO-BA-19	Deora 10.7 SW	0.00	The last couple days have been horribly windy; had winds up to 60 mph yesterday.	View
3/18/2012	CO-BA-12	Springfield 0.5 SE	0.00	Very high winds up to 50mph	View

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


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- Days with Hail
- Search Hail Reports
- Station Hail Reports

- Station Precip Summary
- Station Snow Summary
- Rainy Days Report
- Total Precip Summary
- List Stations

FROST Data

Search Daily Report Comments
Station Fields: Station Number Station Name
Location: USA Colorado LN - Lincoln
Date Range:
Start Date: 3/17/2012 End Date: 3/19/2012
Search
Searched: Stations in Lincoln, Colorado. Report date between 3/17/2012 and 3/19/2012.
Showing 1 Records.

Date ▲	Station Number	Station Name	Total Precip in.	Comments	
3/19/2012	CO-LN-18	Karval 9.8 WSW	0.00	Very Very strong southwest winds began about 11a.m. The air was filled with dust until sundown and probably later.	View

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

March 18, 2012 dust storm in Windsor, CO. Southeast winds of 20 gusting to 35 miles per hour kick up dust after a prolonged period of dry weather.

Retrieved from: http://metstat.com/current-weather/photo-gallery/

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 southern Colorado and New Mexico. The following sections will describe in detail the regulations and programs in place designed to control PM_{10} in each 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 March 18, 2012 event originated outside of the monitored areas, primarily from the desert regions of southern Colorado and New Mexico.

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 March 18, 2012, event. This information confirms that no unusual anthropogenic actions occurred in the local areas of Alamosa and Lamar during this time.

5.1 Regulatory Measures - State

The APCDs regulations on PM_{10} emissions are summarized in Table 23.

Table 23: 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 Performance for New Stationary Sources	Implements federal standards of performance for new stationary sources including ones that have particulate matter emissions. (Section I)

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 Alamosa Regulatory Measures and Other Programs

Natural Events Action Plan (NEAP)

The Final NEAP for High Wind Events in Alamosa, Colorado was completed in May 2003. The NEAP addresses public education programs, public notification and health advisory programs, and determines and implements Best Available Control Measures (BACM) for anthropogenic sources in the Alamosa area. The APCD followed up with the City and County of Alamosa in January 2007 and in the spring of 2013 on whether the NEAP mitigation measures and commitments were satisfied, the results of which are detailed below. The City of Alamosa, Alamosa 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.

Regulatory Measures - City and County

The APCD, the City of Alamosa, and Alamosa County are responsible for implementing regulatory measures to control emissions from agricultural sources, stationary sources, fugitive dust sources, and open burning within Alamosa. Alamosa's ordinances of PM_{10} emissions are summarized in Table 24.

Table 24: Rules and Ordinances Regulating Particulate Matter Emissions in Alamosa

Rule/Ordinance	Description
City of Alamosa Code of Ordinances Article VII of Section 21-140 (5)	Addresses dust control for home occupations
City of Alamosa Code of Ordinances Article V Sec. 17-87(3))	Requires all new roads and alleys to be paved
City of Alamosa Code of Ordinances (Article VI Sec. 21-119(g)(3)).	New large commercial/retail establishments must install underground automatic irrigation systems for all landscaped areas
Alamosa County Land Use and Development Code (1.4.2)	Agriculture an important part of the economy and adds intrinsic value to life in Alamosa County. Agriculture, as a business, brings dust and other inconveniences. To maintain this way of life, Alamosa County intends to protect agricultural operators from unnecessary, intrusive litigation. Therefore, no inconvenience shall be considered a nuisance so long as it occurs as a part of non-negligent and legal agricultural practice, as stated in C.R.S. 35-3.5-101, 102 and 103.
Alamosa County Land Use and Development Code (3.5.2(A)(8))	For Feed lot, animal waste treatment, or animal waste collection facilities fugitive dust shall be confined on the property
Alamosa County Land Use and Development Code (3.5.6(D)(2))	For a proposed oil and gas well installation, any interior transportation network shall be paved, or the company shall undertake appropriate dust abatement measures
Alamosa County Land Use and Development Code (3.5.7(G))	All roads, driveways, parking lots and loading and unloading areas within 500 feet of any lot line shall be graded and paved with an approved concrete or asphalt/concrete surface as to limit adjoining lots and public roads the nuisance caused by wind-borne dust.
Alamosa County Land Use and Development Code (4.2.3(C)(2))	Where off-street facilities are provided for parking or any other vehicular use area, they shall be surfaced with asphalt bituminous, concrete or other dustless material approved by the administrator and shall be maintained in a smooth, well-graded condition.

City of Alamosa's Control Measures

The City of Alamosa has been active in addressing potential PM_{10} sources within the Alamosa area through various efforts. Some of these efforts, plus other potential future measures, include the adoption of local ordinances to reduce PM_{10}. Copies of current ordinances and any related commitments are included in the NEAP in Appendix C. According to the City's Public Works Director, as of 2013, the City is planning on adding additional dust control best management practices to the International Building Codes that are adopted by the city in the next update. The best management practices will include requiring a Dust Control Plan for any site that is issued a clearing permit for any site over 2 acres. The City is also currently (as of 2013) working on revising part of their landscaping ordinances to require mulch in areas that are not vegetated or covered by rock to help mitigate fugitive particulate emissions. These efforts have been stalled in the past due to employee turnover at City Manager's Office.

Street Sweeping
The City of Alamosa sweeps on an every 4-week schedule or as needed, as determined by local officials on a case by case situation (e.g., following each snowstorm and/or where sand was applied). Sweeping occurs on every single City street with an emphasis on the downtown corridor where public exposure is expected to be greatest. As of spring 2013, street sweeping in the downtown corridor currently takes place twice per week according to the City's Public Works Director.

According to the City's Public Works Director, the city (as of 2013) owns an Elgin Pelican (mobile mechanical sweeper) and a Tymko 600 (brush-assisted head) street sweeper. As of June 2013, the City will also own a new Elgin Broom Badger street sweeper at which time the Tymko 600 will be sent in for a re-build. The new Elgin Broom Badger street sweeper can be used in the winter months when the Tymko cannot due to freezing of the water delivery system.

Unpaved Roads within the City
The City of Alamosa (as of 2008) requires all new roads and alleys to be paved according to the Municipal Code (Article V Sec. 17-87(3)) and some existing unpaved roads are being treated with dust suppressants until all underground utilities are installed. No new development is allowed until paving is complete unless a performance bond is in place.

According to the City's Public Works Director in 2013, less than 3% of City roads are unpaved; most of these unpaved roads are legacy annexations. One of these unpaved roads is scheduled for paving this year (2013). The remaining unpaved roads are all low traffic (less than 100 ADT) and the City continues to seek funding sources for paving these streets.

Sod/Vegetative Cover Projects in the City of Alamosa
As of 2008, the City of Alamosa placed vegetative cover in all city parks and has installed irrigation systems to maintain the cover. As of 2013, the City has been emphasizing more low-water use landscaping with shrubs, mulch, etc. including both organic and rock. All turf areas do have irrigation systems which utilize drip systems for specimen plantings.

Alamosa County's Control Measures

Alamosa County has also been active in addressing blowing dust as detailed below.

Unpaved Roads
Alamosa County continues to address unpaved roads and lanes that are anticipated to contribute to PM_{10} emissions in the community. As of 2002, Alamosa County was nearing the end of its five-year road paving plan and was developing their next plan with the intention of

paving on a yearly basis, based on traffic, community needs/priorities, and funding availability.

In 2002, Alamosa County addressed approximately ten (10) miles of unpaved roads. This includes the stabilization of approximately five section roads, the seal coating of two roads, and the overlay (repaving) of four (4) additional roads.

In 2003, approximately 14 miles of roads were paved. This includes the Seven Mile Road (three miles long), Road 109 (one mile long), and 10^{th} Street (also one mile long). These roads are in close proximity to the City of Alamosa, are upwind (prevailing) from the city, and have heavy traffic. Paving is anticipated to greatly reduce blowing dust and impacts in the vicinity.

No paving projects took place between 2004 and 2010 due to lack of funding. Between 2010 and 2013, the County was able to get funding but only for maintenance paving on previously paved roads that needed repair. Now that the county is caught up on maintenance paving, it is focusing on paving the remaining unpaved roads. The County's goal is to pave about 2.5 miles of unpaved road per year depending on funding availability.

As of 2013, Alamosa County had funding to pave approximately 2.5 miles of County Road 106 North (located north of Alamosa off of Highway 17) which is currently unpaved. After this paving project the County will only have 2.5 miles of unpaved road remaining on the 106 North which is anticipated to be paved in the summer of 2014.

In the summer time the County regularly hauls water and wets down the unpaved roads (mostly gravel, clay and sand) to reduce the fugitive particulate emissions. The County wets the unpaved roads on an as needed basis based on weather conditions and traffic volume. In addition, when it gets cold enough in the area, the County wets down some of the more sandy roads. Once the water soaks in and freezes, good dust suppression is seen. Road construction areas are being dampened with water for dust control. These practices reduce PM_{10} emissions in and near Alamosa. This control measure is balanced with the availability of water in the area.

Alamosa County used to assess the need to use $MgC1_2$ treatment on roads in front of residences that request such service. This practice stopped in 2004 when funding was lost. Assessments included the sensitivity to dust of residents, the materials of the road base for safety reasons, and possible environmental concerns of the neighborhood. Most requests for treatment are were granted. Other areas for treatment, such as commercial construction zones or gravel pits, are investigated on a case by case basis. The County hopes to be able to start offering this service again when funding is restored.

Dust Control Plans

Alamosa County requires dust control plans for selected construction/developments. The dust control plans are typically done through a negotiated agreement by the Alamosa Land Use Department and is supported by zoning codes.

The County may update the Comprehensive Plan to include a dust control plan. The Land Use Administrator is researching the potential for a dust control ordinance. This effort is anticipated to reduce PM_{10} emissions in Alamosa, especially as it relates to impacts on the community and high recorded PM_{10} values. At the time of this submittal (December 2013), this effort is still underway.

Wind Erosion of Open Areas
To reduce PM_{10} emissions from open areas outside of the City limits, low tilling and other soil conservation practices continue to be utilized in the community. The Mosca-Hooper Conservation District and Natural Resources Conservation Service is working on education efforts to promote cover crops and no-till agriculture. In addition, the community is using in strategic areas the Colorado State Forest Service's
program to purchase and plant shelter trees to reduce wind erosion in open areas. Nursery seedlings from the program have been sold in Alamosa County since 1956. The number of seedlings sold has varied over the last few years as illustrated in Table 25.

Table 25: Number of Seedlings Sold in Alamosa per Year.

Year:	2008	2009	2010	2011	2012	2013
Seedlings Sold:	7,432	5,963	2,805	4,197	3,327	4,231

These trees have a demonstrated advantage for the community and for air quality. Once the trees reach maturity, it is anticipated that the equivalent of 112 miles of double-rowed trees will be in place. The survival rate of the tree seedlings varies but according to the District Coordinator for the Seedling Tree Program, potted seedlings have about a 60% to 80% survival rate and the bare root seedlings have about a 40 to 60% survival rate. The Seedling Program recommends Siberian elm and Rocky Mountain juniper trees for low maintenance, drought resistance windbreaks in the valley, but offers over 40 varieties to suit specific site conditions. The Colorado State Forest Service and the Mosca-Hooper Conservation District promote the windbreak program through workshops and consulting landowners.

In addition, there is ongoing planting of trees (approximately 50) on newly developed Alamosa County property south/southwest of Alamosa (prevailing winds from southwest) and the Airport south of Alamosa for added air quality improvement. Also, The Bureau of Reclamation has an ongoing project to plant windbreaks along their Closed-Basin Canal.

Windblown Dust from Disturbed Soils
Alamosa has a semi-arid climate with approximately 7.25 inches of precipitation annually. The San Luis Valley, as noted within 25 miles of the San Luis Valley Regional Airport in Alamosa, is primarily comprised of forests (43%) and shrublands (42%). Consequently, soils in all areas are typically a mixture of silt and sand with limited vegetation due to low precipitation. In winter and spring, windstorms are common, especially in drier years. It is due to these high velocity windstorms that Alamosa experiences most of the PM_{10} problems for the area. The City zoning map in Figure 58 which was provided by the City of Alamosa, depicts various areas of possible soil disturbance. These were evaluated by APCD staff in conjunction with local input from the City and County staff for the Alamosa Adams State PM_{10} monitor and Municipal monitors over the past years. The area zoned agricultural remains mostly natural grassland and "Chico" shrubs.

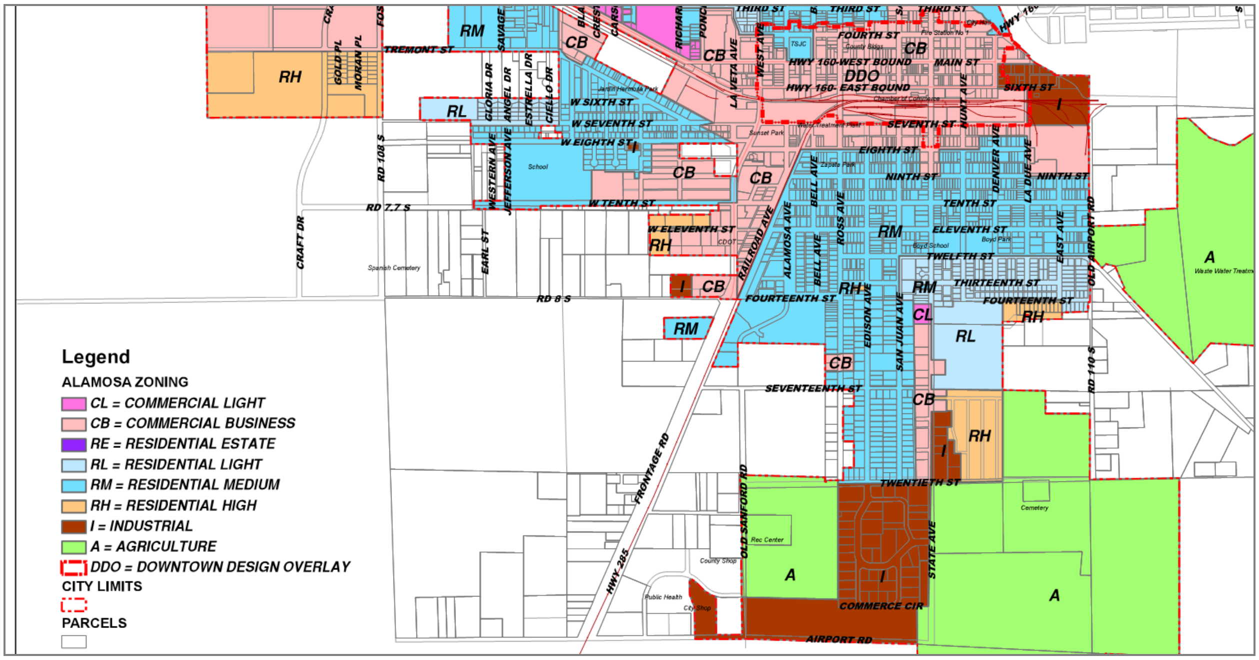

Figure 58: 2011 City of Alamosa Zoning Map (Provided by the Public Works Department)

The APCD also conducted thorough assessments in 2012 and 2013 to determine if the potential soil disturbances shown in Figure 59Error! Reference source not found. were present during the March 18, 2012 blowing dust event. During the course of these assessments, the APCD discovered that these sites were either reasonably controlled or considered to be natural sources during the December 1, 2011 high wind event. Therefore, these sites were not significant contributors to fugitive dust in the Alamosa area during the December February 23, 2012 high wind event. Figure 58 illustrates potential areas of local soil disturbance that have been evaluated by the APCD for the Alamosa Adams State PM_{10} monitor.

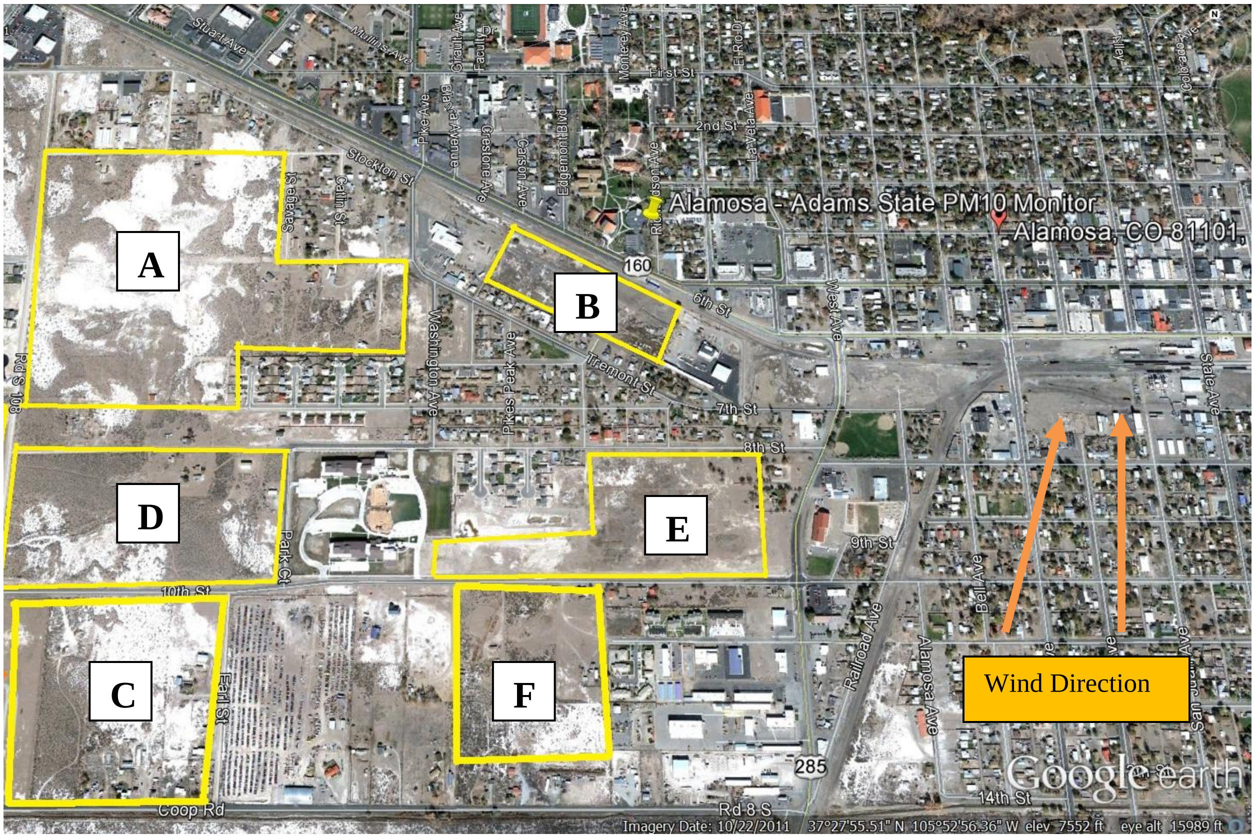

Figure 59: Relative positions of Adam's State College PM_{10} Monitor and potential disturbed soil. (Google Earth 2007)

Site A in Figure 59 (approximately 85 acres) is East of Rd S 108 and South of Chico St. It is zoned outside of the city's limits by the city as a "Parcel" as shown in Figure 59Figure 59. The eastern portion of Area A is being considered for annexation into the City. A photo of site A is shown in Figure 60.


Figure 60: Site A facing north (CDPHE August 2013)

Site D in Figure 59 (approximately 34 acres)is north of 10th street, east of Rd S 108, west of Park Ct, and south of 8th St. It is zoned outside of the city's limits by the city as a "Parcel" as shown in Figure 58. A photo of site D is shown in Figure 61.

Figure 61: Site D facing north (CDPHE August 2013)

Sites A, C and D are noted by the City of Alamosa's Public Works Director and County Health Director to be vacant land with natural vegetation (i.e. shrubland, mostly Chico bush) with no artificial irrigation and no access restriction. The City emphasizes that the areas are not suited for motorized travel. These lots are not considered to be anthropogenically disturbed soils and should be considered to be natural sources. If future high wind or other exceptional events occur, the APCD will re-assess these lots to determine if they are still natural sources.

Site B in Figure 59 (approximately 22 acres) is south of Highway 160 and north east of Tremont St. It is zoned outside of the city's limits by the city as a "Parcel" as shown in Figure 58. Site E in Figure 59 (approximately 30 acres) is north of 10th St, south of 8th St, east of Park Ct, and west of West Ave. It is zoned mostly as a "Commercial Business" as shown in Figure 58. There is a small portion in the top right corner that is zoned outside of the city's limits by the city as a "Parcel". Site F (approximately 23 acres) in Figure 59 is east of Earl St, south of 10th St, and north of Rd 8 S. It is zoned as "Commercial business", "Residential High" and a little "Industrial" as shown in Figure 58. Sites B, E, and F are naturally vegetated and potentially irrigated as shown in Figure 62. Figure 62 demonstrates that these sites are minimally (if at all) disturbed soil areas as of this writing. Photos of sites B, E (2 photos), and F are shown in Figure 63, Figure 64, Figure 65 and Figure 66 respectively.

Figure 62: Sites B, E, and F with natural vegetation (Google Earth 2007)

Figure 63: Site B (CDPHE August 2013)

Figure 64: Site E facing north (CDPHE August 2013)

Figure 65: West end of site E is a gravel elementary school overflow parking lot (CDPHE August 2013)

Figure 66: Site F with natural vegetation (CDPHE August 2013)

Figure 67 illustrates potential areas of local soil disturbance that have been evaluated by the APCD for the Alamosa Municipal Building (08-003-0003) PM10 monitor. The climate for this monitor is identical to the Alamosa Adams State PM10 monitor, described above.

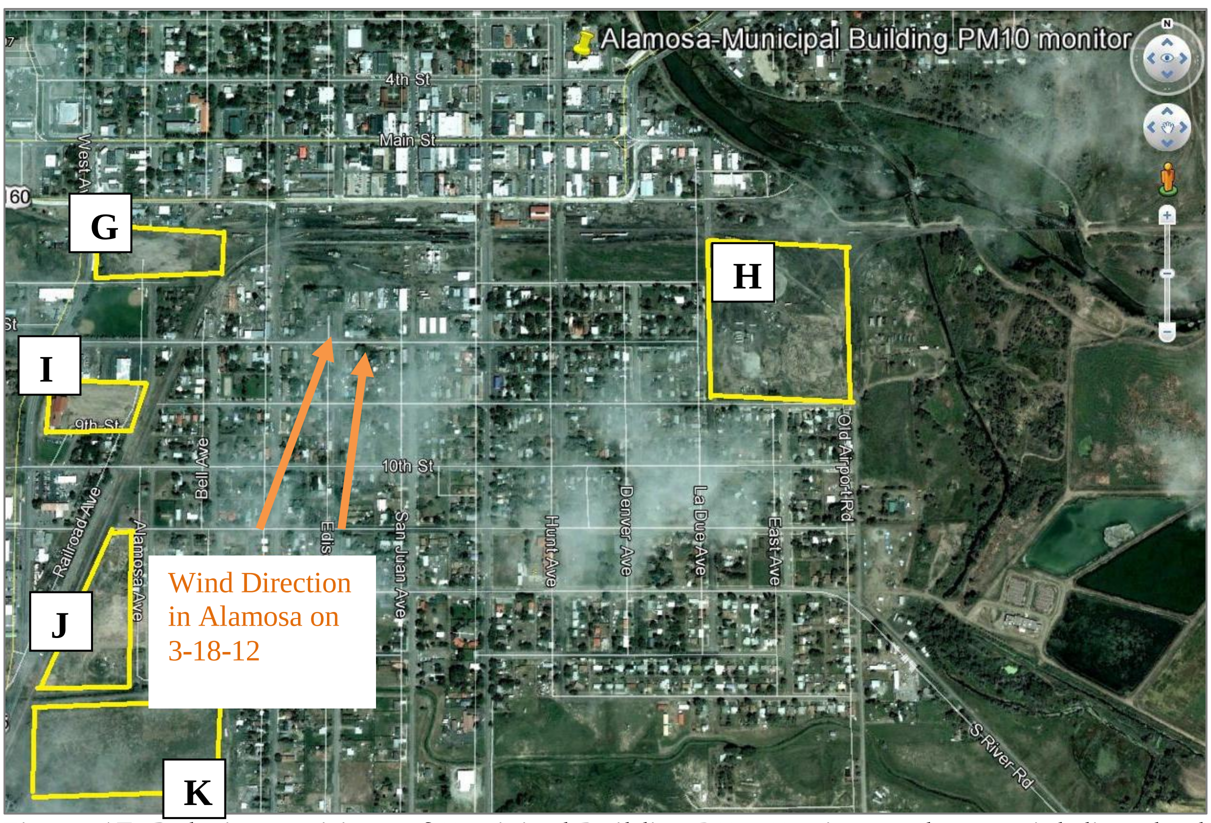

Figure 67: Relative positions of Municipal Building PM_{10} Monitor and potential disturbed soil. (Google Earth 2007)

Site G in Figure 67 (approximately 5 acres) is south of 6th St, west of Ross Ave, east of West Ave, and north of 7th St. It is zoned by the city as “Commercial Business” as shown in Figure 58. The vacant land is undisturbed gravel, dirt, and is naturally vegetated as shown in Figure 68. The railroad runs through this narrow strip of land rendering it unlikely to be developed in the future.

Figure 68: Site G (CDPHE August 2013)

Site H in Figure 67 (approximately 22 acres) is east of La Due Ave, south of 6th St, north of 9th St, and west of Old Airport Rd. It is zoned by the city as “Commercial Business” and “Industrial” as shown in Figure 58. Site H is private property with restricted access located just south of the rail yard. The land is naturally vegetated and undisturbed as shown in Figure 69.

Figure 69: Site H (CDPHE August 2013)

Site I in Figure 67 (approximately 3 acres) is east of West Ave, north of 10th St, south of 8th St, and west of Railroad Ave. It is zoned by the city as “Commercial Business” as shown in Figure 58. Site I is “Friends” Park that is maintained by the City of Alamosa (Figure 70). Friends Park has a well maintained gravel parking lot, a cement basketball court, an irrigated field, and a small hard packed clay BMX bike dirt track. The park is well maintained by the City and implements reasonable dust control measures on a regular basis.

Figure 70: Site I - Friends Park (CDPHE August 2013)

Site J in Figure 67 (approximately 9 acres) is north of 14th St, west of Alamosa Ave, east of Railroad Ave, and south of 10th St. It is zoned by the city as "Residential Medium" as shown in Figure 58. Site J is a vacant lot behind a small apartment building. The land is natural and undisturbed. There is no irrigation but natural vegetation grows as shown in Figure 71. The soil has a crust on the surface. When asked, residents of the adjacent apartment complex did not complain about blowing dust coming from Site J.

Figure 71: Site J (CDPHE August 2013)

Site K in Figure 67 (approximately 26 acres) is south of 14th St, north of 17th St, west of Ross Ave, and east of the Frontage Road. It is zoned by the city as “Residential Medium” as shown in Figure 58. Site K, as shown in Figure 72, is vacant land that is naturally vegetated and undisturbed.

Figure 72: Site K (CDPHE August 2013)

Sod and Vegetative Projects in the County

The development and construction of a local park, Eastside Park, is complete in Alamosa County. It has been completed with turf grass, shrubs, and landscape rock. No exposed soil remains.

Numerous other projects to reduce blowing dust and its impacts have happened or are happening at the County Airport. For example:

- Through additional grounds maintenance of the 40-acre Alamosa County airport south of the city, “Xeriscape” has been installed for aesthetics and dust control.

- Decorative rock and xeriscape have been implemented in the landscaping of the Alamosa County property (2007-2012). These measures have directly abated blowing dust at the Airport.

- Also, the widening of the airport’s safety areas (250 feet on either side of the runway) is complete and seeding of natural grasses was incorporated in the project. Trees and grass were incorporated in the approaches to the airport and have provided additional wind-break advantages to South Alamosa.

In other areas where watering is a problem, xeriscape (the use of native drought resistant vegetation and/or rock cover) is being encouraged for County owned property and for all other property owners.

Colorado State University Co-Op Extension Office

I
n response to extremely dry conditions, the need to maintain area topsoil, and reduce impacts, the Colorado State University Co-Op Extension Office of Alamosa County provides the following outreach efforts and recommendations:

- Modification of grazing practices to improve protective crop cover
- Increasing crop residues left in the fields to reduce blowing dust
- Planting of Fall crops to maintain fields
- Application of manure to protect top soils from blowing away
- Staggering of the harvest to minimize blowing dust
- Outreach programs on soil conservation efforts
- Development of outreach/education materials (e.g., news articles, newsletters, fact sheets, etc.), and
- Attendance at Statewide workshop to educate other Co-Op offices to various practices to reduce blowing top soil and minimize impacts.

These control strategies are not meant to be enforceable. They are meant only to demonstrate the regional nature of cooperation in addressing blowing dust and its impacts on the community.

Natural Resources Conservation Service (NRCS)

Alamosa County is a predominately agricultural area where limited water, coupled with the frequent high winds experienced during late fall and early spring, can destroy crops, encourage pests, and damage soil surfaces lending them susceptible to wind erosion. Thus, activities that improve the topsoil and prevent its lifting during high wind events are encouraged. Some notable NRCS and agricultural examples include:

- Local Conservation Districts and farmers hold monthly meetings as an informal Soil Health Group, discussing ways to improve soil health. Cover crops, compost applications, and reduced tillage are the targeted practices. Public tours are held twice a year.
- NRCS continues to work with area farmers in the development of conservation compliance plans to also protect topsoil;
- NRCS encourages planting perennial grasses or the leaving weeds undisturbed or mowed on the corners of center pivots (instead of tilling that might lead to open, barren lands) to reduce soil blowing;
- NRCS “cost shares” on soil health practices and perennial grass seeding conservation practices with local farmers to prevent soil erosion, and;
- The NRCS is working with Colorado State University, local Water Conservation District, and Farm Service Agency to encourage retirement of marginal cropland in the Conservation Enhanced Reserve Program (CREP) and seeding those acreages back to native grass, forbs and shrubs.

Other successful agricultural practices encouraged in the area include: timing of tillage, crop rotation, amount of crop residue left on the land, and proper water usage. These control strategies are not meant to be enforceable. They are meant only to demonstrate the regional nature of cooperation in addressing blowing dust and its impacts on the community.

Please refer to the Final NEAP for Alamosa at: http://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=AlamosaNaturalEventsActionPlan2003.pdf for more detail if needed.

5.3 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 23 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 has 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 23.]

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 stated 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 74 as Site D. 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), siting, 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 siting 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 77 through Figure 83 illustrate potential areas of local soil disturbance that have been evaluated by the APCD for the Lamar Power Plant (080990001) and Lamar Municipal PM_{10} monitors (080990002).

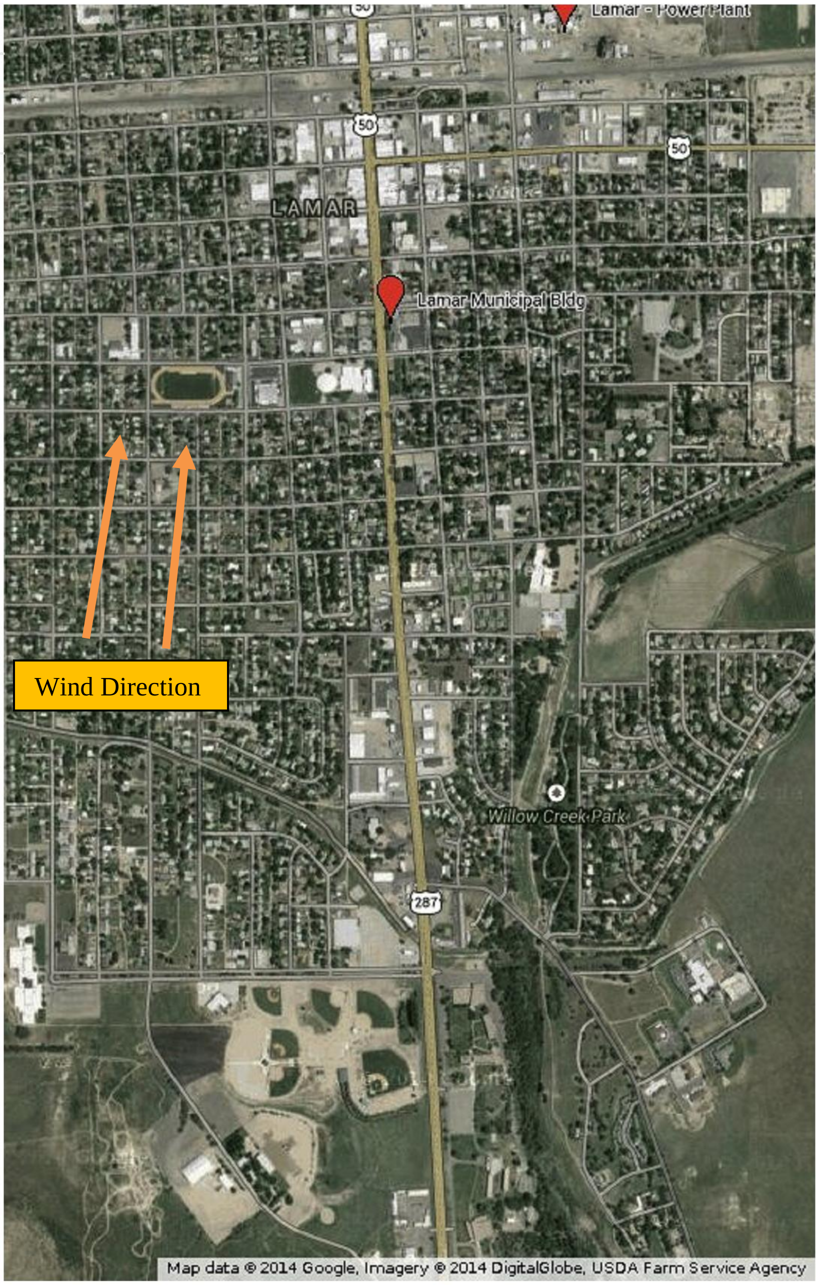

Figure 73: Wind Direction relative to Lamar Power Plant PM10 monitor and Lamar Municipal PM10 monitor for the March 18, 2012 event (Google Earth 2014)

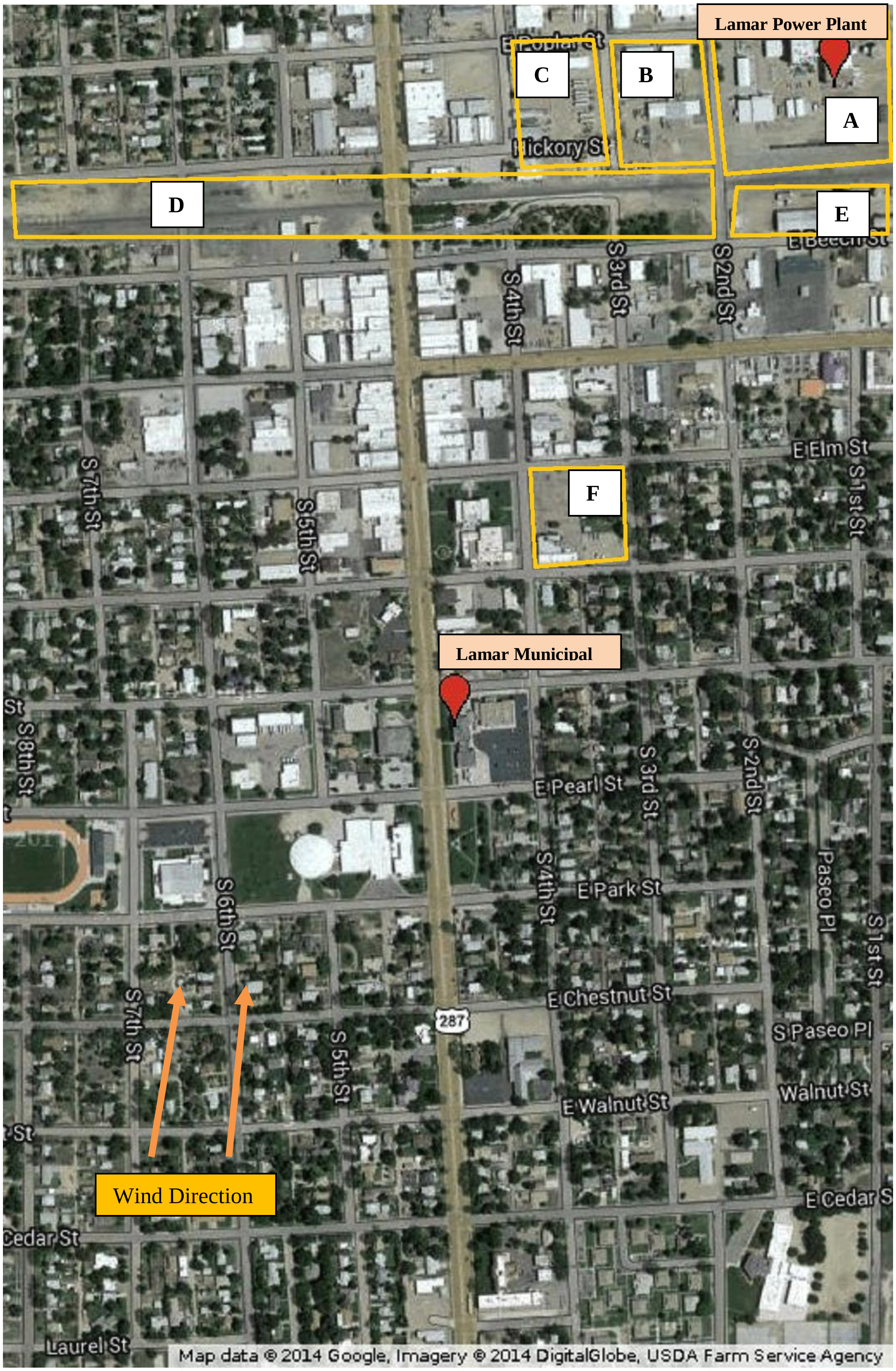

Figure 74: Southwest of Lamar Power Plant PM_{10} monitor and Lamar Municipal PM_{10} monitor for the March 18, 2012 event (Google Earth 2014)

Site A in Figure 74 is the power plant that the Lamar PM_{10} monitor is located within at 100 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.

Site B in Figure 74 is west of the Lamar PM_{10} monitor at about 103 North 2^{nd} Street. It is the “Lamar Water Department”. Also on site B 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 C in Figure 74 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 75. 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 76.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 75: Cowboy Corral Storage (Google Image 2012)

Figure 76: Feed Storage Company (Google Image 2012)

Site D in Figure 74 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 77. 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 77: Railroad tracks with gravel on each side (Google Image 2012)

Site E in Figure 74 is Colorado Mills LLC, a facility that produces sunflower oil and processes the leftover solids combined with grains and additives into feed that is used locally for cattle and hogs. The facility is shown in Figure 78. APCD issued the initial permit 95PR622 for this facility in 1996 to Cargill, Inc. A final approval permit and two transfers of ownership have since been issued in 1997, 1999 and 2000 respectively and the facility is now owned and operated by Colorado Mills, LLC. The permit includes the following point and fugitive dust control measures:

- Visible emissions shall not exceed 20% opacity during normal operations and 30% opacity at all other times.
- Permit limits on Particulate Matter
- Requirement to follow the developed Operation and Maintenance plan

This Facility was inspected by the APCD on 2/14/12 and no visible emissions were observed. Records review revealed that Colorado Mills has been in compliance with their permitted emission limits. An Operating and Maintenance Plan was submitted to the APCD for this facility on November 21, 1996 and approved by the APCD on December 24, 1996. The General Manager of the facility stated during the inspection that Colorado Mills conducts monthly inspection and maintenance on process and control equipment at the facility and no evidence was observed during the inspection to suggest that process and control equipment at the facility are not operated and maintained in a manner consistent with good air pollution control practices for minimizing emissions. Additionally, particulate emissions from oil extraction activities, grinding of grains, extruding and materials conveyance are controlled by several cyclones. The APCD considers the enforceable conditions of the permit, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site.

Figure 78: Colorado Mills LLC (Google Image 2012)

Site F in Figure 74 is southwest of the Lamar PM_{10} monitor. It is located at about 356 South 4th Street. Part of the property is owned by Century Link. Century Link has a storage lot for fleet vehicles that is well maintained gravel. Access to the storage lot is restricted by a fence as shown in Figure 79.

A large part of site F is a free public gravel parking lot for the Prowers County Jail and the Prowers County Municipal Court as shown in Figure 80. The lot is maintained by the County. The parking lot is chip sealed and covered in crushed gravel. Site F has reasonable dust control measures in place with regard to AQCC Regulation 1 requirements (Section III.D.1(a)). 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 businesses to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 79: Site F- Century Link Fleet Storage Lot (Google Image 2012)

Figure 80: Site F- Parking lot for the Prowers County Jail and the Prowers County Municipal Court (Google Image 2012)

Figure 81: Further South of Lamar Power Plant PM_{10} monitor and Lamar Municipal PM_{10} monitor for the March 18, 2012 event. (Google Earth 2014)

Site G in Figure 81 is further south/southwest of the Lamar PM10 monitors. It is located at approximately 106 Savage Ave., Lamar, CO 81052. This parking lot has been paved over and is not a source of PM_{10}.

Site H in Figure 81 is restricted access property that boarders the southeastern side of Lamar and is bordered by Memorial Drive on the west and Bent Fort Canal on the north. The land is naturally vegetated and undisturbed. Figure 82 demonstrates that this site has minimally (if any) disturbed soil as of this writing.

Figure 82: Restricted access, vegetated land southeast of PM_{10} monitors. (Google Image 2012)

Site I in Figure 81 is the Lamar Ball Complex at approximately 100 Savage St., which has limited access through fencing. These fields are used by the Lamar Community College but owned and maintained by the city of Lamar. City personnel reported that they have brought rotomilling and pea gravel in to help with dust control. Rotomilling is ground up asphalt that has been spread across parts of the parking areas and much of the open areas around the fields consist of pea gravel. The city will also drag the parking areas and apply water as needed for dust. The APCD considers pavement, maintained gravel, natural vegetation, and restricted access 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. The fields are turf and regularly watered as shown in Figure 83. This complex is well maintained by the City and implements reasonable dust control measures on a regular basis.

Figure 83: Lamar Ball Complex (Google Image 2012)

Site J in Figure 81 is the Prowers County Fairgrounds located at 2206 Saddle Club Dr., Lamar, CO 81052. The land is maintained by the county and is grated annually and watered frequently during most of the year. County personnel reported that the facility is frequently used from April to September and watered as needed during these times. The APCD considers pavement, maintained gravel, natural vegetation, and restricted access 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.

<u>Colorado State University CO-OP Extension Office</u>

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.

<u>USDA: Natural Resources Conservation Service (NRCS)</u>

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

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

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 84 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 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.

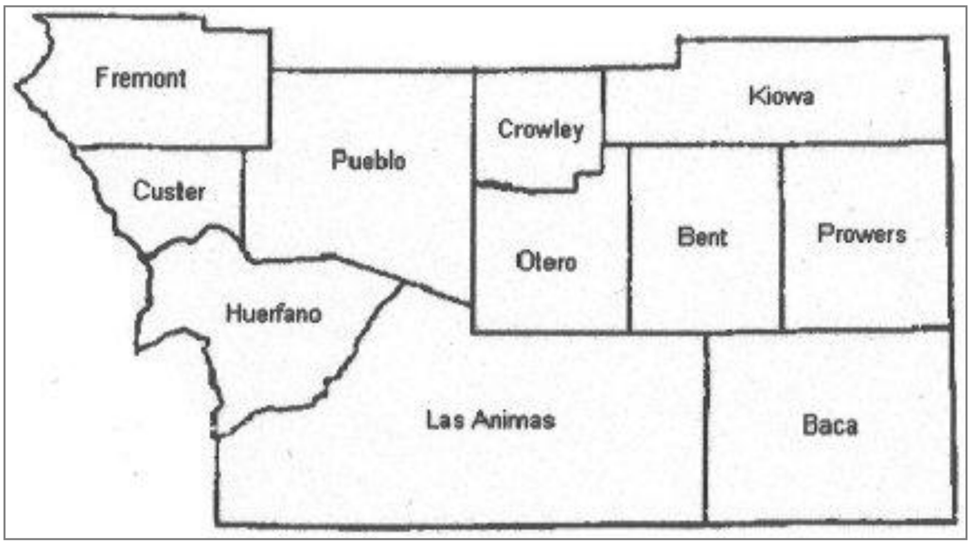

Figure 84: Southeast Colorado Counties

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 PM_{10} values from Alamosa – Adams State College (08-003-0001), Alamosa – Municipal Building (08-003-0003), Lamar – Power Plant (08-099-0001) and Lamar – Municipal Building (08-099-0002) on March 18, 2012.

Elevated 24-hour PM_{10} concentrations were recorded in parts of Colorado on March 18, 2012. All of the noted March 18, 2012, twenty-four-hour PM_{10} concentrations were above the 90th percentile concentrations for their locations (see Table 22). This event produced the maximum value for any sample taken in April and exceeded the 99th% value of any evaluation criteria. The statistical and meteorological data clearly shows that but for this high wind blowing dust event, Alamosa and Lamar would not have exceeded the 24-hour NAAQS on March 18, 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} exceedances in Alamosa and Lamar on March 18, 2012, would not have occurred if not for the following: (a) dry soil conditions over New Mexico and southern Colorado with 30-day precipitation totals below the threshold identified as a precondition for blowing dust in New Mexico and south-central and southeast Colorado; (b) a surface low pressure system and vigorous cold front that were associated with a strong upper-level trough that caused strong surface winds over the area of concern; and (c) friction velocities over regions of New Mexico and southern 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 observations from Colorado and New Mexico provide strong evidence that a dust storm took place on March 18, 2012. The combination of intense surface winds in advance of an approaching cold front, with a strong upper-level trough that was moving across the western United States 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 intense surface winds in advance of an approaching cold front. These surface features were associated with a strong upper-level trough that was moving across the western United States. The surface winds were predominantly out of a south to southwesterly direction and moved over dry soils in New Mexico and southern Colorado producing significant blowing dust. 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 New Mexico and southern Colorado. These sources are not reasonably controllable during a significant windstorm under abnormally dry or moderate drought conditions.

The blowing dust climatology for Lamar indicates that the area can be susceptible to blowing dust when winds are high. Surface geologic features in some areas of eastern Colorado reflect the effects of wind-blown dust caused by passing, intense low pressure systems and their associated cold fronts. This part of Colorado has been subject to dust storms since the end of the last Ice Age. Forecast products from the Navy Aerosol Analysis and Prediction System model provide supporting evidence for a regional blowing dust event on March 18, 2012, suggesting that significant source regions for dust in Colorado were located in arid regions of New Mexico and Colorado. NOAA HYSPLIT forward and backward trajectories provide clear supporting evidence that dust from arid regions of New Mexico and southern Colorado caused the PM_{10} exceedances measured across portions of southern and southeastern Colorado on March 18, 2012. Soils in south-central and southeast Colorado along with much of 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 New Mexico and southern and eastern 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 New Mexico, and southern Colorado. But for the dust storm on March 18, 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 New Mexico and southern and eastern Colorado were above 1.0 meters per second on March 18, 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 severe to extreme drought sections of New Mexico and southern Colorado on March 18, 2012. These elevated friction velocities (shown in Figure 37 and Figure 38) 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 New Mexico and southern and eastern Colorado) prove that this dust storm was a natural event that was not reasonably controllable or preventable.

MODIS and GASP satellite imagery reveal that a dust storm was taking place in New Mexico on the same day that Alamosa and Lamar in southern Colorado reported an exceedance of the twenty-four hour PM_{10} standard. The drought-stricken soils of New Mexico were a likely contributor to the blowing dust in Alamosa and Lamar which produced the PM_{10} exceedances on March 18, 2012. This is consistent with the climatology for many dust storms in Colorado as described in the Lamar, Colorado, Blowing Dust Climatology 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, the PM_{10} exceedances in Alamosa and Lamar on March 18, 2012, would not have occurred “but for” the large regional dust storm on March 18, 2012.

7.0 References

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Lancaster, N. 2009. Aeolian Features and processes, In R. Young and L. Norby, Geological Monitoring. Boulder, Colorado, Geological Society of America, 1-25.

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
March 18, 2012

865
WWUS75 KPUB 181002
NPWPUB

URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE PUEBLO CO
402 AM MDT SUN MAR 18 2012

COZ089-093>099-181615-
/O.UPG.KPUB.HW.A.0004.120318T1700Z-120319T0100Z/
/O.NEW.KPUB.HW.W.0007.120318T1700Z-120319T0100Z/
CROWLEY COUNTY-LA JUNTA VICINITY/OTERO COUNTY-
EASTERN LAS ANIMAS COUNTY-WESTERN KIOWA COUNTY-
EASTERN KIOWA COUNTY-LAS ANIMAS VICINITY/BENT COUNTY-
LAMAR VICINITY/PROWERS COUNTY-SPRINGFIELD VICINITY/BACA COUNTY-
INCLUDING...ORDWAY...OLNEY SPRINGS...LA JUNTA...ROCKY FORD...
BRANSON...KIM...EADS...SHERIDAN LAKE...LAS ANIMAS...LAMAR...
SPRINGFIELD...WALSH
402 AM MDT SUN MAR 18 2012

...HIGH WIND WARNING IN EFFECT FROM 11 AM THIS MORNING TO 7 PM MDT THIS EVENING...

THE NATIONAL WEATHER SERVICE IN PUEBLO HAS ISSUED A HIGH WIND WARNING...WHICH IS IN EFFECT FROM 11 AM THIS MORNING TO 7 PM MDT THIS EVENING. THE HIGH WIND WATCH IS NO LONGER IN EFFECT.

* LOCATION...CROWLEY...OTERO...EASTERN LAS ANIMAS...KIOWA... BENT...PROWERS...AND BACA COUNTIES.

* CAUSE AND TIMING...STRONG SOUTH WINDS WILL SPREAD ACROSS CENTRAL AND EASTERN COLORADO TODAY AHEAD OF AN APPROACHING STORM SYSTEM...WITH THE STRONGEST WINDS OCCURRING SUNDAY AFTERNOON.

* WIND...SOUTH TO SOUTHWEST 35 TO 45 MPH WITH GUSTS TO 60 MPH.

* IMPACT...DRIVERS OF HIGH PROFILE VEHICLES...WILL BE VULNERABLE TO THE THREAT OF STRONG CROSS WINDS...ESPECIALLY ALONG EAST WEST ORIENTED HIGHWAYS. 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.

&&

$$

COZ070-071-084-088-181615-
/O.NEW.KPUB.HW.W.0007.120318T1700Z-120319T0100Z/
ALAMOSA VICINITY/CENTRAL SAN LUIS VALLEY BELOW 8500 FT-
SOUTHERN SAN LUIS VALLEY-
NORTHERN EL PASO COUNTY/MONUMENT RIDGE/RAMPART RANGE BELOW
7500 FT-TRINIDAD VICINITY/WESTERN LAS ANIMAS COUNTY BELOW 7500 FT-
INCLUDING...ALAMOSA...MONTE VISTA...MANASSA...LA JARA...
ANTONITO...SANFORD...SAN LUIS...FORT GARLAND...BLANCA...
BLACK FOREST...AIR FORCE ACADEMY...TRINIDAD
402 AM MDT SUN MAR 18 2012

...HIGH WIND WARNING IN EFFECT FROM 11 AM THIS MORNING TO 7 PM MDT THIS EVENING...

THE NATIONAL WEATHER SERVICE IN PUEBLO HAS ISSUED A HIGH WIND WARNING...WHICH IS IN EFFECT FROM 11 AM THIS MORNING TO 7 PM MDT THIS EVENING.

* LOCATION...NORTHERN EL PASO...WESTERN LAS ANIMAS COUNTIES...AND THE SOUTHERN AND CENTRAL PORTIONS OF THE SAN LUIS VALLEY.

* CAUSE AND TIMING...STRONG SOUTH WINDS WILL SPREAD ACROSS CENTRAL AND EASTERN COLORADO TODAY AHEAD OF AN APPROACHING STORM SYSTEM...WITH THE STRONGEST WINDS OCCURRING SUNDAY AFTERNOON.

* WIND...SOUTH TO SOUTHWEST 35 TO 45 MPH WITH GUSTS TO 60 MPH.

* IMPACT...DRIVERS OF HIGH PROFILE VEHICLES...WILL BE VULNERABLE TO THE THREAT OF STRONG CROSS WINDS...ESPECIALLY ALONG EAST WEST ORIENTED HIGHWAYS. 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.

FXUS65 KPUB 181739
AFDPUB

AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE PUEBLO CO
1139 AM MDT SUN MAR 18 2012

.AVIATION...SOUTH WINDS INCREASING ABOUT AS EXPECTED...WITH GUSTS OVER 40 KNOTS AND BLOWING DUST ALREADY AT KALS. KPUB/KCOS WINDS A LITTLE SLOWER TO RAMP UP AS CLOUDS HAVE LIMITED MIXING LATE THIS MORNING...THOUGH LATEST OBS SHOW GUSTS BEGINNING TO MAKE AN APPEARANCE. FOR THE REMAINDER OF THE AFTERNOON...S/SW WINDS WILL CONTINUE TO INCREASE ALL AREAS...WITH GUSTS OVER 40 KNOTS AT THE TAF SITES. BLOWING DUST WILL CONTINUE TO PRODUCE PERIODS OF MAINLY MVFR VISIBILITY AT KALS THROUGH 00Z...WITH POTENTIAL FOR SOME REDUCED VIS AT TIMES SPREADING ACROSS THE EASTERN PLAINS AFTER 20Z. SNOW HAS BEEN SLOW TO GET GOING OVER THE MOUNTAINS...THOUGH EXPECT IT TO INCREASE THROUGH THE DAY WITH IFR CONDITIONS BECOMING FAIRLY WIDESPREAD OVER THE HIGHER TERRAIN BY 22Z. OVERNIGHT...WINDS WILL SLOWLY DECREASE AFTER 06Z...WHILE -SHSN CONTINUE TO PRODUCE AREAS OF IFR CONDITIONS MOST MOUNTAIN AREAS THROUGH 12Z. ON MONDAY...STILL POTENTIAL FOR S/SW WINDS GUSTING TO 25 KNOTS AT THE TAF SITES...MAINLY IN THE 15Z-20Z PERIOD...WHILE MOUNTAINS ALONG THE CONTINENTAL DIVIDE REMAIN IFR DUE TO CLOUDS AND -SN.

FXUS65 KPUB 182146
AFDPUB

AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE PUEBLO CO
346 PM MDT SUN MAR 18 2012

.SHORT TERM...
(TONIGHT AND MONDAY)

...SPRING...

VIGOROUS UPPER LOW OVER THE DESERT SOUTHWEST SLOWLY EDGING EASTWARD TODAY WITH INITIAL UPPER LEVEL WIND MAX ROTATING NORTHWARD ACROSS COLORADO. BRUTE FORCE MIXING HAS PUSHED WIND SPEEDS TO NEAR/SLIGHTLY

OVER HIGH WIND THRESHOLDS OVER THE SAN LUIS VALLEY AND SOUTHERN I-25 CORRIDOR AROUND TRINIDAD...WHILE SPEEDS OVER THE EASTERN PLAINS HAVE BEEN RUNNING ABOUT 5 KNOTS SHORT OF CRITERIA AS CLOUDS LIMIT DEEP MIXING. STILL TIME FOR THE PLAINS TO REACH 50 KNOT GUSTS THROUGH EARLY EVENING...ESPECIALLY WITH VIRGA/HIGH BASED SHOWERS BEGINNING TO DEVELOP EAST OF I-25. AIR HAS BECOME FAIRLY DUSTY/HAZY OVER MUCH OF THE SAN LUIS VALLEY AND EASTERN PLAINS...AND EXPECT THIS TO CONTINUE UNTIL WINDS BEGIN TO DIE AFTER SUNSET. WEB CAMS SUGGEST SNOW HAS BEEN VERY SLOW DEVELOP OVER THE MOUNTAINS THIS AFTERNOON...WITH ONLY MINOR ACCUMULATIONS AT WOLF CREEK PASS SO FAR TODAY. THIS WILL CHANGE LATER THIS AFTERNOON AND INTO THIS EVENING AS CONVECTION ROTATES NORTHWARD OUT OF NEW MEXICO...WITH POTENTIAL FOR THUNDERSNOW AND HIGH SNOWFALL RATES THIS EVENING OVER THE SAN JUANS. SNOW ADVISORIES OVER THE CENTRAL AND EASTERN MOUNTAINS MAY BE OVERDONE AS SNOW ACCUMS WILL BE SPOTTY...THOUGH WITH PLENTY OF CONVECTION THE NEXT SEVERAL HOURS WILL KEEP HIGHLIGHTS GOING AS IT MAY TAKE ONLY A COUPLE HOURS OF CONVECTIVE SHOWERS TO PRODUCE SIGNIFICANT ACCUMS. LEFT THE MENTION OF PRECIP OUT OF THE FORECAST FROM I-25 EASTWARD...THOUGH SUPPOSE A FEW SPRINKLES/VIRGA COULD MAKE IT EAST OF THE MOUNTAINS THIS EVENING.

.AVIATION...
SOUTH WINDS GUSTING TO AROUND 40 KNOTS ALL TAF SITES...WITH REDUCTIONS IN CIGS/VIS DUE TO BLOWING DUST NOTED AT KPUB AND KALS THIS AFTERNOON. THROUGH SUNSET...S/SW WINDS WILL CONTINUE...WITH GUSTS OVER 40 KNOTS AND OCCASIONAL MVFR DUE TO BLOWING DUST AT THE TAF SITES UNTIL 01Z-03Z. HAVE SEEN AN INCREASE IN -SHRA/-SHSN OVER THE MOUNTAINS THIS AFTERNOON...AND EXPECT MOST HIGHER TERRAIN TO BE OBSCURED BY CLOUDS/SHOWERS OVERNIGHT. ON MONDAY...STILL POTENTIAL FOR S/SW WINDS GUSTING TO 25 KNOTS AT THE TAF SITES...MAINLY IN THE 15Z-20Z PERIOD...WHILE MOUNTAINS ALONG THE CONTINENTAL DIVIDE REMAIN IFR DUE TO CLOUDS AND -SN.

Air Quality Advisory
Denver Metro/Front Range:
Issued: 3/18/2012 3:18:00 PM
Residential Burning Unrestricted - No Action Day
Effective: 3/18/2012 4:00:00 PM - 3/19/2012 4:00:00 PM
Strong winds are expected to cause blowing dust across the Denver Metro Area until midnight on Sunday. If visibility is less than 10 miles in blowing dust in your area, people with heart and lung disease, older adults, and children should reduce prolonged or heavy indoor or outdoor exertion.

Other Areas:
Blowing Dust Advisory for Eastern Colorado until midnight on Sunday, March 18, 2012. Areas of blowing dust will cause particulate matter to climb into the Unhealthy-for-Sensitive-Groups category in many areas of eastern Colorado. These areas include the Denver metro area, Greeley, Fort Collins, Limon, Ft Morgan, Sterling, Colorado Springs, Pueblo, and Lamar. If visibility is less than 10 miles in blowing dust in your area, then the following precautions apply. People with heart and lung disease, older adults, and children should reduce prolonged or heavy indoor or outdoor exertion.

DESCRIPTIVE TEXT NARRATIVE FOR SMOKE/DUST OBSERVED IN SATELLITE IMAGERY THROUGH 0015Z March 19, 2012

No significant areas of detached smoke could be seen.

Dust/Sand:
It is very likely there is blowing dust/sand from N Chihuahua across E New Mexico/TX and OK Panhandles into E CO, W KS and the NE Panhandle... but thin clouds obscure best detection at this time. However, clouds in this area have a milky appearance potentially giving a general idea of where the blowing dust likely is.