Technical Support Document for the May 26, 2012 and June 20, 2012 Alamosa Exceptional Events

COLORADO
Department of Public Health & Environment

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

June 30, 2015

Executive Summary

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 On May 2, 2011, in an attempt to clarify this rule, EPA released draft guidance documents on the implementation of the EER to State, tribal and local air agencies for review.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

Due to the semi-arid nature of 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 events that occurred on May 26, 2012 and June 20, 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EPA's June 2012 draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule states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 both eastern and western Colorado it has been shown that wind speeds of 30 mph or greater and gusts of 40 mph or greater can cause blowing dust (see the Lamar, Colorado, Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx). For these blowing dust events, 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 Colorado and the surrounding states.

The PM_{10} exceedances in Alamosa on May 26, 2012 and June 20, 2012, would not have occurred if not for the following: (a) dry soil conditions over source regions with 30-day precipitation totals below the threshold identified as a precondition for blowing dust; and (b) meteorological conditions that caused strong surface winds over the area of concern. These PM_{10} exceedances were due to exceptional events associated with regional windstorm-caused emissions from erodible soil sources outside the monitored areas. These sources are not reasonably controllable during significant windstorms under abnormally dry or moderate drought conditions.

APCD is requesting concurrence on exclusion of the PM_{10} values from the Alamosa-Adams State College (08-003-0001) and Alamosa-Municipal Building (08-003-0003) sites on May 26, 2012 and June 20, 2012.

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

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1.0 Exceptional Events Rule Requirements

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

1.1 Procedural Criteria

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

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

Public notification that event was occurring (40 CFR 50.14(c)(1)(i))
APCD issued a Blowing Dust Advisory for eastern Colorado advising citizens of the potential for high wind/dust on May 26, 2012. This area includes: Rangely, Craig, Steamboat Springs, Meeker, Aspen, Grand Junction, Rifle, Montrose, Delta, Nucla, Telluride, Cortez, Durango, Pagosa springs, Alamosa, Trinidad La Junta and Lamar. The advisory that was issued on May 26, 2012 can be viewed at: http://www.colorado.gov/airquality/forecast_archive.aspx?seeddate=03%2f18%2f2012 and is described further in Section 2.

For the event that occurred on June 20, 2012, for which APCD did not issue a specific Blowing Dust Advisory due to unforeseen and/or sudden weather changes, the APCD had developed and implemented processes and measures within the 2003 Natural Events Action Plan (NEAP) for Alamosa (See http://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=AlamosaNaturalEventsActionPlan2003.pdf), including public education programs and Best Available Control Measures (BACM). APCD asserts that continual public outreach and notification in the Alamosa area was adequate on June 20, 2012 when drastic weather patterns prevented meteorologists from issuing timely advisories.

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 the Primary Quality Assurance Organization 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 with the measurement when the data are 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 with a date/time stamp 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 May 26, 2012 and June 20, 2012, sample values greater than 150 µg/m^3 were taken in Alamosa, Colorado during the high wind events that occurred on those days. These were the monitors located in Alamosa at Adams State College (SLAMS) and the Municipal Building (SLAMS). Both 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 May 26, 2015 and closed the comment period on June 26, 2015. A copy of the public notice certification (in cover letter), along with any 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))
At the close of the comment period, and after APCD has had the opportunity to consider any comments submitted on this document, 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 June 30, 2015 or one year prior to a regulatory action.

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 May 26, 2012 and June 20, 2012, blowing dust events and PM_{10} exceedances – Conceptual Model and Wind Statistics

Two powerful storm systems caused exceedances of the twenty-four hour PM_{10} standard in Alamosa, Colorado on May 26, 2012 and June 20, 2012. Exceedances were recorded in Alamosa at the Alamosa Municipal Building monitor and the Alamosa Adams State College (ASC) monitor. A meteorological analysis for each event is discussed further below.

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 wind speeds of 30 mph or greater and gusts of 40 mph or greater can cause blowing dust (see the Alamosa Blowing Dust Climatology available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2). For these blowing dust events, 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 Colorado.

2.1 May 26, 2012 Meteorological Analysis

On May 26 of 2012, a powerful spring storm system caused an exceedance of the 24-hour PM_{10} standard in Alamosa, Colorado, at the Adams State College monitor with a concentration of 253 $\mu g/m^3$ and at the Municipal Building monitor with a concentration of 182 $\mu g/m^3$. These elevated readings and the location of the monitors are plotted on a map of the Greater Alamosa area in Figure 1. The exceedances in Alamosa 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 southwest direction which moved over dry soils in southern Colorado and northern New Mexico, producing significant blowing dust.

High PM10 Natural Event in Colorado (May 26, 2012)

Figure 1: 24-hour PM_{10} concentrations for May 26, 2012.
(Source: http://webapps.datafed.net/datafed.aspx?dataset=AQS_D&parameter=pm10)

The upper-level trough associated with this storm system is shown on the 700 mb and 500 mb height analysis maps at 5:00 AM MST, May 26, 2012 in Figure 2 and Figure 3, respectively. The 700 mb level is located roughly 3 kilometers above mean sea level (MSL) while the 500 mb level is approximately 6 km above MSL. These two charts show that a deep trough of low pressure was present at both the 700 and 500 mb level in the hours preceding the blowing dust event of May 26 and that it was moving over the southwestern United States. This is a typical upper-air pattern for blowing dust events in Colorado (see previous exceptional event documents located at http://www.colorado.gov/airquality/tech_doc_repository.aspx#exceptional_events).

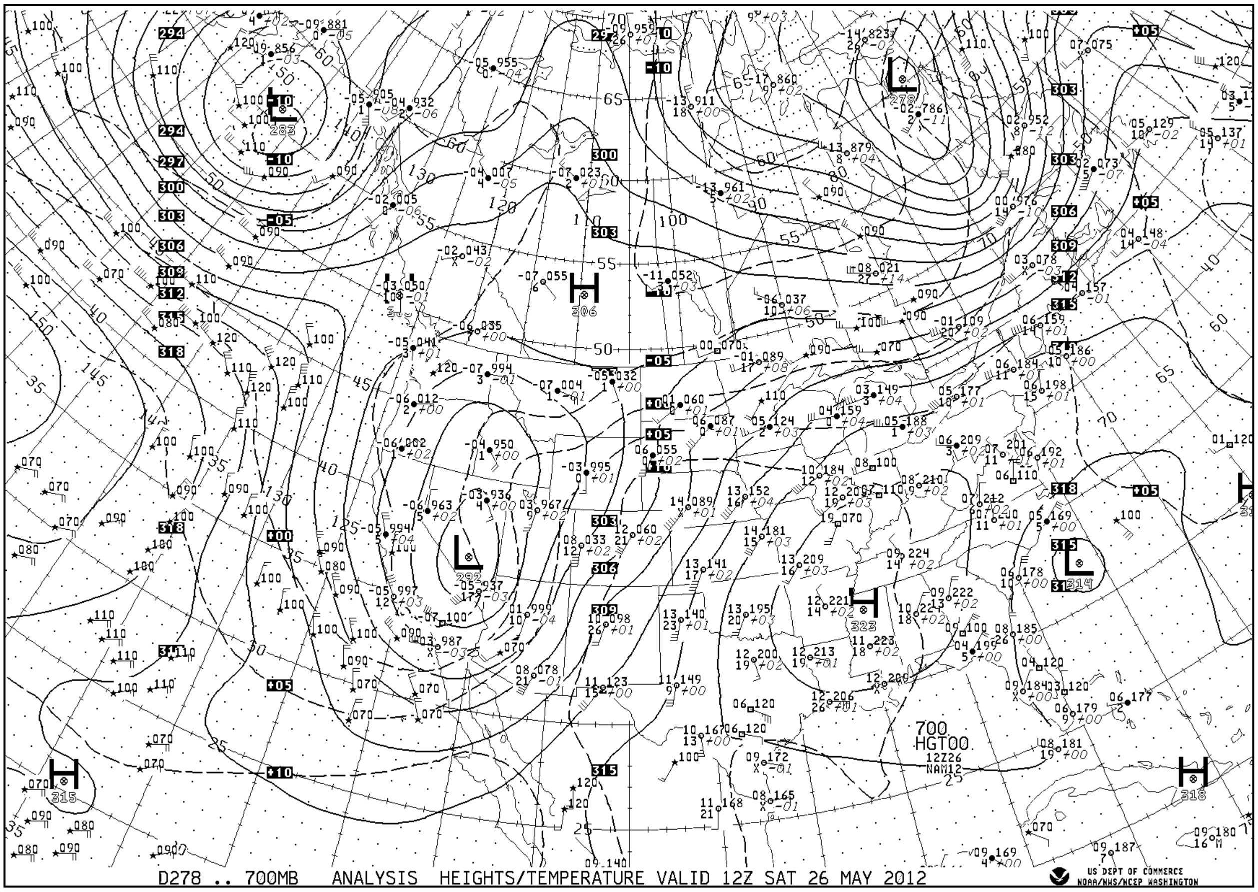


Figure 2: 700 mb (about 3 kilometers above mean sea level) analysis for 12Z May 26, 2012, or 5:00 AM MST May 26, 2012.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

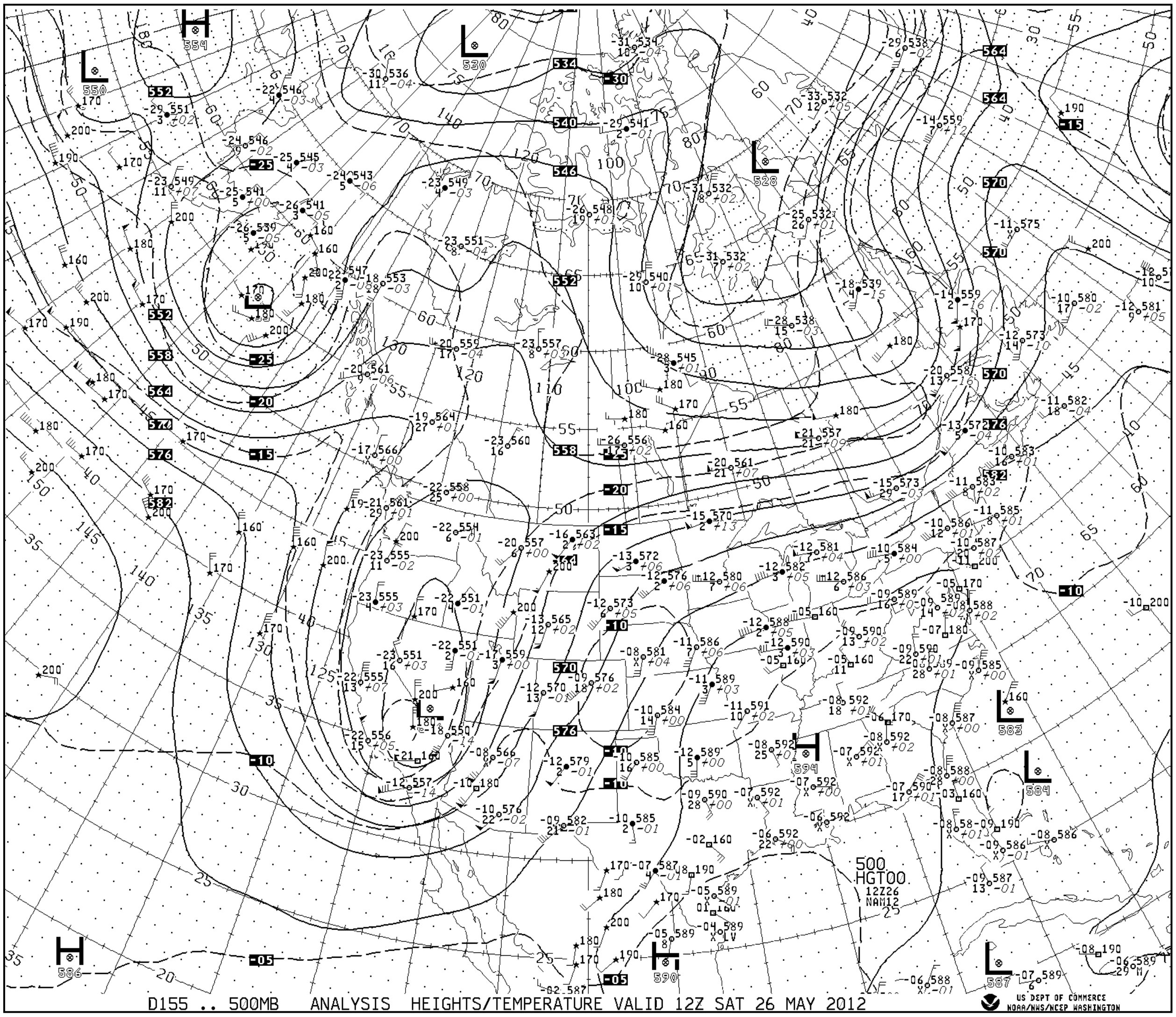


Figure 3: 500 mb (about 6 kilometers above mean sea level) analysis for 12Z May 26, 2012, or 5:00 AM MST May 26, 2012.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

The surface weather associated with the storm system of May 26, 2012, is presented in Figure 4. Significant surface features impacting southern Colorado at 11:00 AM MST (18Z) included a cold front in Utah and Arizona moving eastward into Colorado and New Mexico. This front was associated with a strong area of surface low pressure that was slowly moving eastward from Nevada into northern Utah. The winds in southern Colorado and northern New Mexico out ahead of this system were from a south to southwest direction and intensifying in speed during the afternoon hours of May 26, 2012.

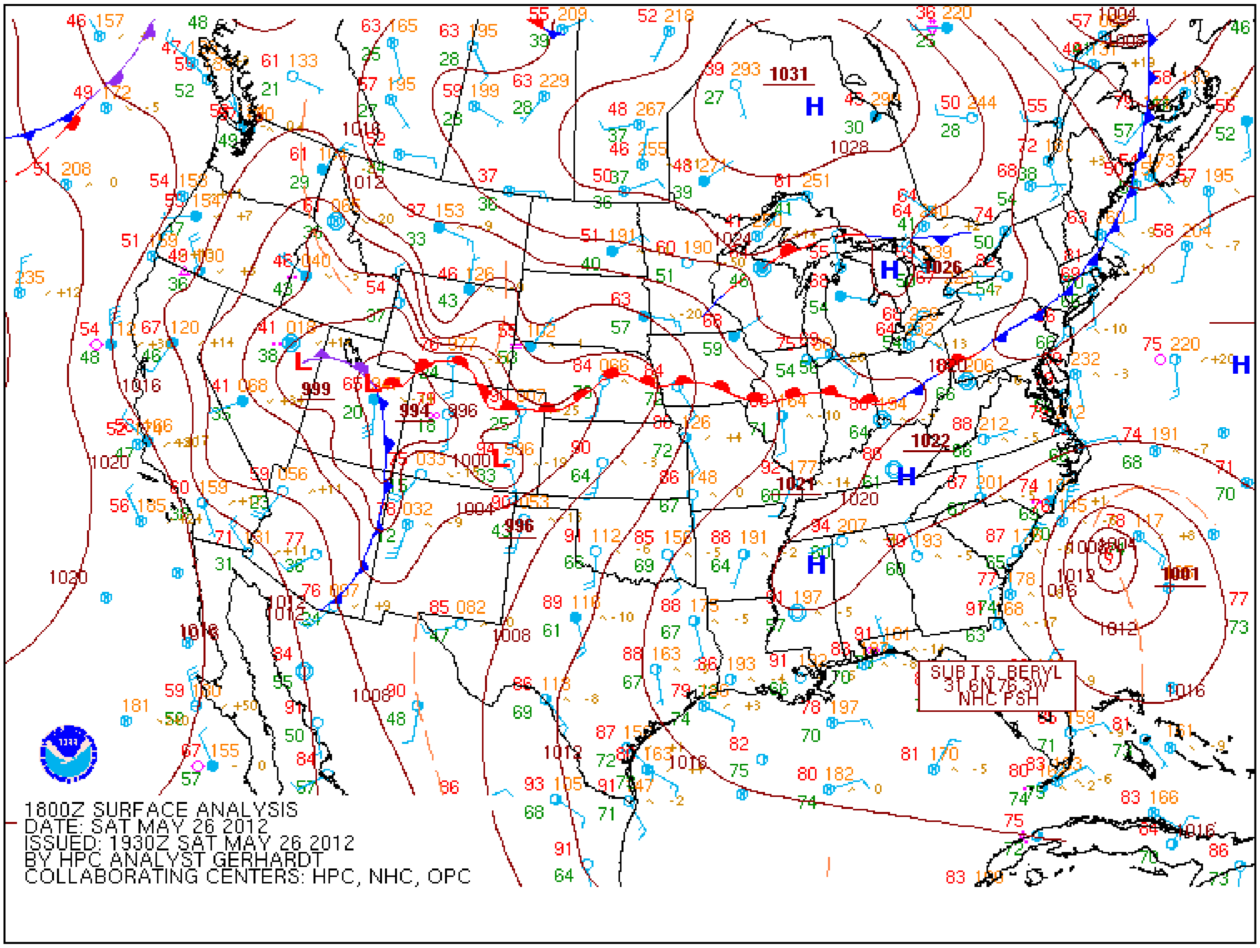


Figure 4: Surface analysis for 18Z May 26, 2012, or 11:00 AM MST May 26, 2012. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

In order to fully evaluate the synoptic meteorological scenario of May 26, 2012, regional surface weather maps are provided showing individual station observations during the height of the event in question. Figure 5 presents weather observations for the Desert Southwest, including southern Colorado, at (a) 11:00 AM and (b) 2:00 PM MST on May 26. On the map in Figure 5(a) the station observation for Alamosa (circled in red) shows 3 full flags indicating sustained winds of 30 knots (35 mph). Additionally, the observation includes the weather symbol of infinity (∞). The infinity sign is the weather symbol for haze. Haze is often reported during dust storms, and in dry and windy conditions haze typically refers to blowing dust (see the following link for the description of haze published by the National Oceanic and Atmospheric Administration (NOAA): http://www.crh.noaa.gov/lmk/?n=general_glossary). To the west of the Alamosa and in closer proximity to the approaching cold front, high winds and haze were also being reported. In Blanding, Utah (circled in green), sustained winds of 30 knots (35 mph) were recorded along with the weather symbol of the dollar sign ($). The dollar sign in meteorological observations is defined as “dust or sand raised by the wind at the time of the observation” (Source: http://oceanservice.noaa.gov/education/yos/resource/JetStream/synoptic/ww_symbols.htm).

Three hours later at 2:00 PM MST (Figure 5(b)), high winds and haze continued to be reported in Alamosa (circled in red). Concurrently other weather stations around the region were starting to report blowing dust and reduced visibility, indicating that this dust storm was a regional event. In Albuquerque, New Mexico (circled in green and located directly upwind of Alamosa to the south-southwest), the surface observation shows high winds (sustained at 35 knots (40 mph)) with blowing dust.

Hourly surface observations, in table form, from Alamosa and Albuquerque provide additional evidence that there was an extended period of high winds, haze and blowing dust within the region. Table 1 lists observations for the PM_{10} exceedance location of Alamosa while Albuquerque observations can be found in Table 2. Observations that are climatologically consistent with blowing dust conditions (see the Alamosa Blowing Dust Climatology available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2) are highlighted in yellow. Collectively, Alamosa and Albuquerque experienced many hours of reduced visibility along with sustained wind speeds and gusts at or above the thresholds for blowing dust.

Surface weather maps and hourly observations show that a regional dust storm occurred under south to southwesterly flow in advance of a cold front. This data provides clear evidence of blowing dust and winds well above the threshold speeds for blowing dust on May 26, 2012.

a)
b)

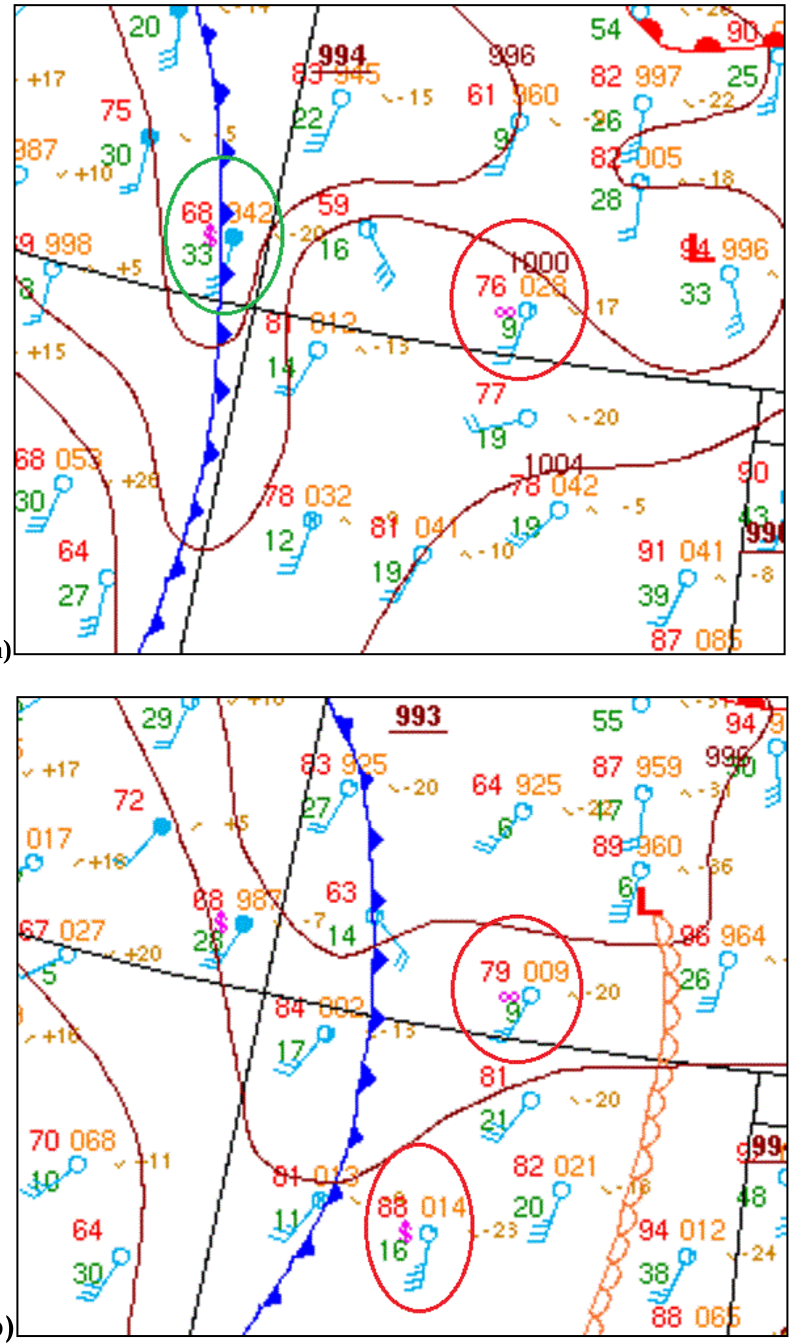


Figure 5: Four Corners regional surface analysis for (a) 11:00 AM MST and (b) 2:00 PM MST, May 26, 2012.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

Table 1: Weather observations for Alamosa, CO, on May 26, 2012
(Source: http://mesowest.utah.edu/)

Time MST May 26, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
2:52	49	30	7		140	haze	5
3:52	48	30	8		150	haze	6
4:52	42	46	7		100		10
5:52	48	35	10		130		10
6:52	61	20	18		180		10
7:52	66	16	20	28	190		10
8:52	70	12	25	38	190		10
9:52	75	9	35	47	200		8
10:34	75	8	37	47	190	haze	2.5
10:52	76	8	37	51	190	haze	1.25
11:07	75	8	31	45	200	haze	3
11:23	77	7	33	50	180	haze	2.5
11:35	79	7	38	48	190	haze	1.75
11:52	77	7	39	48	190	haze	1.5
12:20	79	7	35	50	210	haze	3
12:27	79	7	33	50	190	haze	4
12:52	78	7	33	50	190		7
13:06	79	7	31	47	190	haze	4
13:30	79	7	33	52	190	haze	2.5
13:38	79	7	37	50	190	haze	4
13:52	79	7	31	47	200	haze	5
14:50	81	7	36	51	220	haze	2.5
14:52	80	8	37	51	230	haze	2
15:07	79	8	29	45	230	haze	4
15:52	78	9	31	47	210		8
16:52	76	10	35	47	200		8
17:52	72	11	35	44	210		8
18:52	71	11	36	50	220	haze	5
19:52	62	21	25	35	260		7
20:52	58	22	25	33	240		9
21:52	55	21	21	30	250		10

Table 2: Weather observations for Albuquerque, NM, on May 26, 2012.
(Source: http://mesowest.utah.edu/)

Time MST May 26, 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	66	14	8		170		10
1:52	61	17	8		120		10
2:52	64	15	7		160		10
3:52	62	16	8		170		10
4:52	65	15	15		160		10
5:52	60	19	6		130		10
6:52	67	16	10		190		10
7:52	75	14	20	27	190		10
8:52	78	12	17	32	200		10
9:52	80	11	23	37	170		10
10:52	81	10	23	32	200		10
11:52	84	9	25	38	200		10
12:52	86	8	35	43	170	blowing dust	6
13:52	88	7	38	54	180	blowing dust	5
14:52	88	6	36	47	170	blowing dust	7
15:52	88	6	35	44	180	blowing dust	8
16:52	86	6	28	43	190		
17:52	83	7	22	40	200		
18:52	80	9	22	29	210		8
19:05	79	10	13	28	210	smoke	6
19:52	78	10	21	31	220	smoke	6
20:52	76	12	17	27	230	smoke	6
21:19	72	16	17	24	280	smoke	5
21:52	70	18	14		290		10
22:52	67	19	18		290		10
23:52	65	19	14		290		10

Satellite-generated data products from May 26, 2012 also indicate that dust caused the PM_{10} exceedance in Alamosa. Figure 6 displays the AIRS (Atmospheric Infrared Sounder) Dust Score zoomed on the San Luis Valley of south-central Colorado at 12:35 PM MST. The AIRS Dust Score is derived from the MODIS Aqua satellite image (see the following link for more information on Dust Score and other AIRS variables: http://disc.sci.gsfc.nasa.gov/nrt/data-holdings/airs-nrt-products). The tan pixels represent dust scores greater than 360, which is indicative of dust particles. It should be noted that at the time of this image Alamosa was in the midst of an extended period of high winds, haze and reduced visibility, suggesting that a dust storm was indeed occurring. By referring back to Table 1, from 12:27 PM to 12:52 PM MST (the time period encompassing Figure 6) Alamosa reported sustained winds of 33 mph, gusts to 50 mph with haze and visibility reduced to 4 -7 statute miles. These are observations that are consistent with blowing dust conditions in Colorado (30 mph sustained winds, 40 mph gusts -- see the Alamosa Blowing Dust Climatology available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2)

The National Oceanic and Atmospheric Administration (NOAA) Satellite Services Division is in agreement with the conclusion that blowing dust was occurring in the San Luis Valley on May 26, 2012. The Smoke Text Product from NOAA at 8:00 PM MST stated:

> "Saguache and Alamosa counties appear to be the origin of blowing dust/sand that moves to the NE, originates at 1800Z (11 AM MST) and continues through sunset."

The same text product also identified widespread blowing dust across New Mexico moving in the direction of southern Colorado:

> "Blowing dust/sand, which is moving to the NE and originates in McKinley and San Juan counties, is observed starting at 1900Z (12 PM MST) and continuing through sunset. Blowing dust/sand also originates from White Sands and moves to the NE." (Source: http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012E270314.html)

Additionally, the Colorado Department of Public Health and Environment issued a Blowing Dust Advisory in anticipation of the blowing dust event of May 26. Text from this advisory included:

> "Strong gusty winds are expected to develop across Western Colorado, the San Luis Valley, Northeast Arizona and Western New Mexico. These winds will create periods with areas of blowing dust." (Source: http://www.colorado.gov/airquality/forecast_archive.aspx?seeddate=05%2f26%2f2012)

Satellite-generated imagery combined with reports and advisories from government agencies on May 26, 2012 clearly reveal that a dust storm was taking place in the San Luis Valley of south-central Colorado. This collection of data indicates that this storm was regional in scale and therefore not controllable or preventable.

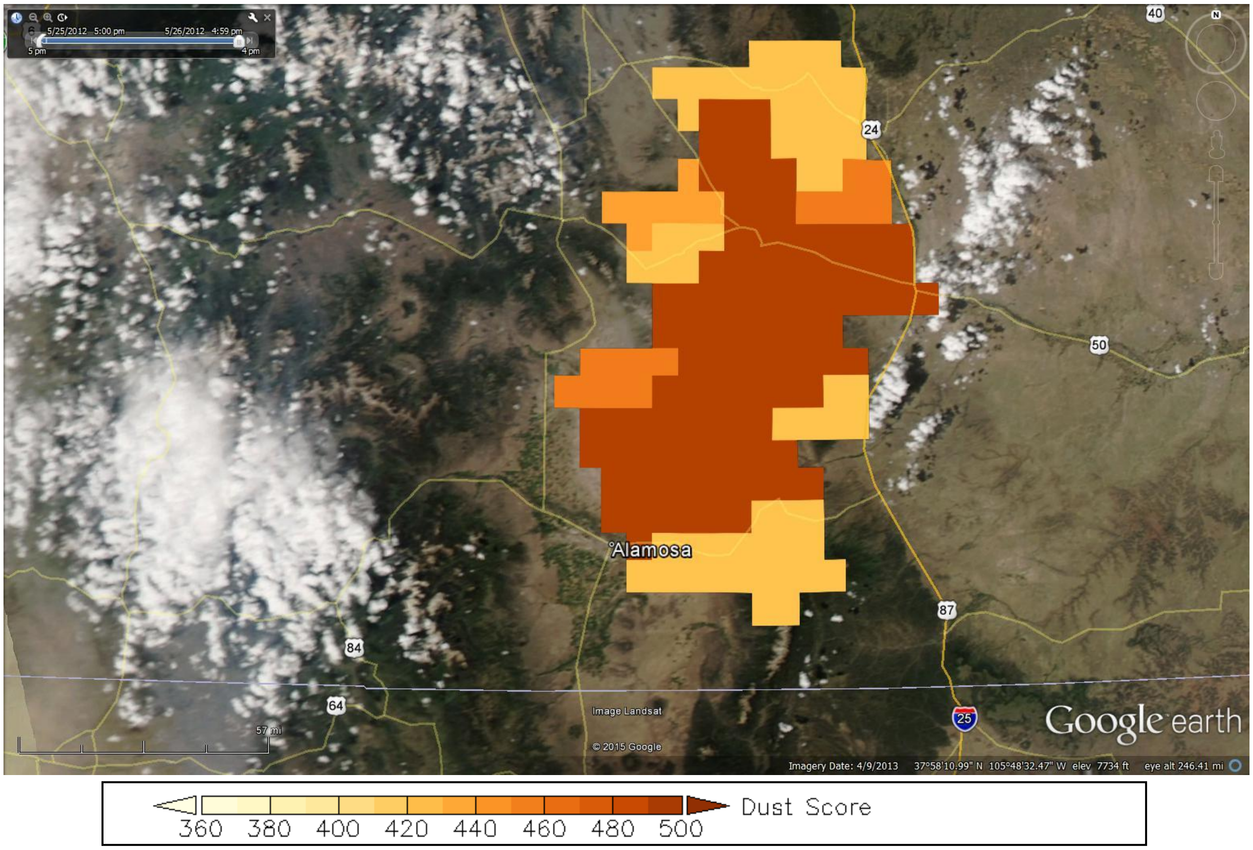


Figure 6: AIRS Dust Score from the MODIS Aqua satellite image at 12:35 PM MST (1935Z) May 26, 2012.
(Source: http://www.earthdata.nasa.gov/labs/worldview)

In order to definitively attribute at least a portion of the dust deposition in Alamosa to long-range transport and establish that the May 26, 2012 storm was a regional event, a NOAA HYSPLIT backward trajectory analysis (Draxler and Rolph, 2012) was conducted (Figure 7). The analysis includes 6-hour duration back trajectories from Alamosa initializing at 11:00 AM MST and ending at 5:00 PM MST. This encompasses the vast majority of haze and reduced visibility observations recorded in Alamosa on May 26 (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 northern New Mexico, including directly from the Albuquerque area where high surface winds and blowing dust are already known to have been occurring on May 26, 2012 (Table 2).

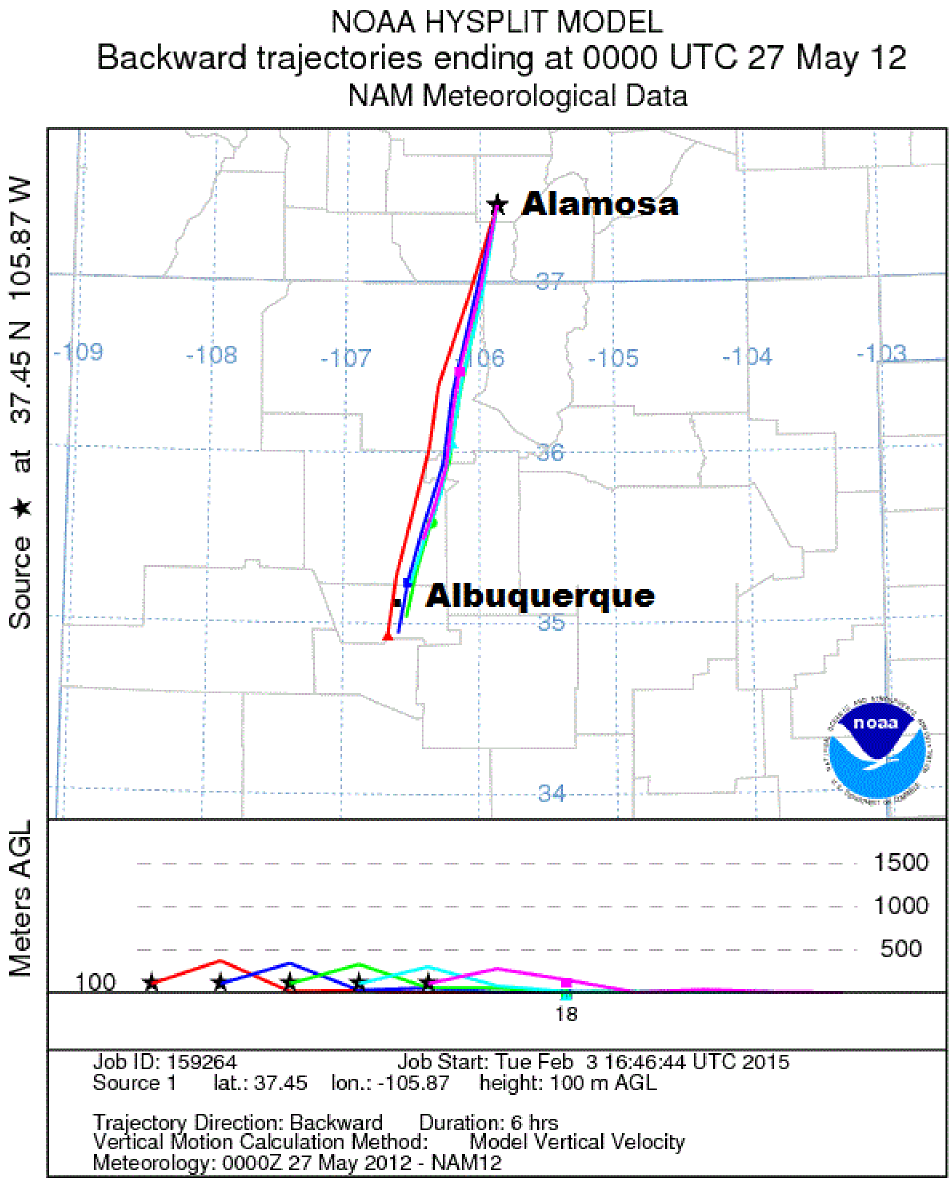


Figure 7: NOAA HYSPLIT NAM12 6-hour back-trajectories for Alamosa, CO from 11:00 AM MST (18Z) May 26, 2012, to 5:00 PM MST (0Z May 27) May 26, 2012. (Source: http://ready.arl.noaa.gov/HYSPLIT.php)

The synoptic weather conditions described above impacted a region that was in the midst of a moderate to severe drought (Figure 8). Sustained drought conditions are known to make topsoil susceptible to high winds and produce blowing dust (see the following link from the National Climatic Data Center for more information: https://www.ncdc.noaa.gov/paleo/drought/drght_history.html). Figure 9 shows the total precipitation in inches from April 26, 2012 to May 25, 2012 for southern Colorado and northern 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 are more likely to occur in Colorado when combined with high winds (see the Alamosa Blowing Dust Climatology available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2). Although Alamosa and the surrounding San Luis Valley was relatively "wet" in the 30 days leading up to the May 26, 2012 dust event, northern New Mexico was significantly drier. The HYSPLIT back-trajectory analysis in Figure 7 has already established the area around Albuquerque as a likely source region for the blowing dust in Alamosa. Figure 9 clearly shows that the vast majority of the area around Albuquerque received less than 0.5 inches of precipitation during the 30-day period leading up to the May 26, 2012 dust event in Alamosa, providing additional evidence of a regional blowing dust event.

The U.S. Drought Monitor and 30-day precipitation totals indicate that soils in southern Colorado and particularly northern New Mexico were dry enough to produce blowing dust when winds were at or above the thresholds for blowing dust. This information, combined with other evidence provided in this report, proves that this dust storm was a natural, regional event that was not reasonably controllable or preventable.

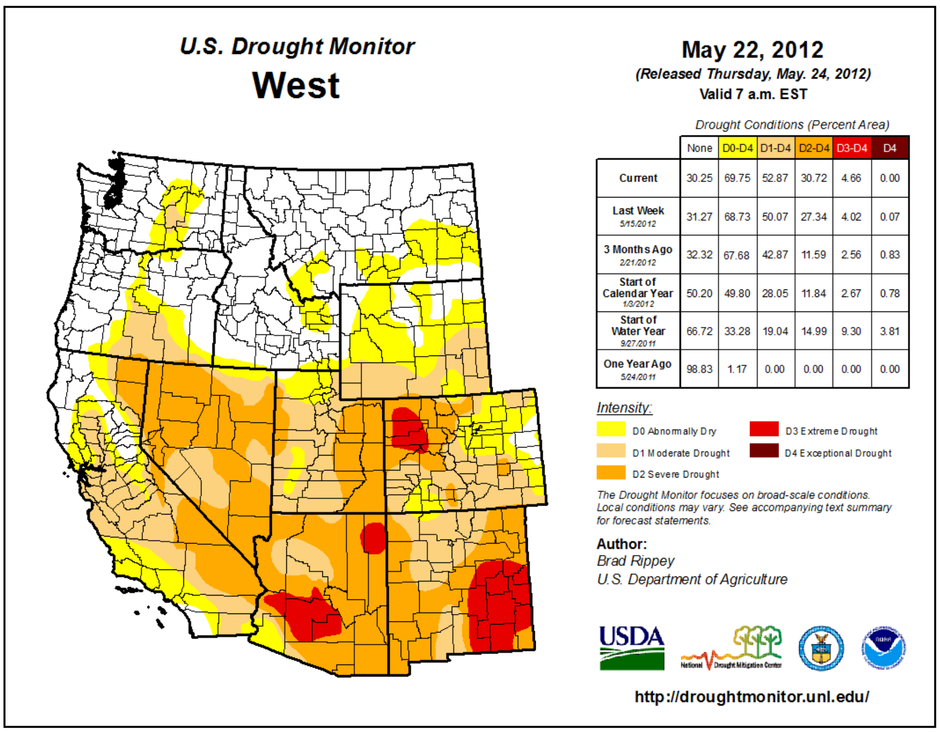


Figure 8: Drought conditions for the Western U.S. at 5:00 AM MST May 22, 2012. (Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

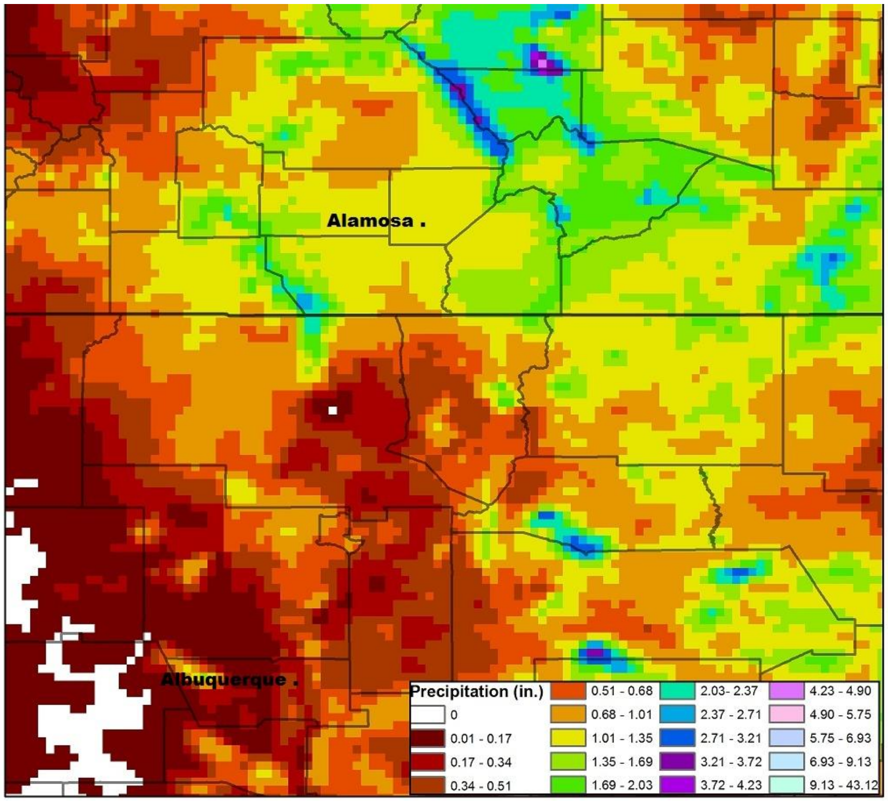


Figure 9: Total precipitation in inches for the southern Colorado and northern New Mexico, April 26, 2012 – May 25, 2012.
(Source: http://prism.nacse.org/recent/)

2.2 June 20, 2012 Meteorological Analysis

On June 20 of 2012, a strong thunderstorm developed over the Sangre de Cristo Mountains on the eastern side of the San Luis Valley. The thunderstorm created powerful outflow winds which resulted in significant blowing dust. That, in turn, produced an exceedance of the 24-hour PM_{10} standard in Alamosa, Colorado. The Municipal Building monitor recorded a concentration of 207 µg/m^3 while the Adams State College monitor logged a concentration of 204 µg/m^3. Those elevated readings and the location of the monitors are plotted on a map of the Greater Alamosa area in Figure 10. The thunderstorm was primarily initiated by a strong upper-level disturbance that was moving over the region, but was likely aided by strong easterly upslope flow from the eastern Colorado plains in the wake of a cold front. The intense outflow winds from this thunderstorm consequently moved over very dry soils in the eastern San Luis Valley which ushered a significant amount of blowing dust into the Alamosa area.

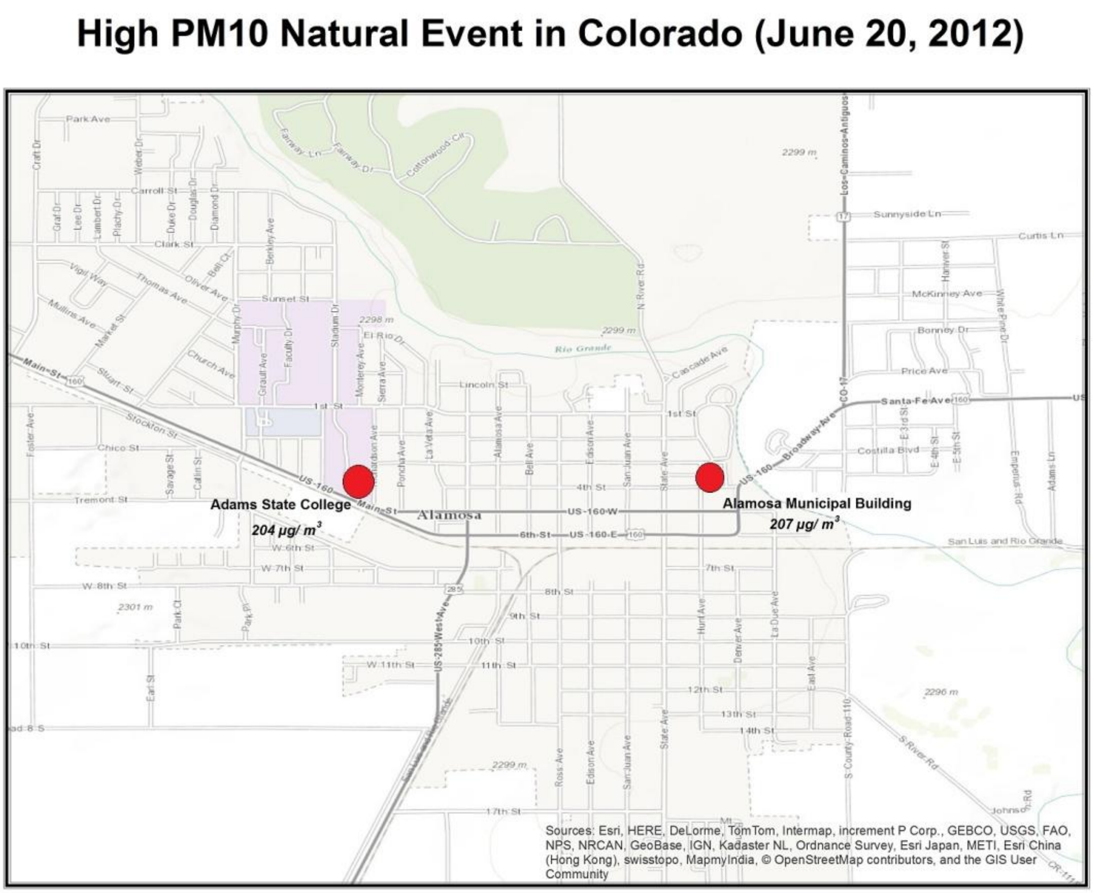


Figure 10: 24-hour PM_{10} concentrations for June 20, 2012.
(Source: http://webapps.datafed.net/datafed.aspx?dataset=AQS_D&parameter=pm10)

The surface weather associated with the storm system of June 20, 2012, is presented in Figure 11. Significant surface features at 5:00 PM MST (0Z, June 21) included a cold front that had cleared eastern Colorado and was continuing to drop southward into New Mexico. Behind the cold front, surface high pressure was building across the eastern Colorado plains and producing increasingly gusty east to northeasterly winds. The cold front was also to the south of the San Luis Valley, but was nearly stationary so atmospheric pressure rises in south-central Colorado were slower to occur. This produced a building pressure gradient between the San Luis Valley and the eastern Colorado plains. Wind speed is directly proportional to the pressure gradient, so a higher pressure gradient will produce stronger winds (see the following link for additional information on pressure gradient and its relationship to wind speed from the National Oceanic and Atmospheric Administration (NOAA): http://www.srh.noaa.gov/jetstream/synoptic/wind.htm). This increase of the pressure gradient was likely a contributor to thunderstorm development over the Sangre de Cristo Mountains as easterly upslope flow increased significantly during the late afternoon of June 20, 2012.

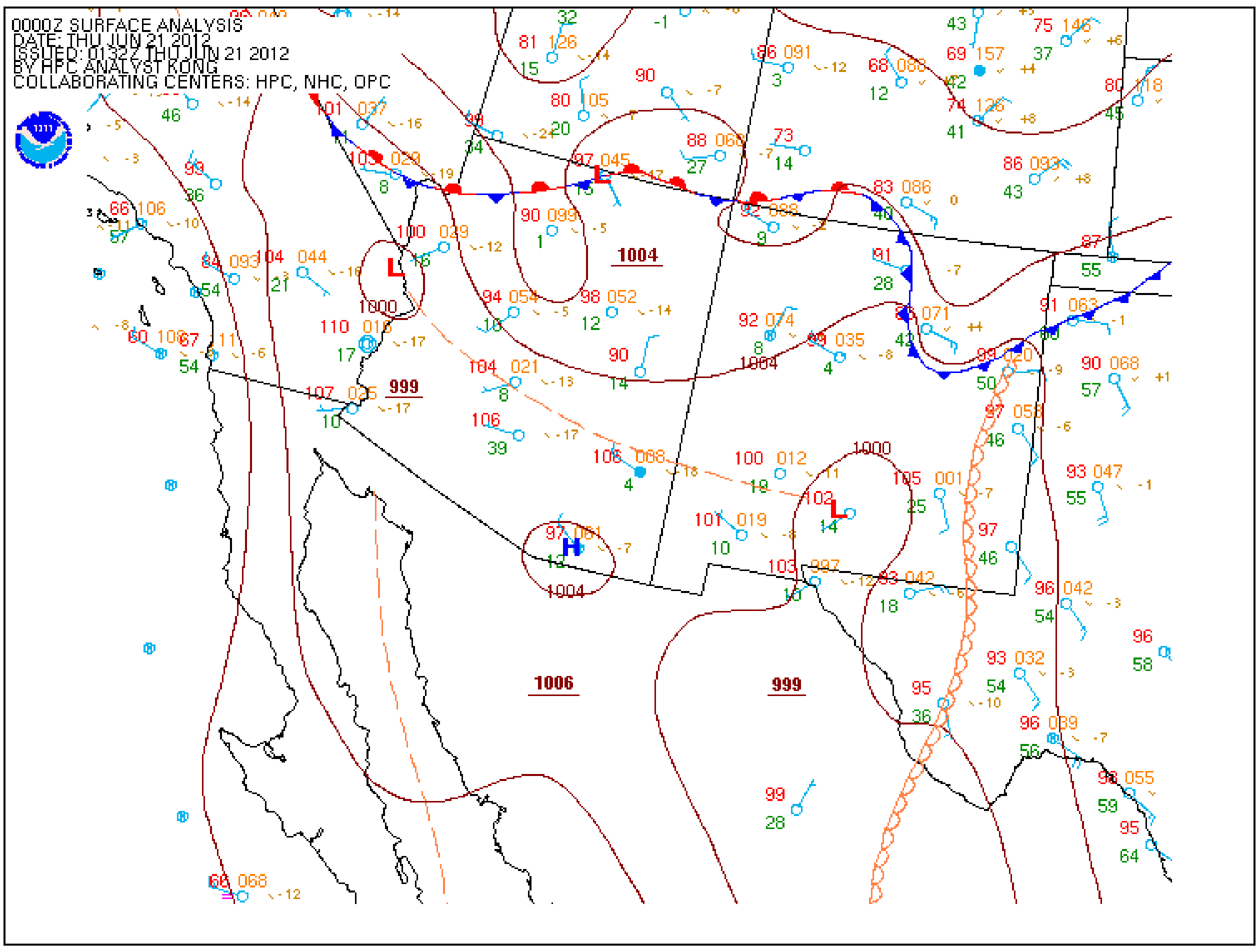


Figure 11: Southwestern United States regional surface analysis for 0Z June 21, 2012 or 5:00 PM MST June 20, 2012.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

The upper-level disturbance that helped initiate thunderstorms on June 20, 2012 is shown on the North American Regional Reanalysis (NARR) 500 mb height analysis map at 5:00 PM MST in Figure 12. The 500 mb level is located roughly 6 kilometers above mean sea level (MSL). This chart shows that a well-defined trough of low pressure (red dashed line) at the 500 mb level was moving over the San Luis Valley area of south-central Colorado during the initial stages of the blowing dust event of June 20, 2012.

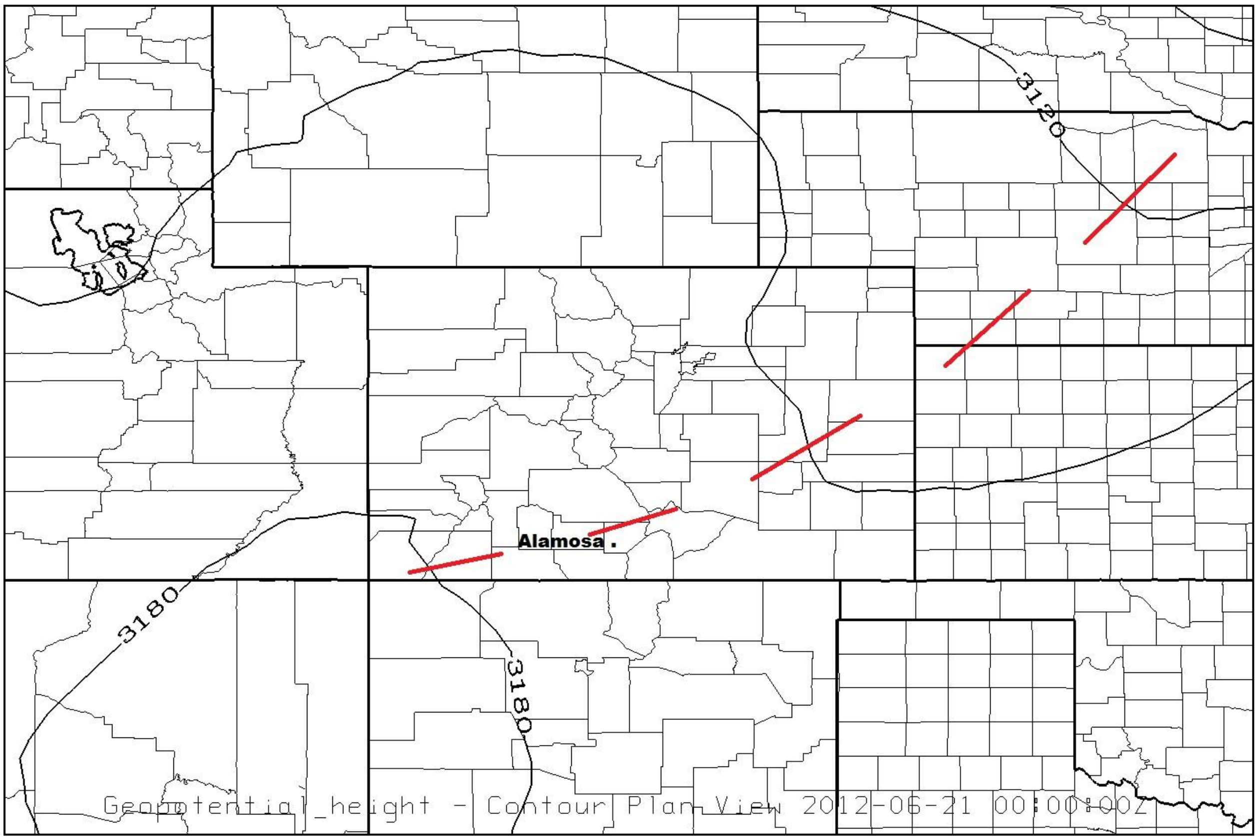


Figure 12: NARR 500 mb analysis for 0Z June 21, 2012, or 5:00 PM MST June 20, 2012. (Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

The North American Mesoscale (NAM) analysis in Figure 13 illustrates the increasingly unstable atmospheric conditions that were developing over the San Luis Valley by the late afternoon of May 20, 2012. The shaded areas represent positive values of convective available potential energy (CAPE). CAPE is an index used to measure the amount of instability in the atmosphere. Observed values in thunderstorm environments often exceed 1000 Joules(J)/kg (Source: http://forecast.weather.gov/glossary.php?word=CAPE). From Figure 13 we can observe that the atmosphere was particularly unstable along the eastern boundary of the San Luis Valley where CAPE values were approaching 1500 J/kg (circled in red). This eastern edge of the valley contains a section of the Sangre de Cristo mountain range which was being significantly impacted by easterly upslope flow from the eastern Colorado plains. Adding to the highly unstable enviornment in this area was the upper-level disturbance from Figure 12 that was also overhead at the time.

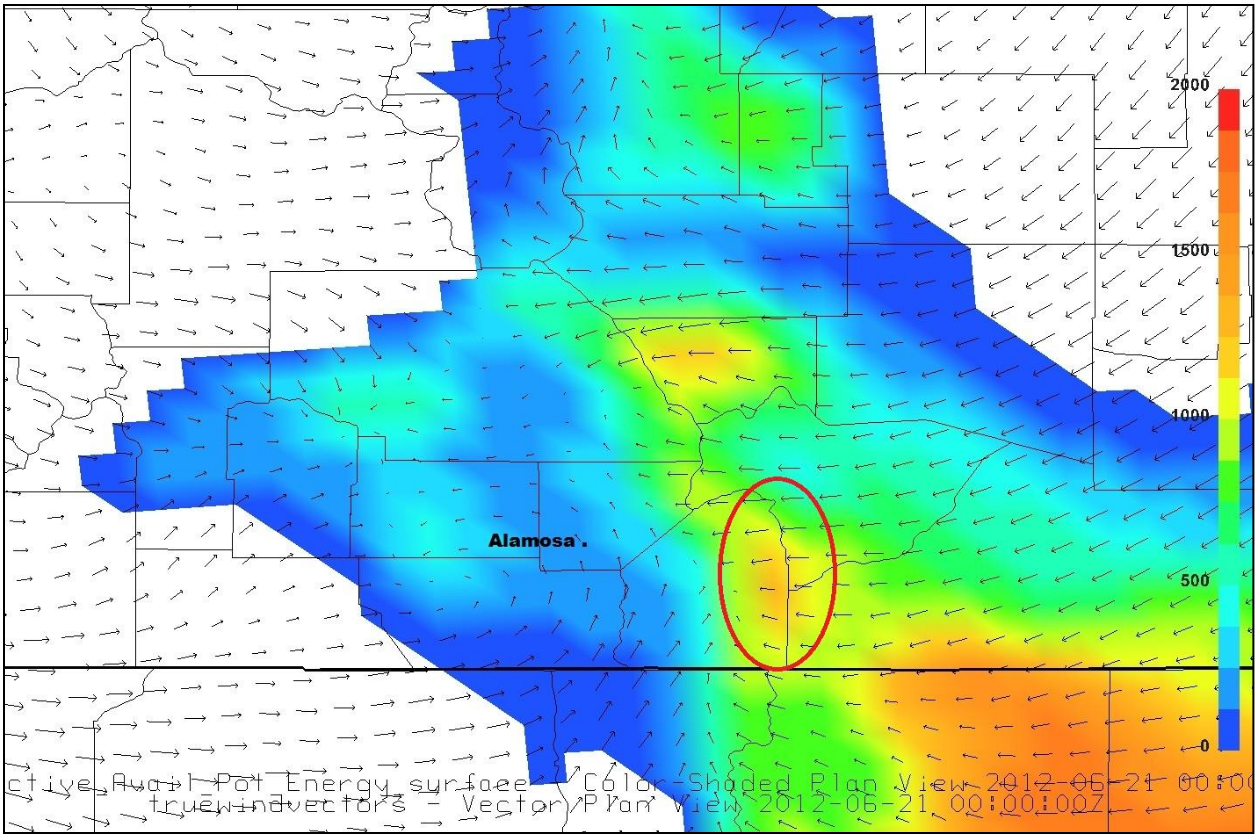


Figure 13: NAM CAPE and surface wind analysis at 0Z June 21, 2012, or 5:00 PM MST June 20, 2012. Only CAPE values greater than zero are shaded. (Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

As the atmosphere continued to destabilize late in the afternoon of June 20, 2012, thunderstorms began to develop over the eastern edge of the San Luis Valley. Radar imagery combined with regional surface observations provide compelling evidence that the PM_{10} exceedance in Alamosa on June 20 was caused by blowing dust from thunderstorm downburst winds. The Arizona Department of Environmental Quality produced a comprehensive Exceptional Event report thoroughly describing the mechanisms of dust-producing thunderstorm outflow (see the reference for the State of Arizona Exceptional Event Documentation). The analysis that follows will show that the thunderstorm which impacted Alamosa on June 20 was very similar to the thunderstorms described in the State of Arizona Exceptional Event Documentation which received EPA concurrence on September 6, 2012 (Source: http://www.azdeq.gov/environ/air/plan/download/epacon090612.pdf).

The hourly surface observations for this analysis were gathered from the Alamosa and Great Sand Dunes National Park weather stations. A reference map showing the location of those two stations within the San Luis Valley is provided in Figure 14. The observations for Alamosa are provided in Table 3 while Sand Dunes observations are shown in Table 4. Observations that are climatologically consistent with blowing dust conditions (see the Alamosa Blowing Dust Climatology available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2) are highlighted in yellow. It should be noted that observed weather and visibility observations are unavailable for the Great Sand Dunes National Park since it is a remote automatic weather station.

Figure 15 displays the Pueblo National Weather Service (NWS) composite reflectivity image at 3:56 PM MST overlain on a topographic map of the San Luis Valley. This map includes the Alamosa surface observation for 3:52 PM MST. A thunderstorm can be observed building over the Sangre de Cristo Mountains along the eastern boundary of the San Luis Valley. The wind in Alamosa at the approximate time of this radar image was generally light at 13 mph with gusts to 20 mph (Table 3).

The 5:19 PM MST radar image (Figure 16) continues to show radar echoes over the higher terrain east of Alamosa, and by 5:23 PM MST the NWS in Pueblo had issued a Significant Weather Advisory. The advisory indicated that the thunderstorm was strong and approaching severe limits. Included in the text of the advisory was:

> "PENNY TO NICKEL SIZE HAIL…AND WINDS AROUND 50 MPH ARE EXPECTED WITH THIS STORM." (Source: http://mesonet.agron.iastate.edu/wx/afos/)

At approximately 5:52 PM MST it appears that outflow from the strong thunderstorm was beginning to have a significant impact on Alamosa, as the wind sharply increased to 29 mph with gusts to 40 mph and visibility had dropped to 8 statute miles (Table 3). Also notice that the wind barb from Figure 17 reveals a subtle shift to a more easterly component, pointing directly toward the strong thunderstorm over the Sangre de Cristo Mountains.

The 6:51 PM MST radar image (Figure 18) indicates that the thunderstorm had weakened. However, conditions in Alamosa had not improved. The 6:52 PM MST observation shows that the wind remained strong in Alamosa (sustained at 29 mph with gusts to 37 mph) and visibility decreased significantly to 5 statute miles (Table 3). Additionally, the observation from Figure 18 includes the weather symbol of infinity (∞). The infinity sign is the weather symbol for haze. Haze is often reported during dust storms, and in dry and windy conditions haze typically refers to blowing dust (see the following link for the description of haze published by the National Oceanic and Atmospheric Administration (NOAA): http://www.crh.noaa.gov/lmk/?n=general_glossary). This sequence of observations and radar images suggests that strong outflow from the thunderstorm over the Sangre de Cristo Mountains produced blowing dust in the eastern San Luis Valley which consequently moved into the Alamosa area.

Radar imagery in conjunction with surface observations reveals that a strong thunderstorm over the higher terrain of the eastern San Luis Valley produced blowing dust which caused the PM_{10} exceedance in Alamosa on June 20, 2012.

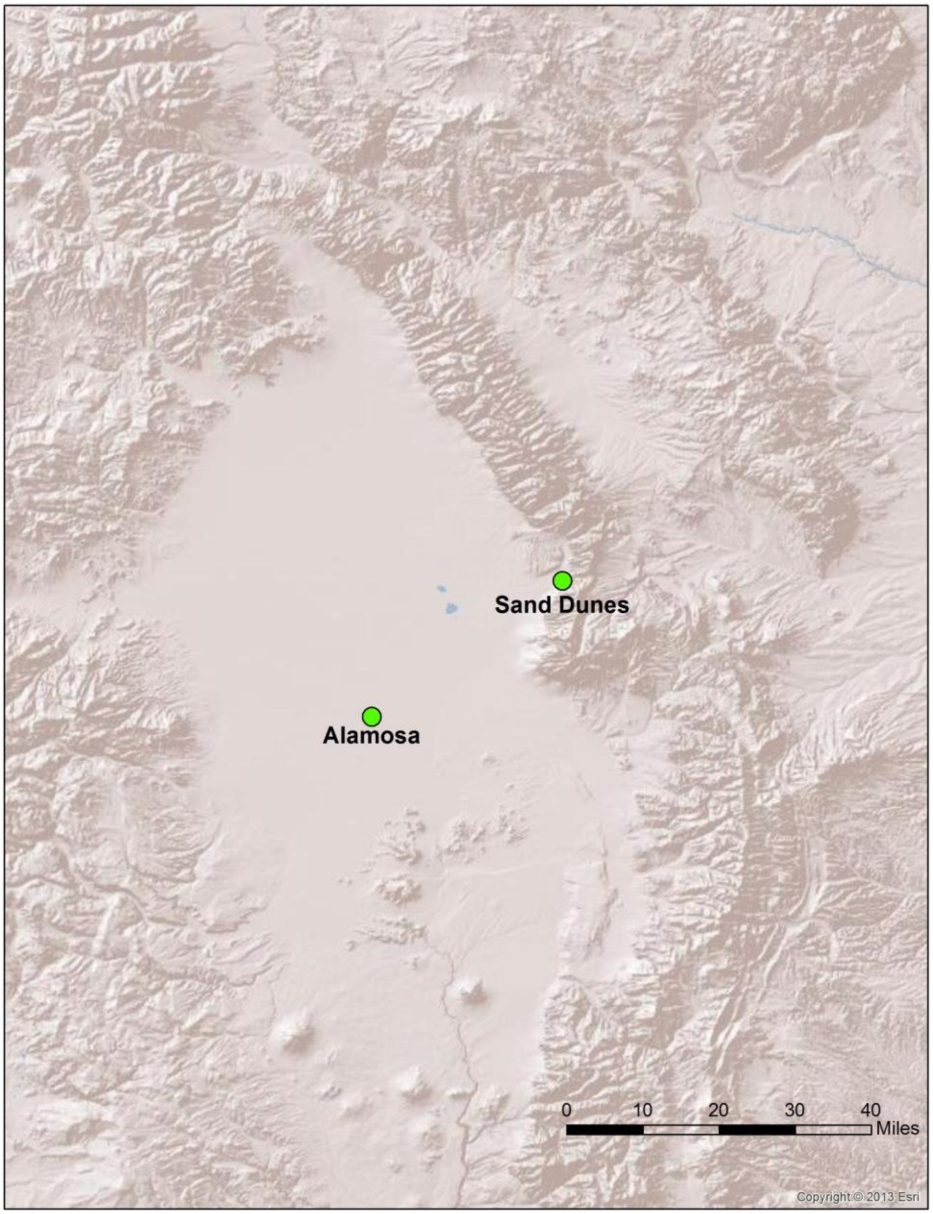


Figure 14: San Luis Valley weather observation stations for June 20, 2012.

Table 3: Weather observations for Alamosa, CO, on June 20, 2012
(Source: http://mesowest.utah.edu/)

Time MST June 20, 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	50	40	4		60		10
1:52	51	30	8		80		10
2:52	48	32	7		80		10
3:52	46	37	6		100		10
4:52	43	43	5		350		10
5:52	50	37	6		100		10
6:52	60	27	6		130		10
7:52	67	20	0				10
8:52	75	11	0				10
9:52	79	10	6		350		10
10:52	81	8	6				10
11:52	83	8	0				10
12:52	86	7	6				10
13:52	87	7	4				10
14:52	91	6	12	16	320		10
15:52	90	7	13	20	110		10
16:52	83	22	20	25	110		10
17:52	76	31	27	40	100		8
18:52	71	36	29	37	100	haze	5
19:52	68	40	22	35	90		10
20:52	67	40	25	33	90	haze	6
21:52	66	40	23	33	100		10
22:52	64	45	17	24	110		10
23:52	62	48	13		100		10

Table 4: Weather observations for Great Sand Dunes National Park, CO, on June 20, 2012 (Source: http://mesowest.utah.edu/)

Time MST June 20, 2012	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:44	65	10	2	7	225		
1:44	64	10	4	10	205		
2:44	59	12	2	11	171		
3:44	52	15	0	8	107		
4:44	52	15	4	6	127		
5:44	56	14	4	6	134		
6:44	68	11	0	7	114		
7:44	75	6	1	6	354		
8:44	76	5	4	6	287		
9:44	79	5	6	9	13		
10:44	79	4	7	12	326		
11:44	83	4	8	13	309		
12:44	84	3	7	17	237		
13:44	87	3	6	21	307		
14:44	82	18	12	17	100		
15:44	78	21	13	27	345		
16:44	76	25	14	27	104		
17:44	69	32	14	32	89		
18:44	66	34	16	34	99		
19:44	64	38	18	36	99		
20:44	63	39	17	39	99		
21:44	61	40	16	39	96		
22:44	59	42	15	36	101		
23:44	56	44	15	35	96		

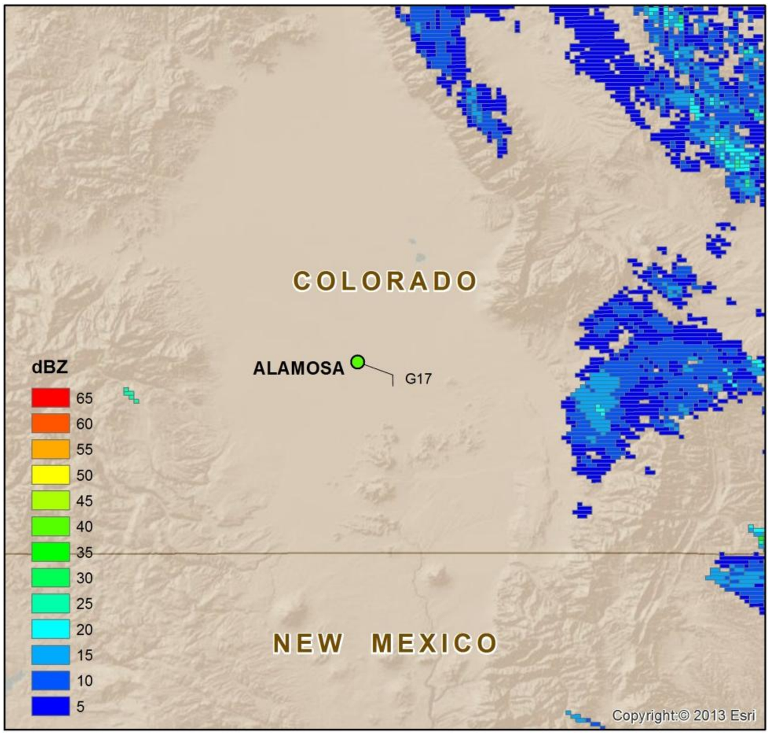


Figure 15: NEXRAD Short-Range Composite Reflectivity image from the Pueblo, CO radar at 3:56 PM MST (2256Z), June 20, 2012.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

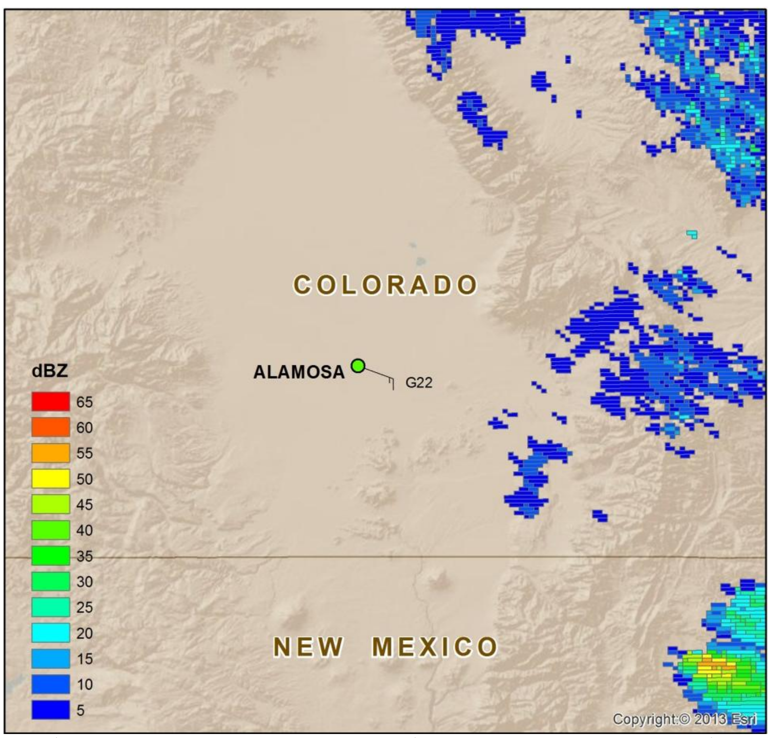


Figure 16: NEXRAD Short-Range Composite Reflectivity image from the Pueblo, CO radar at 5:19 PM MST (0019Z June 21), June 20, 2012.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

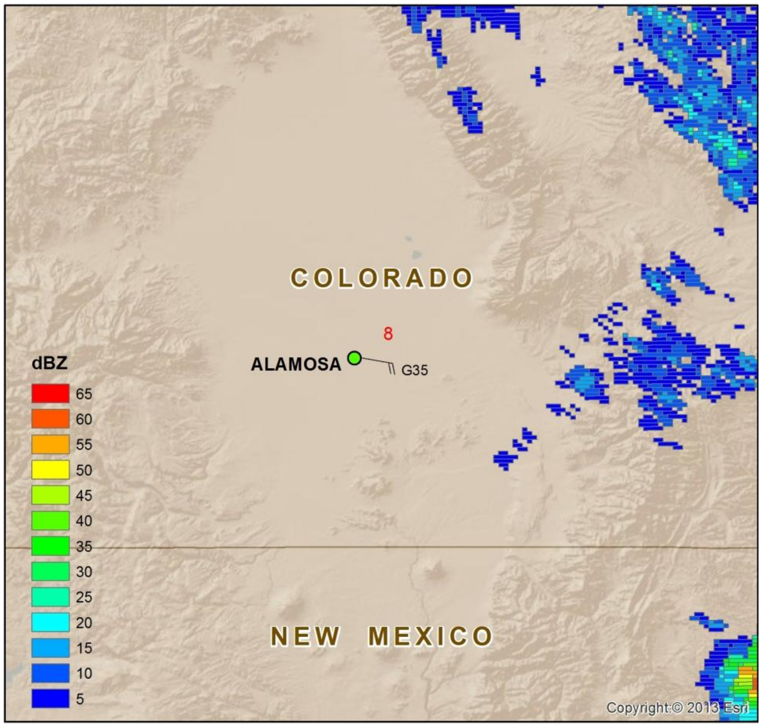


Figure 17: NEXRAD Short-Range Composite Reflectivity image from the Pueblo, CO radar at 5:51 PM MST (0051Z June 21), June 20, 2012.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

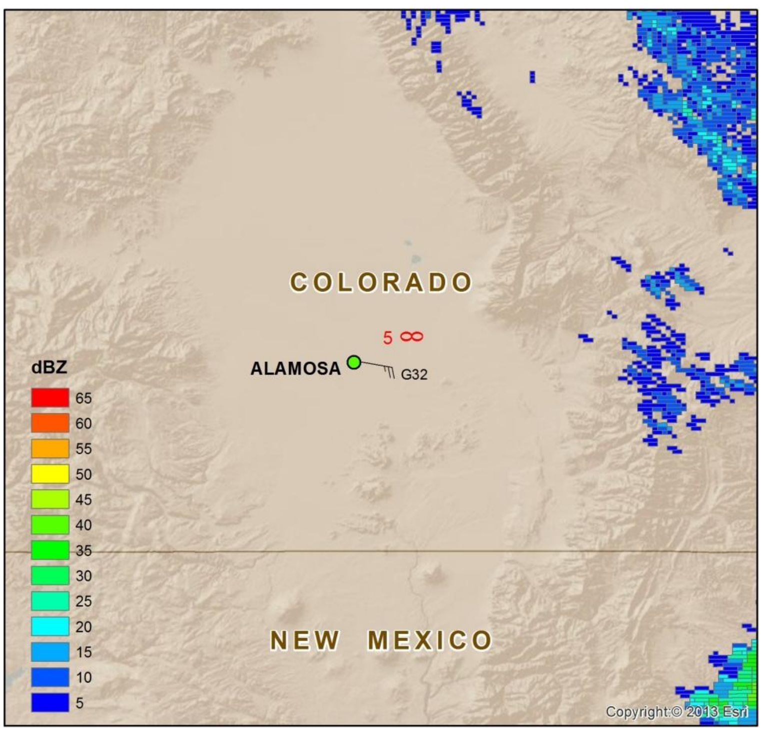


Figure 18: NEXRAD Short-Range Composite Reflectivity image from the Pueblo, CO radar at 6:51 PM MST (0151Z June 21), June 20, 2012.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

Much of the San Luis Valley was in the midst of a moderate to severe drought at the time of the dust event of June 20, 2012 (Figure 19). Sustained drought conditions are known to make topsoil susceptible to high winds and produce blowing dust (see the following link from the National Climatic Data Center for more information: https://www.ncdc.noaa.gov/paleo/drought/drght_history.html). In fact, the high winds produced by the thunderstorm described above travelled over some of the driest soils of the San Luis Valley before arriving in the Alamosa area. This was determined through a NOAA HYSPLIT backward trajectory analysis (Draxler and Rolph, 2012). Figure 20 shows 2-hour duration back trajectories from Alamosa initializing at 6:00 PM MST and ending at 11:00 PM MST. This encompasses the period of time where high winds, haze and reduced visibility were observed in Alamosa on June 20, 2012 (Table 3). The trajectory analysis clearly shows the transport of air from the eastern side of the San Luis Valley.

Figure 21 shows the total precipitation in inches from May 21 to June 19, 2012 for south-central Colorado and north-central New Mexico. Note that the area immediately surrounding Alamosa along with locations upwind to the east received little or no precipitation during the 30-day period leading up to the June 20 dust event. 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 the Alamosa Blowing Dust Climatology available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

The U.S. Drought Monitor and 30-day precipitation totals combined with HYSPLIT back trajectories indicate that soils in the eastern San Luis Valley upwind of Alamosa were easily dry enough to produce blowing dust when winds were at or above the thresholds for blowing dust. This information, combined with other evidence provided in this report, proves that this dust storm was a natural, regional event that was not reasonably controllable or preventable.

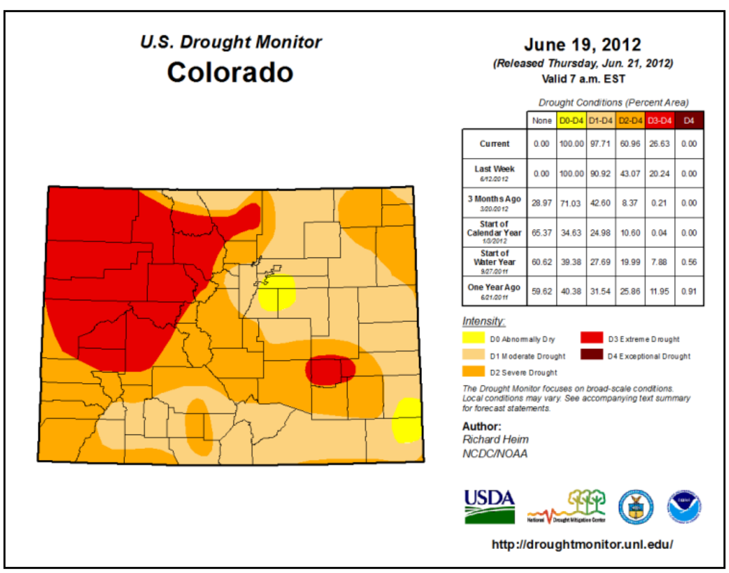


Figure 19: Drought conditions for the Western United States at 5:00 AM MST June 19, 2012.
(Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

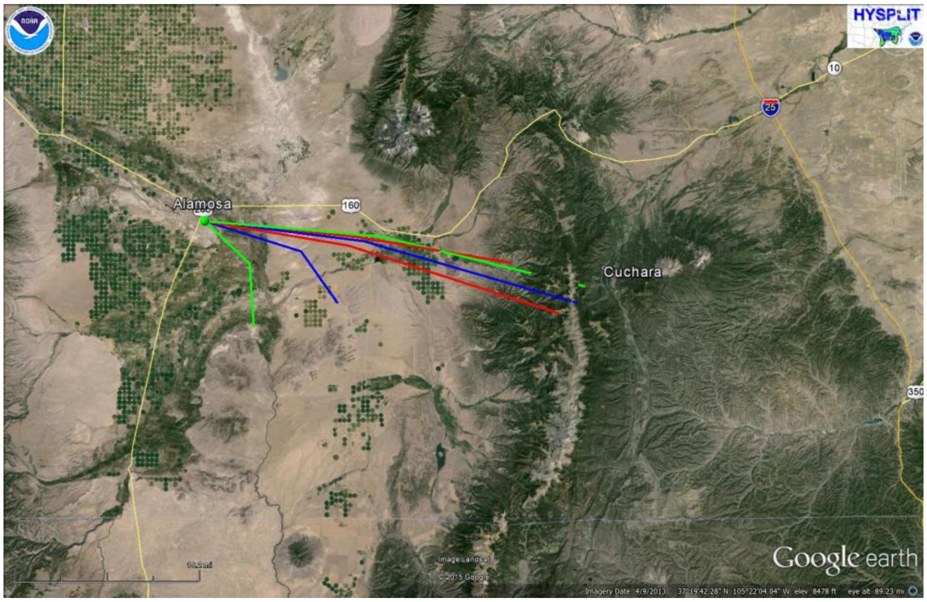


Figure 20: NOAA HYSPLIT 12 km NAM 2-hour back trajectories for Alamosa, CO from 5:00 PM MST (0Z June 21) June 20, 2012, to 11:00 PM MST (6Z June 21) June 20, 2012. (Source: http://ready.arl.noaa.gov/HYSPLIT.php)

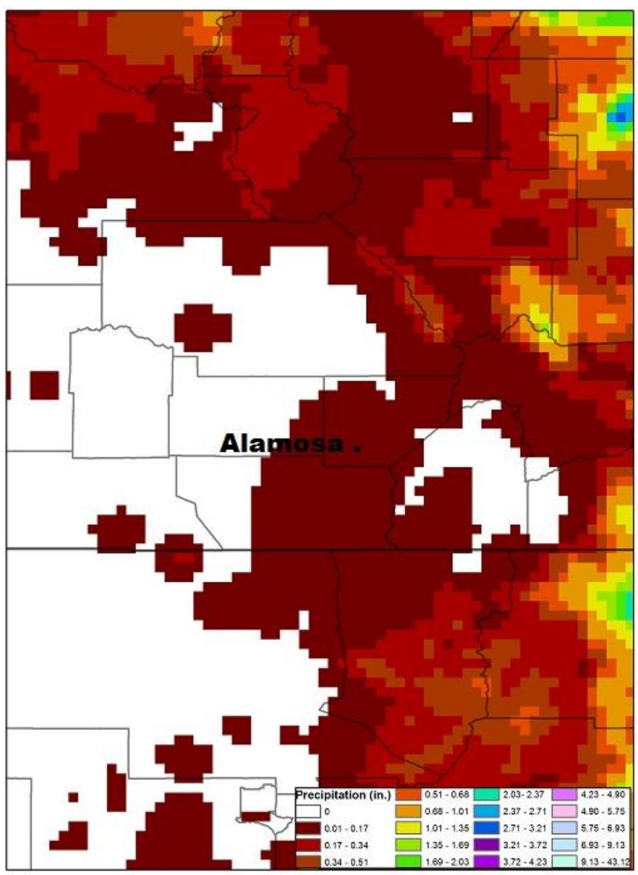


Figure 21: Total precipitation in inches for southern Colorado and northern New Mexico, May 21, 2012 – June 19, 2012.
(Source: http://prism.nacse.org/recent/)

3.0 Evidence - Ambient Air Monitoring Data and Statistics

Multiple intense fronts moved across southern Colorado in 2012. Two of these transported blowing dust into Alamosa from source regions outside of the monitoring area. Ambient Air Monitoring Data and Statistics for the events occurring on May 26, 2012 and June 20, 2012 are discussed further on the following pages.

3.1 May 26, 2012 Monitoring Data and Statistics

On May 26, 2012, a powerful spring storm moved across southeast Colorado. The wake of the storm generated strong surface winds moving over dry soils affected PM_{10} samples at multiple sites across southern Colorado. During this event samples in excess of 150 µg/m^3 were recorded at Alamosa Adams State College (Alamosa ASC, 253 µg/m^3) and Alamosa Municipal Building (Alamosa Muni, 182 µg/m^3).

3.1.1 Historical Fluctuations of PM_{10} Concentrations in Alamosa

This evaluation of PM_{10} monitoring data for sites affected by the May 26, 2012, event was made using valid samples from PM_{10} samplers in Alamosa from 2008 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 5, with all data values being presented in µg/m^3:

Table 5: May 26, 2012, Event Data Summary

Evaluation	*Alamosa ASC*	*Alamosa Muni*
5/26/2012	**253**	**182**
Mean	23.5	29.7
Median	19	24
Mode	13	18
St. Dev.	26.15	28.3
Var	683.7	801.5
Minimum	1	1
Maximum	440	635
Count	1634	1510

Alamosa ASC – 080030001

The PM_{10} sample on May 26, 2012 at Alamosa ASC of 253 µg/m^3 is the seventh largest sample in the entire data set and exceeds 99% of all samples from 2008 through 2012. The six samples greater than the event sample are all associated with high wind events. There are 1,634 samples in this dataset. The sample of May 26, 2012 clearly exceeds the typical samples for this site.

Figure 22 and Figure 23 graphically characterize the Alamosa ASC PM_{10} data. The first, Figure 22, is a simple time series; every sample in this dataset (2008 – 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 1,634 samples in this data set, less than 1% are greater than 100 µg/m^3.

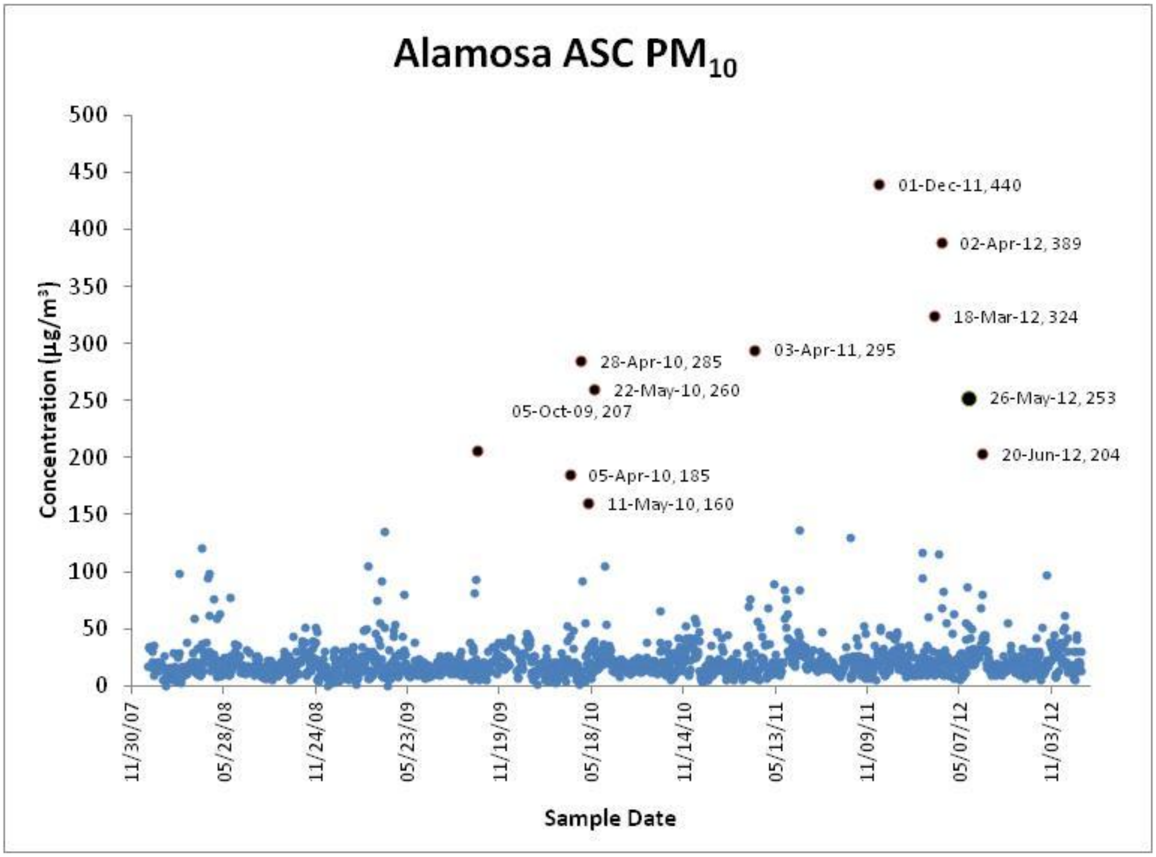


Figure 22: Alamosa Adams State College PM_{10} Time Series, 2008 - 2012

The monthly box-whisker plot inFigure 23, 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 May 26, 2012. Although these high values affect the variability and central tendency (average) of the dataset they are not representative of what is typical at the site.

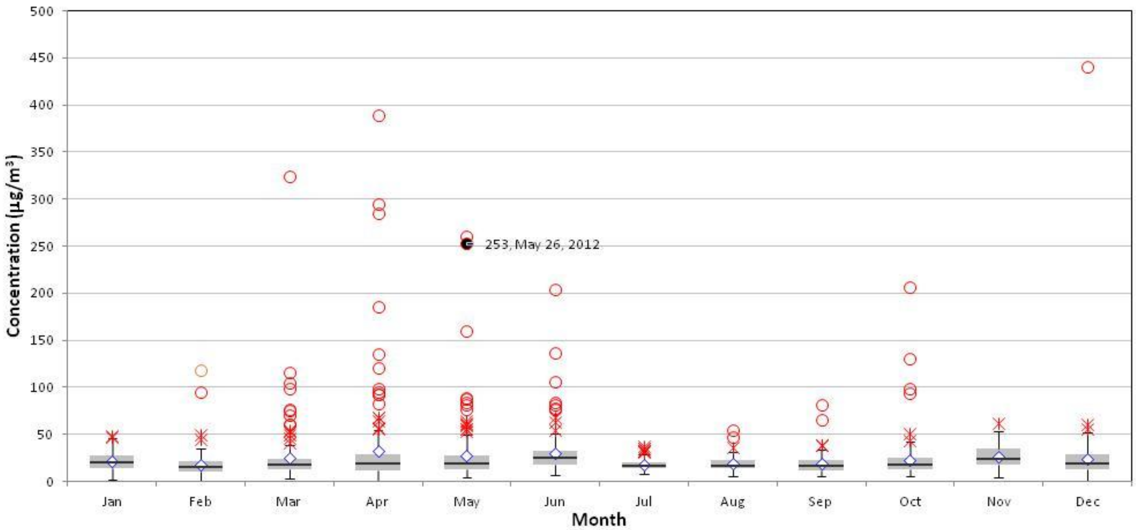


Figure 23: Alamosa ASC PM_{10} Box-whisper Plot, 2008 - 2012

The box-whisper plot graphically represents the overall distribution of the data set including the mean (◊), the inner quartile range (IQR, defined to be the distance between the 75^{th}% and 25^{th}%), the median (represented by the horizontal black line) and two types of outliers identifed in this plot: outliers greater than 75th% +1.5*IQR (✳)and outliers greater than 75th% + 3*IQR (○). At Alamosa ASC every sample greater than 150 µg/m^3 are associated with a known high-wind event similar to that of May 26.

Note the degree to which the data in the months of winter and spring, including May, is skewed. The May mean (27.3 µg/m^3) is nearly greater than the May 75^{th} percentile value (28 µg/m^3). This 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 as the typical data is similar to every other month of the year. The sample of May 26, 2012 clearly exceeds the typical data at this site.

Alamosa Municipal – 080030003

The PM_{10} sample on May 26, 2012 at Alamosa Muni of 182 µg/m^3 exceeds the 99^{th} percentile value for all evaluation criteria and is the 8^{th} largest sample of all samples from 2008 through 2012. All seven samples greater than the event sample are both associated with high wind events. There are 1,510 samples in this dataset. The sample of May 26, 2012 clearly exceeds the typical samples for this site.

Figure 24 and Figure 25 graphically characterize the Alamosa Muni PM_{10} data. The first is a simple time series; every sample in excess of 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 1,510 samples in this data set less than 2% are greater than 100 µg/m^3.

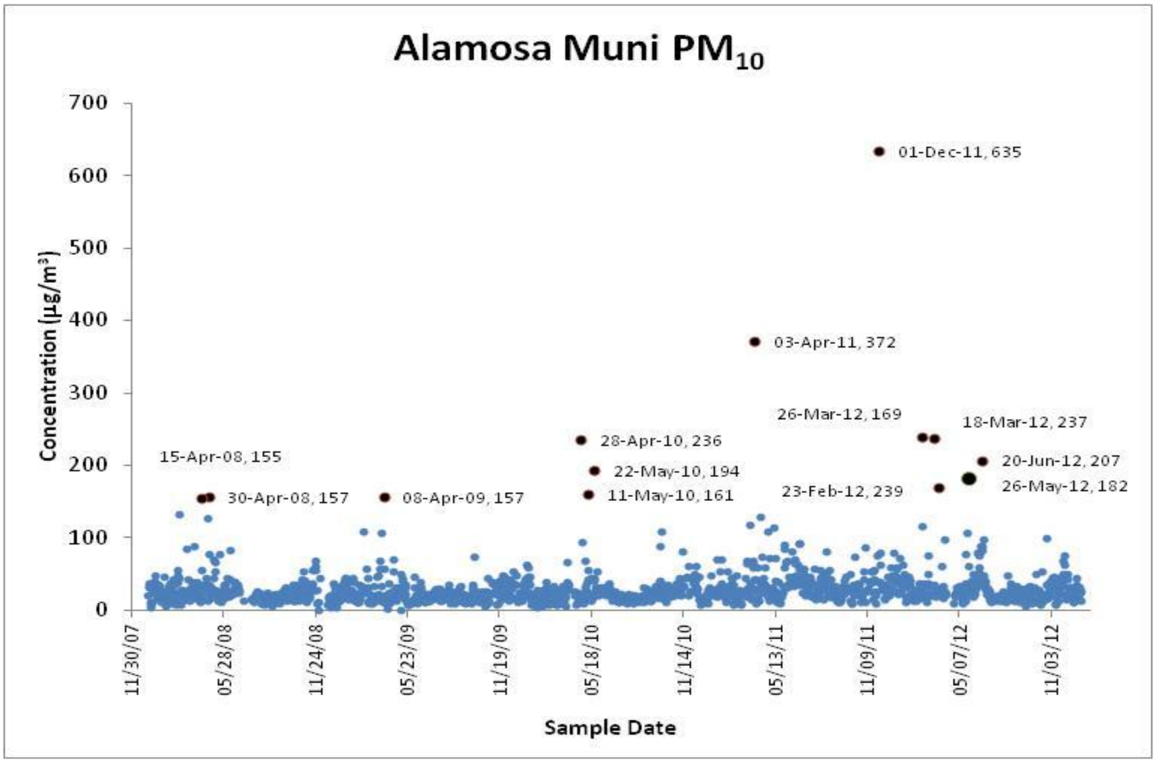


Figure 24: Alamosa Municipal PM_{10} Time Series, 2008 - 2012

The monthly box-whisker plot in Figure 25 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 May 26, 2012. Although these high values affect the variability and central tendency (average) of the dataset they are not representative of what is typical at the site.

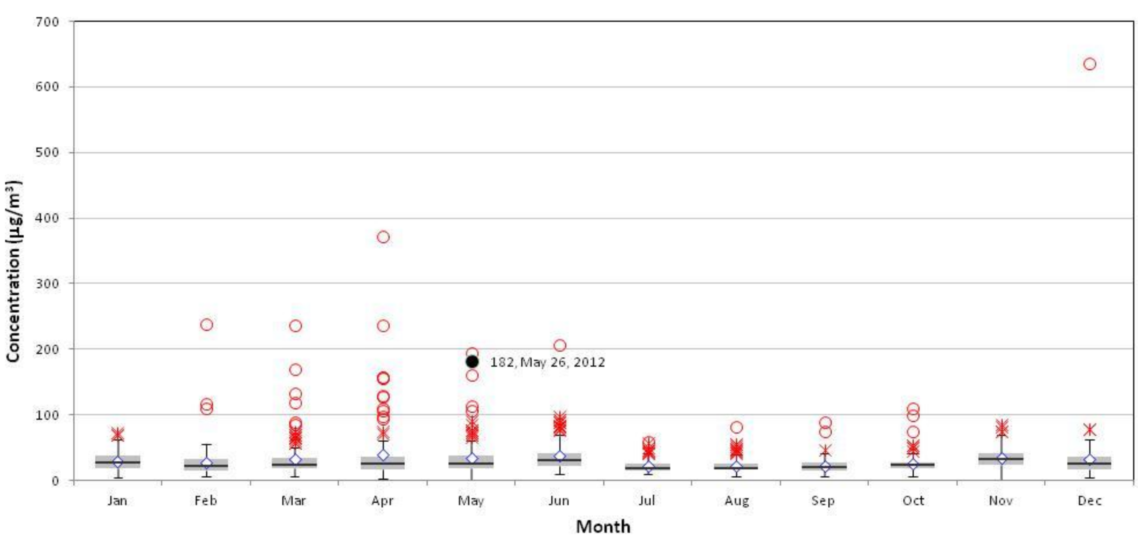


Figure 25: Alamosa Municipal PM_{10} Box-whisper Plot, 2008 - 2012

Note the degree to which the data from the months of winter/spring, including May, is skewed. The May mean (33.7 µg/m^3) is only slightly less than the 75th percentile value (37 µg/m^3). This 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 as the typical data is similar to every other month of the year. The sample of May 26, 2012 clearly exceeds the typical data at this site.

3.1.2 Wind Speed Correlations

Wind speeds in southeast Colorado increased late in the evening of May 26, 2012, and stayed elevated through the late evening of May 26, 2012, gusting to speeds in excess of 40 mph. The following chart (Figure 26) displays 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.

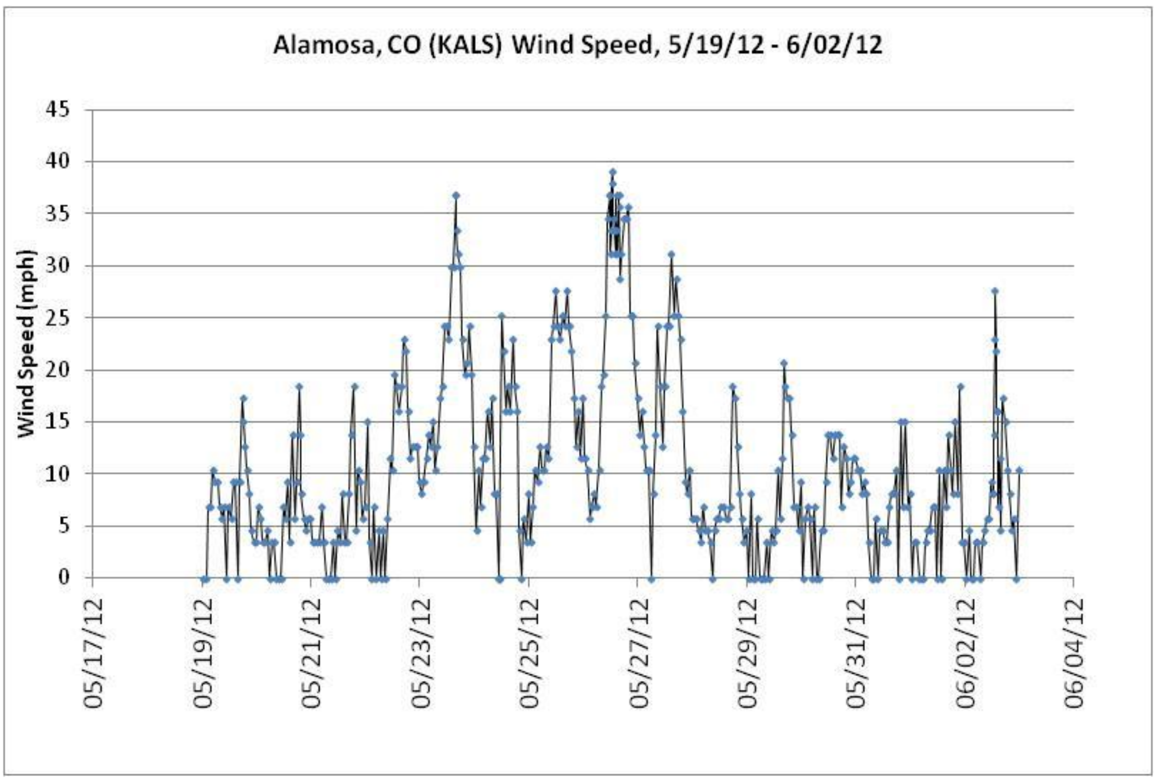


Figure 26: Wind Speed (mph) for Alamosa, 5/19/2012 – 6/02/2012

Figure 27 plots PM_{10} concentrations from the affected sites for the period for seven days prior to and following the samples of May 26, 2012.

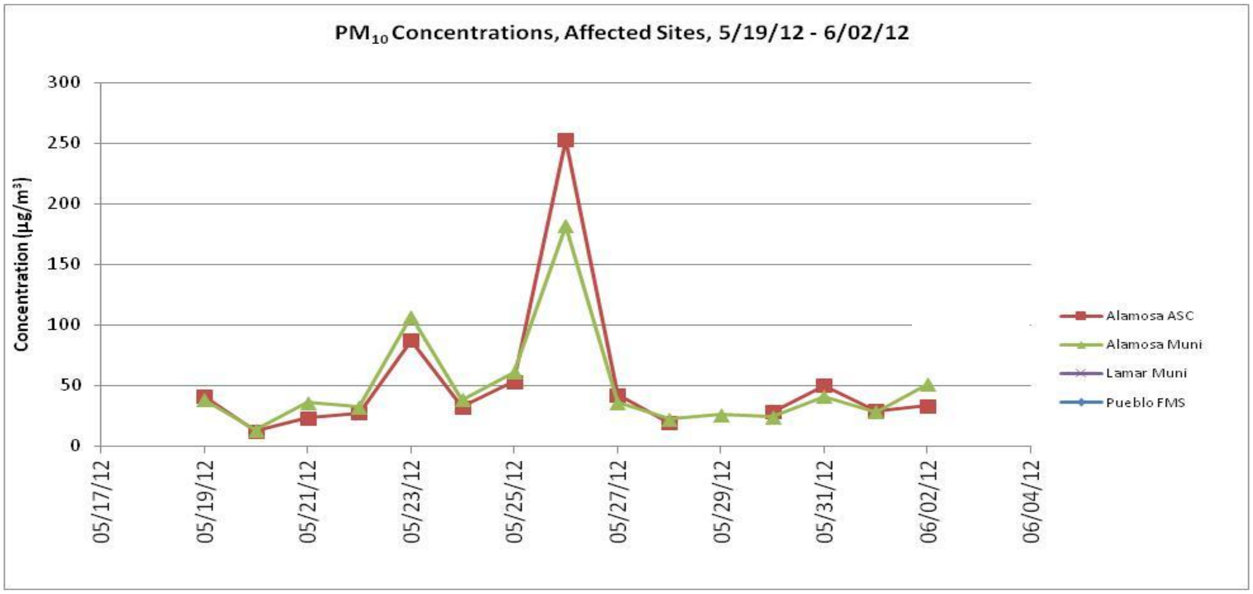


Figure 27: PM_{10} Concentrations, Alamosa, 5/19/2012 – 6/02/2012

Figure 27 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 in Alamosa 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 Alamosa on May 26, 2012.

3.1.3 Percentiles

Monthly percentile plots in Figure 28 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 Alamosa Muni and the monthly median is 0.57. As the percentile value decreases (i.e. 85%, 75%, etc) the correlation between those values and the monthly median values increases sharply.

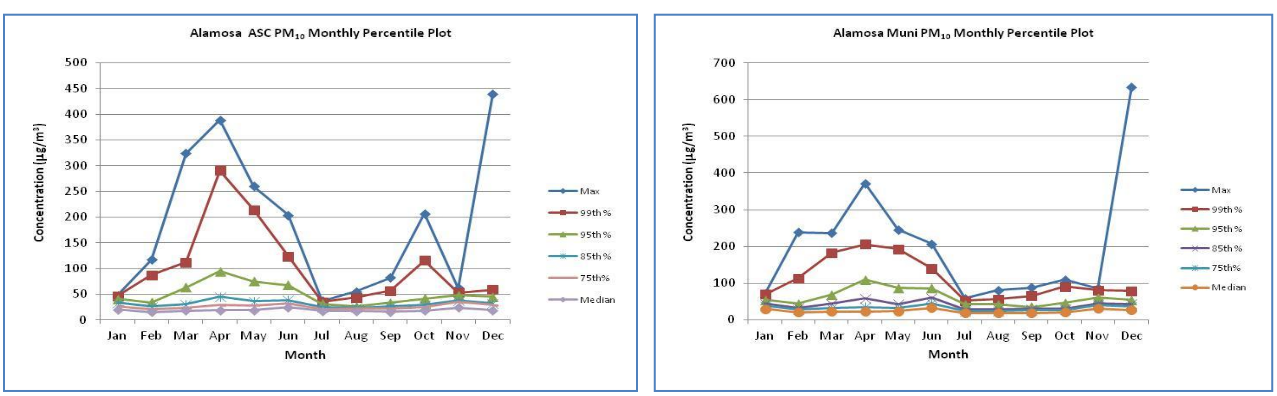


Figure 28: Monthly PM_{10} Percentile Plots, 2008 - 2012

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 and Alamosa 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 two data sets can be explained by the variation in monthly medians; for these two sites the correlation between the median and monthly 75th percentile values vary from an $r^2 = 0.94$ (Alamosa Muni) to an $r^2 = 0.91$ (Alamosa ASC). 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 two sites the correlation between the median and the monthly 85th percentile values vary from an $r^2 = 0.69$ (Alamosa ASC) to an $r^2 = 0.80$ (Alamosa Muni). If these percentile values are taken as an estimate of event PM_{10} due to local variation then the portion of the sample concentration remaining from these monthly percentile values would be the sample contribution due to the event.

Table 6 identifies various percentile values that are representative of the maximum contribution due to local sources for each site from all May data. In Table 6 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 May 26, 2012 sample at the sites listed in the table due to the high wind event.

Table 6: Estimated Maximum Event PM_{10} Contribution

Site	Event Day Concentration (µg/m^3)	May Median (µg/m^3)	May Average (µg/m^3)	May 75th % (µg/m^3)	May 85th % (µg/m^3)	Est. Conc. Above Typical (µg/m^3)
Alamosa ASC	253	19	27.3	28	36.4	**217 - 225**
Alamosa Muni	182	25	33.7	37	48.6	**133 - 145**

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

3.2 June 20, 2012 Monitoring Data and Statistics

On June 20, 2012, a powerful spring storm moved across southeast Colorado. The storm generated strong surface winds moving over dry soils affected PM_{10} samples at multiple sites across southern Colorado. During this event samples in excess of 150 µg/m^3 were recorded at Alamosa Adams State College (Alamosa ASC, 204 µg/m^3) and Alamosa Municipal Building (Alamosa Muni, 207 µg/m^3).

3.2.1 Historical Fluctuations of PM_{10} Concentrations in Alamosa

This evaluation of PM_{10} monitoring data for sites affected by the June 20, 2012, event was made using valid samples from PM_{10} samplers in Alamosa from 2008 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 7, with all data values being presented in µg/m^3:

Table 7: June 20, 2012, Event Data Summary

Evaluation	*Alamosa ASC*	*Alamosa Muni*
6/20/2012	**204**	**207**
Mean	23.5	29.7
Median	19	24
Mode	13	18
St. Dev.	26.15	28.3
Var	683.7	801.5
Minimum	1	1
Maximum	440	635
Count	1634	1510

Alamosa ASC – 080030001

The PM_{10} sample on June 20, 2012 at Alamosa ASC of 204 µg/m^3 is the ninth largest sample in the entire data set and exceeds 99% of all samples from 2008 through 2012. The eight samples greater than the event sample are all associated with high wind events. There are 1,634 samples in this dataset. The sample of June 20, 2012 clearly exceeds the typical samples for this site.

Figure 29 and Figure 30 graphically characterize the Alamosa ASC PM_{10} data. The first, Figure 29, is a simple time series; every sample in this dataset (2008 – 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 1,634 samples in this data set less than 1% are greater than 100 µg/m^3.

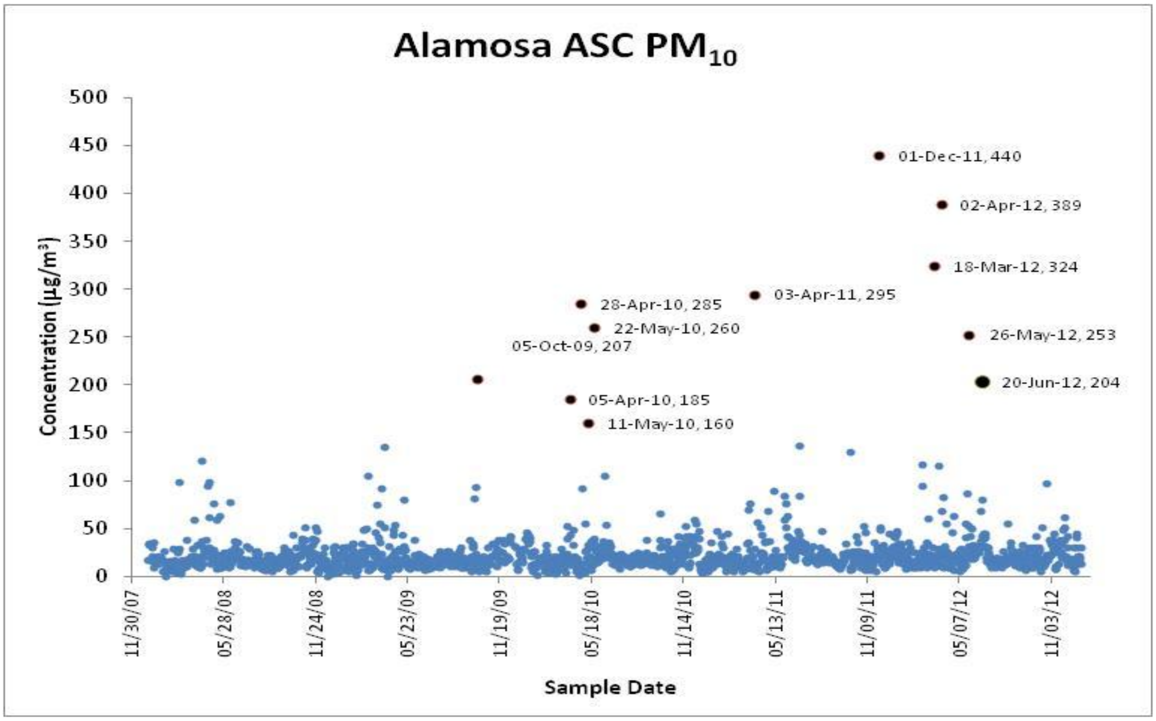


Figure 29: Alamosa Adams State College PM_{10} Time Series, 2008 - 2012

The monthly box-whisker plot in Figure 30 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 June 20, 2012. Although these high values affect the variability and central tendency (average) of the dataset they are not representative of what is typical at the site.

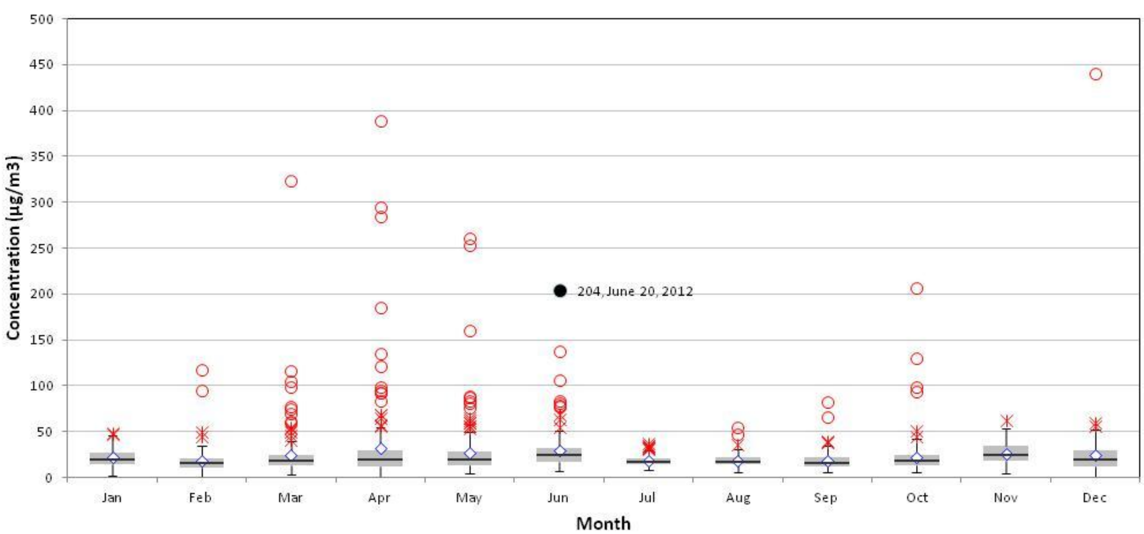


Figure 30: Alamosa ASC PM_{10} Box-whisper Plot, 2008 - 2012

The box-whisper plot graphically represents the overall distribution of the data set including the mean (◊), the inner quartile range (IQR, defined to be the distance between the 75^{th}% and 25^{th}%), the median (represented by the horizontal black line) and two types of outliers identifed in this plot: outliers greater than 75th% +1.5*IQR (*)and outliers greater than 75th% + 3*IQR (○). At Alamosa ASC every sample greater than 150 $\mu g/m^3$ are associated with a known high-wind event similar to that of June 20, 2012.

Note the degree to which the data in the months of winter and spring, including June, is skewed. The June mean (29.5 $\mu g/m^3$) is nearly greater than 80% of all samples in any June. This 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 as the typical data is similar to every other month of the year. The sample of June 20, 2012 clearly exceeds the typical data at this site.

Alamosa Municipal – 080030003

The PM_{10} sample on June 20, 2012 at Alamosa Muni of 207 $\mu g/m^3$ exceeds the 99^{th} percentile value for all evaluation criteria and is the sixth largest sample of all samples from 2008 through 2012. All five samples greater than the event sample are both associated with high wind events. There are 1,510 samples in this dataset. The sample of June 20, 2012 clearly exceeds the typical samples for this site.

(Figure 31 and Figure 32 graphically characterize the Alamosa Muni PM_{10} data. The first, Figure 31, is a simple time series; every sample in excess of 150 $\mu g/m^3$ 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 $\mu g/m^3$. Of the 1,510 samples in this data set less than 2% are greater than 100 $\mu g/m^3$.

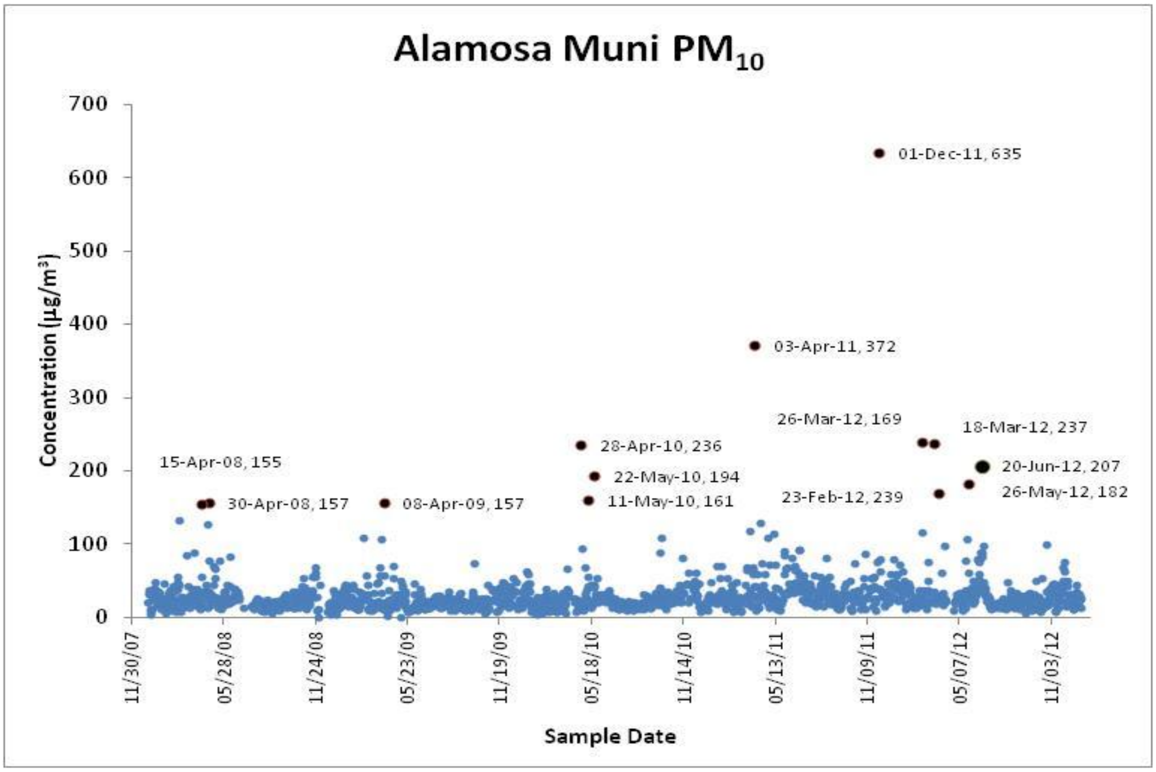


Figure 31: Alamosa Municipal PM_{10} Time Series, 2008 - 2012

The monthly box-whisker plot in Figure 32 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 June 20, 2012. Although these high values affect the variability and central tendency (average) of the dataset they are not representative of what is typical at the site.

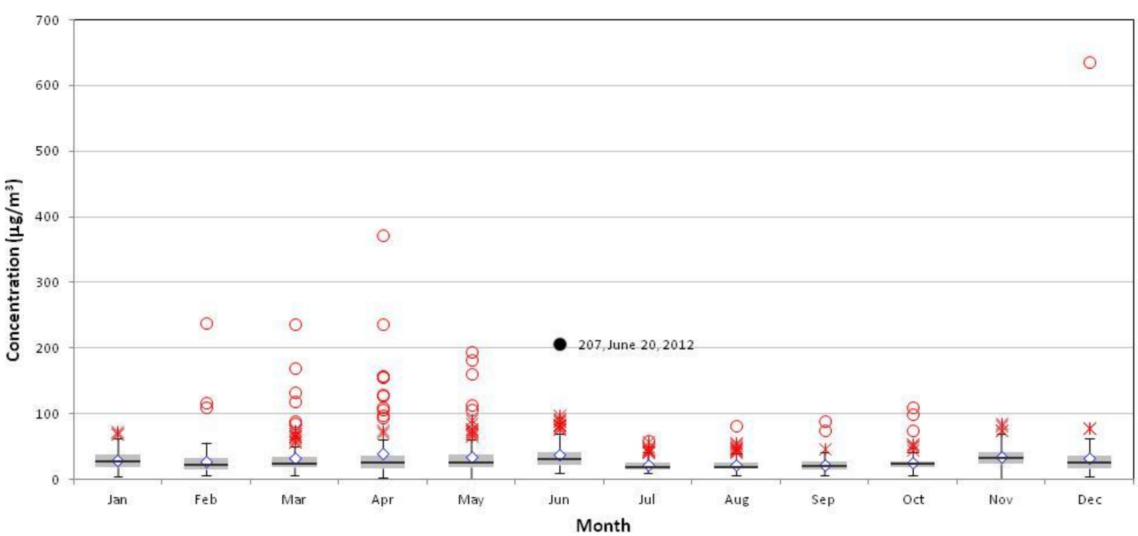


Figure 32: Alamosa Municipal PM_{10} Box-whisper Plot, 2008 - 2012

Note the degree to which the data from the months of winter/spring, including June, is skewed. The June mean (36.9 µg/m^3) is only slightly less than the 75th percentile value (41 µg/m^3). This 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 as the typical data is similar to every other month of the year. The sample of June 20, 2012 clearly exceeds the typical data at this site.

3.2.2 Wind Speed Correlations

Wind speeds in southeast Colorado increased mid afternoon in the evening of June 20, 2012, and stayed elevated through the late evening of June 20, 2012, gusting to speeds in excess of 40 mph. Figure 33 displays 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.

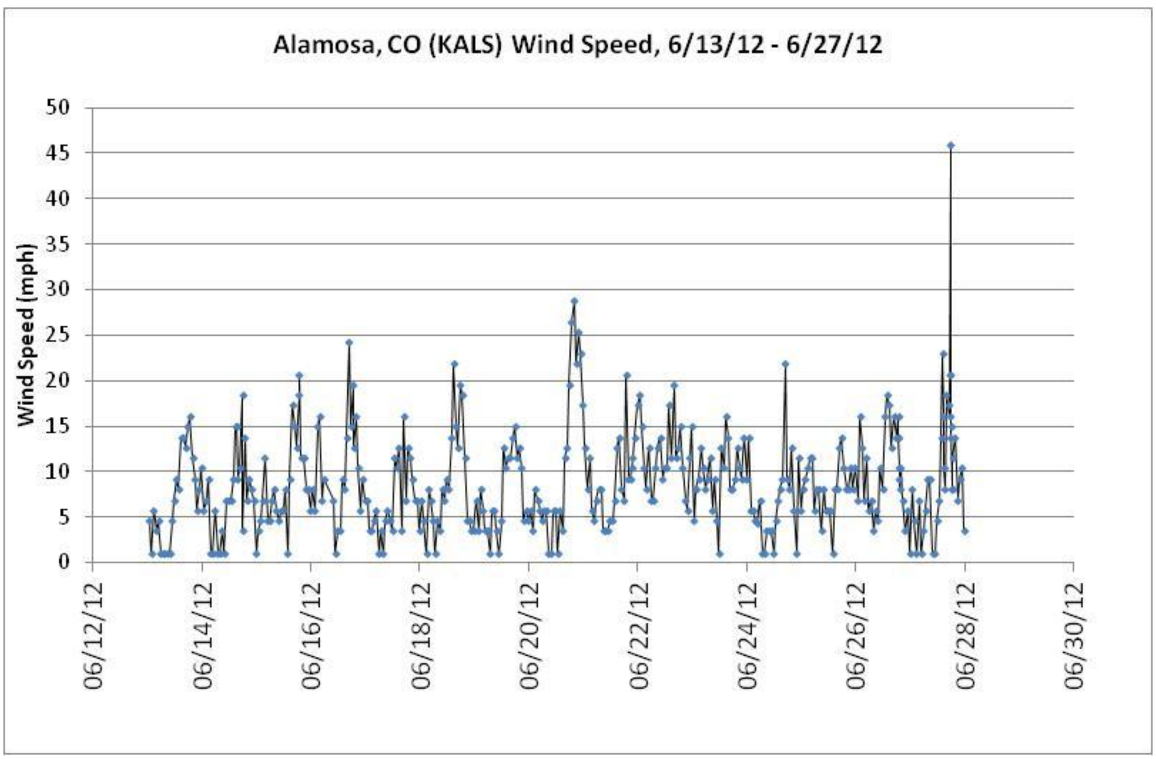


Figure 33: Wind Speed (mph) for Alamosa, 6/13/2012 – 6/27/2012

Figure 34 plots PM_{10} concentrations from the affected sites for the period for seven days prior to and following the samples of June 20, 2012.

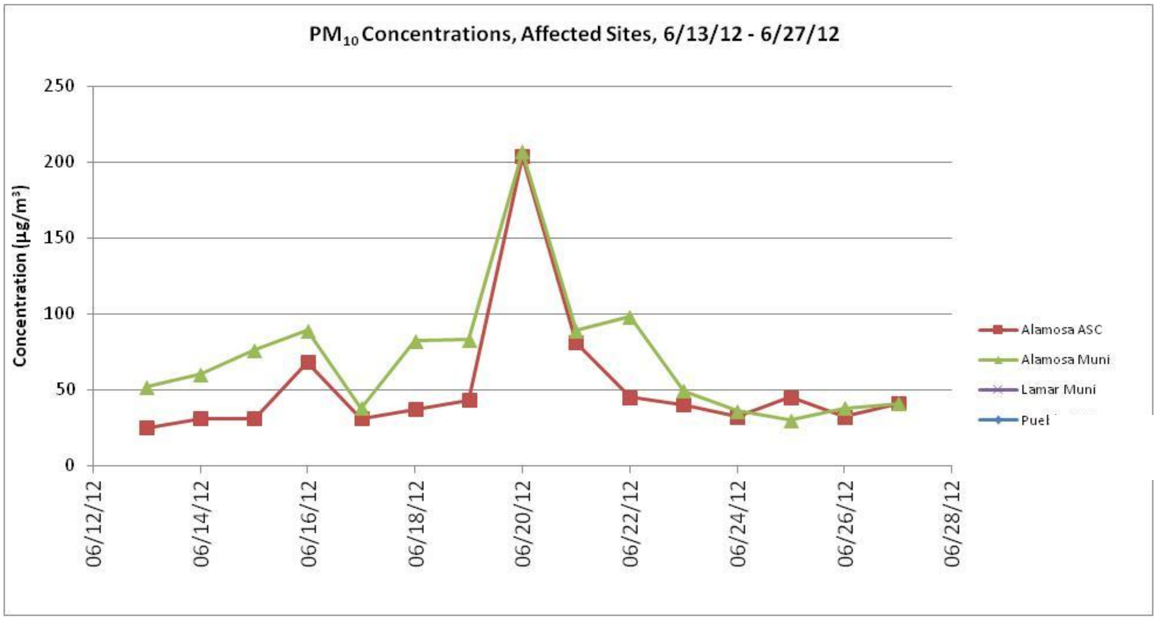
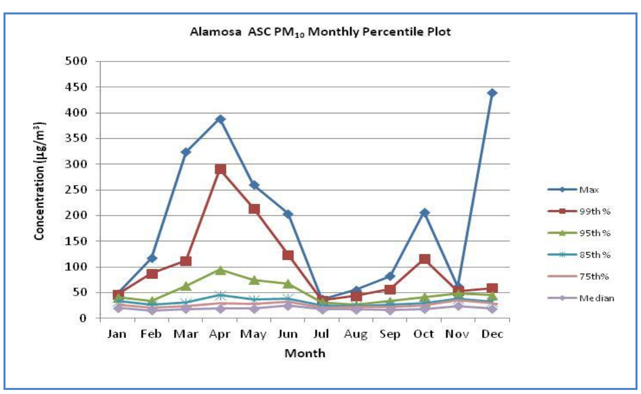


Figure 34: PM$_{10}$ Concentrations, Alamosa, 6/13/2012 – 6/27/2012

Figure 34 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 in Alamosa 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 Alamosa on June 20, 2012.

3.2.3 Percentiles

Monthly percentile plots in Figure 35 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 Alamosa Muni and the monthly median is 0.57. As the percentile value decreases (i.e. 85%, 75%, etc) the correlation between those values and the monthly median values increases sharply.



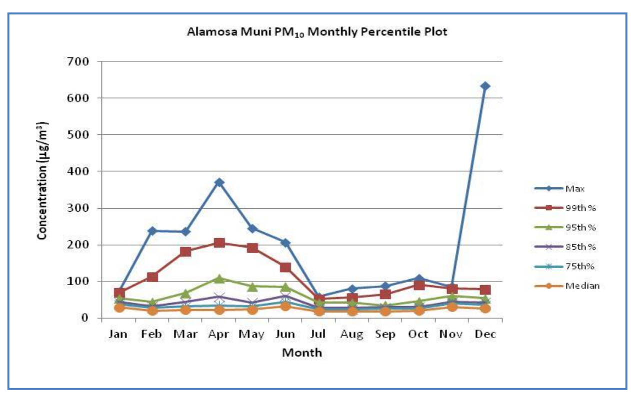


Figure 35: Monthly PM$_{10}$ Percentile Plots, 2008 - 2012

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 and Alamosa Muni) a conservative estimate of the percentile value that is reflective of typical, day to day variation is the 75^{th} percentile value. Nearly all of the variation in the monthly 75^{th} percentile values of these two data sets can be explained by the variation in monthly medians; for these two sites the correlation between the median and monthly 75^{th} percentile values vary from an $r^2 = 0.94$ (Alamosa Muni) to an $r^2 = 0.91$ (Alamosa ASC). A reasonable estimate of the contribution to the event from local sources for these data sets may be the monthly 85^{th} percentile values; for these two sites the correlation between the median and the monthly 85^{th} percentile values vary from an $r^2 = 0.69$ (Alamosa ASC) to an $r^2 = 0.80$ (Alamosa Muni). If these percentile values are taken as an estimate of event PM_{10} due to local variation then the portion of the sample concentration remaining from these monthly percentile values would be the sample contribution due to the event.

Table 8 identifies various percentile values that are representative of the maximum contribution due to local sources for each site from all June data. In Table 8 the range estimate in the 'Est. PM_{10} Contribution' column is derived using the difference between the actual sample value and the 85^{th} percentile as the minimum (reasonable) event contribution estimate and the difference between the actual sample value and the 75^{th} percentile as the maximum (conservative) event contribution estimate. This column represents the range of estimated contribution to the June 20, 2012 sample at the sites listed in the table due to the high wind event.

Table 8: Estimated Maximum Event PM_{10} Contribution

Site	Event Day Concentration (μg/m^3)	June Median (μg/m^3)	June Average (μg/m^3)	June 75th % (μg/m^3)	June 85th % (μg/m^3)	Est. Conc. Above Typical (μg/m^3)
Alamosa ASC	253	19	29.5	32	38.4	**217 - 225**
Alamosa Muni	182	25	36.9	41.5	55.5	**133 - 145**

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

4.0 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 storms 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 surrounding area. 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 events were 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 May 26, 2012 and June 20, 2012 events originated outside of the monitored areas.

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 May 26, 2012 and June 20, 2012, events. This information shall confirm that no unusual anthropogenic actions occurred in the local areas of Alamosa on these dates.

Regulatory Measures - State
The APCDs regulations on PM_{10} emissions are summarized in Table 9.

Table 9: 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	Prohibits open burning throughout the state unless a permit has been obtained from the appropriate air

Regulation 9- Open Burning, Prescribed Fire, and Permitting	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.

4.1 Alamosa Regulatory Measures and Other Programs

<u>Natural Events Action Plan (NEAP)</u>

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.

Please refer to the Final Natural Events Action Plan for High Wind Events, Alamosa, Colorado at:
http://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=AlamosaNaturalEventsActionPlan2003.pdf for more detail if needed.

<u>Regulatory Measures - City and County</u>

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 10.

Table 10: 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 Final NEAP (See http://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=AlamosaNaturalEventsActionPlan2003.pdf). According to the City's Public Works Director, in 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. In 2013 the City was also 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 takes place twice per week according to the City's Public Works Director.

According to the City's Public Works Director in 2013, the city owns an Elgin Pelican (mobile mechanical sweeper) and a Tymko 600 (brush-assisted head) street sweeper. In June 2013, the City also acquired a new Elgin Broom Badger street sweeper and the Tymko 600 was 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 were unpaved; most of these unpaved roads are legacy annexations. One of these unpaved roads was scheduled for paving in 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
In 2008, the City of Alamosa placed vegetative cover in all city parks and has installed irrigation systems to maintain the cover. In 2013, the City began 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. In 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 included 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 10th 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.

In 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 were granted. Other areas for treatment, such as commercial construction zones or gravel pits, were 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, 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 11.

Table 11: 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 scrublands (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. Figure 36 through Figure 63 illustrate potential areas of local soil disturbance that have been evaluated by the APCD for the Alamosa Adams State PM_{10} monitor and the Alamosa Municipal Building PM_{10} monitor.

4.2 Potential areas of local soil disturbance south of Alamosa (ASC Monitor)

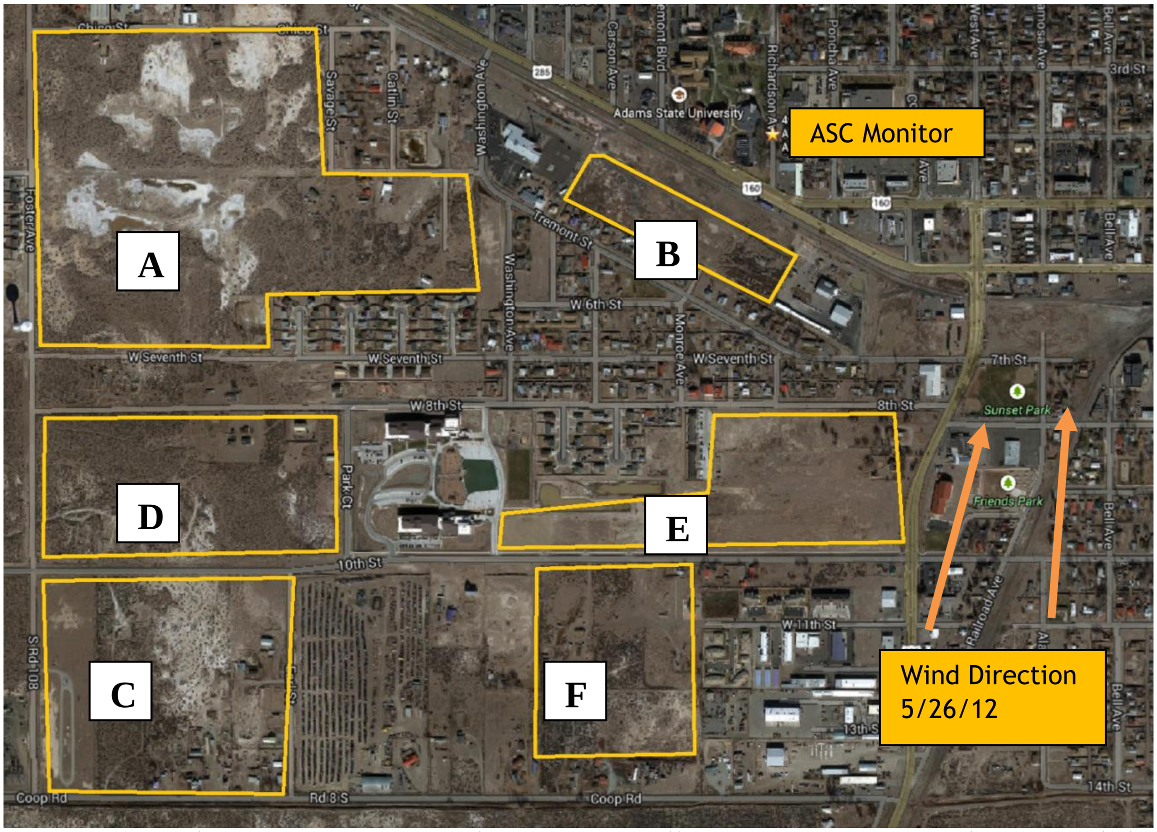


Figure 36: Relative positions of Adam's State College PM_{10} Monitor and potential disturbed soil. (Google Image 2015)

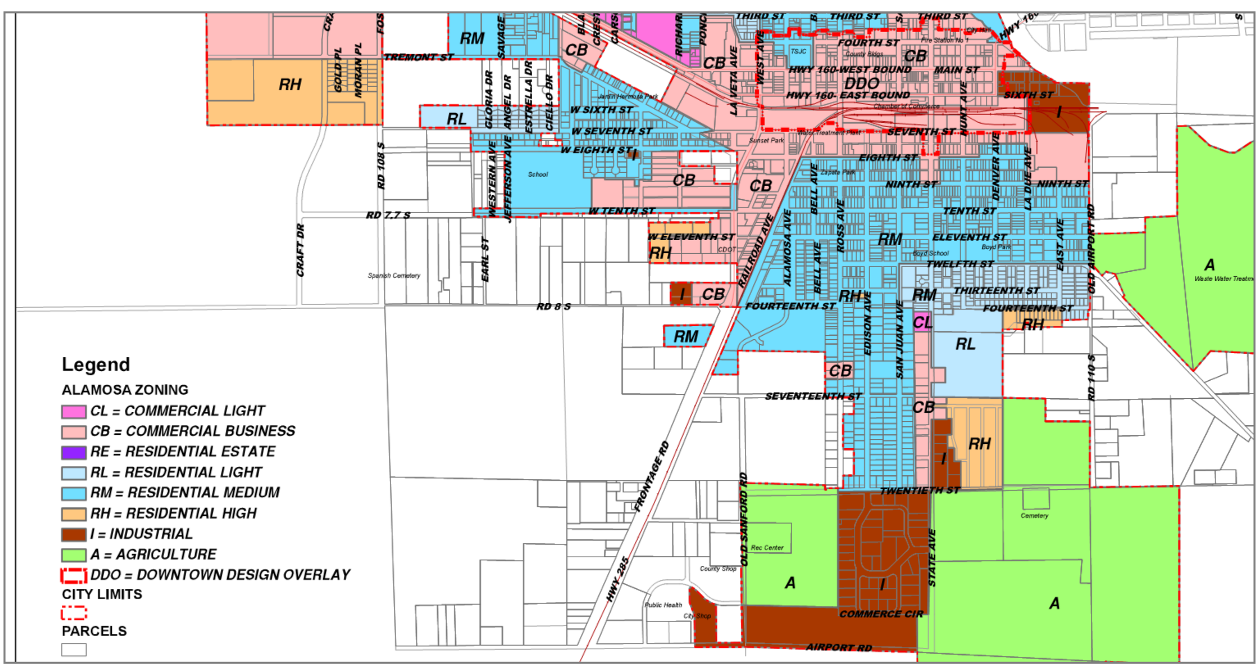


Figure 37: 2011 City of Alamosa Zoning Map (Provided by the Public Works Department)

Site A in Figure 36 (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 37. The eastern portion of site A is being considered for annexation into the City. A photo of site A is shown in Figure 38.

Figure 38: Site A facing north (CDPHE August 2013)

Site D in Figure 36 (approximately 34 acres) is north of 10th Street, east of Road S 108, west of Park Ct, and south of 8th St. It is zoned as a "Parcel" outside of the city's limits as shown in Figure 37. A photo of site D is shown in Figure 39.

Figure 39: 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. scrubland, 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 as of this writing. 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 36 (approximately 22 acres) is south of Highway 160 and north east of Tremont St. It is zoned as a "Parcel" outside of the city's limits as shown in Figure 37. Site E in Figure 36 (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 37. There is a small portion in the top right corner that is zoned as a “Parcel” and is outside of the city’s limits. Site F (approximately 23 acres) in Figure 36 is east of Earl St, south of 10th St, and north of Rd 8 S. It is zoned as “Commercial business”, “Residential High” and some “Industrial” as shown in Figure 37. Sites B, E, and F are naturally vegetated and potentially irrigated as shown in Figure 40. Figure 40 demonstrates that these sites are minimally (if at all) disturbed soil areas as of this writing. Photos of sites B, E, and F are shown in Figure 41 through Figure 44.

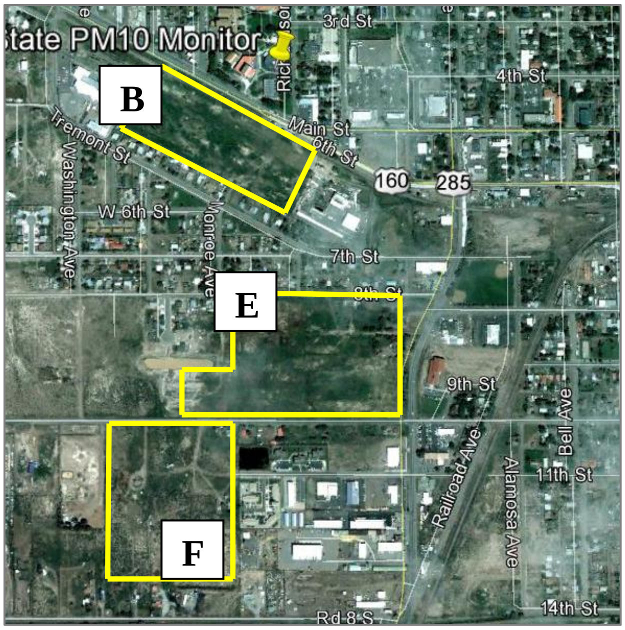


Figure 40: Sites B, E, and F with natural vegetation (Google Earth 2007)

Figure 41: Site B (CDPHE August 2013)

Figure 42: Site E facing north (CDPHE August 2013)

Figure 43: Site E, west end, elementary school overflow gravel parking lot (CDPHE August 2013)

Figure 44: Site F with natural vegetation (CDPHE August 2013)

The APCD conducted thorough assessments to determine if the potential soil disturbances shown in Figure 36 were present during the 2012 exceedances. During the course of these assessments, the APCD discovered that these sites were either reasonably controlled or considered to be natural sources during the May 26, 2012 high wind event. Therefore, these sites were not significant contributors to fugitive dust in the Alamosa area during the May 26, 2012, high wind event.

4.3 Potential areas of local soil disturbance south of Alamosa (Municipal Monitor)

Figure 45 illustrates potential areas of local soil disturbance that have been evaluated by the APCD for the Alamosa Municipal Building (08-003-0003) PM_{10} monitor. The climate for this monitor is identical to the Alamosa Adams State College PM_{10} monitor, described above.

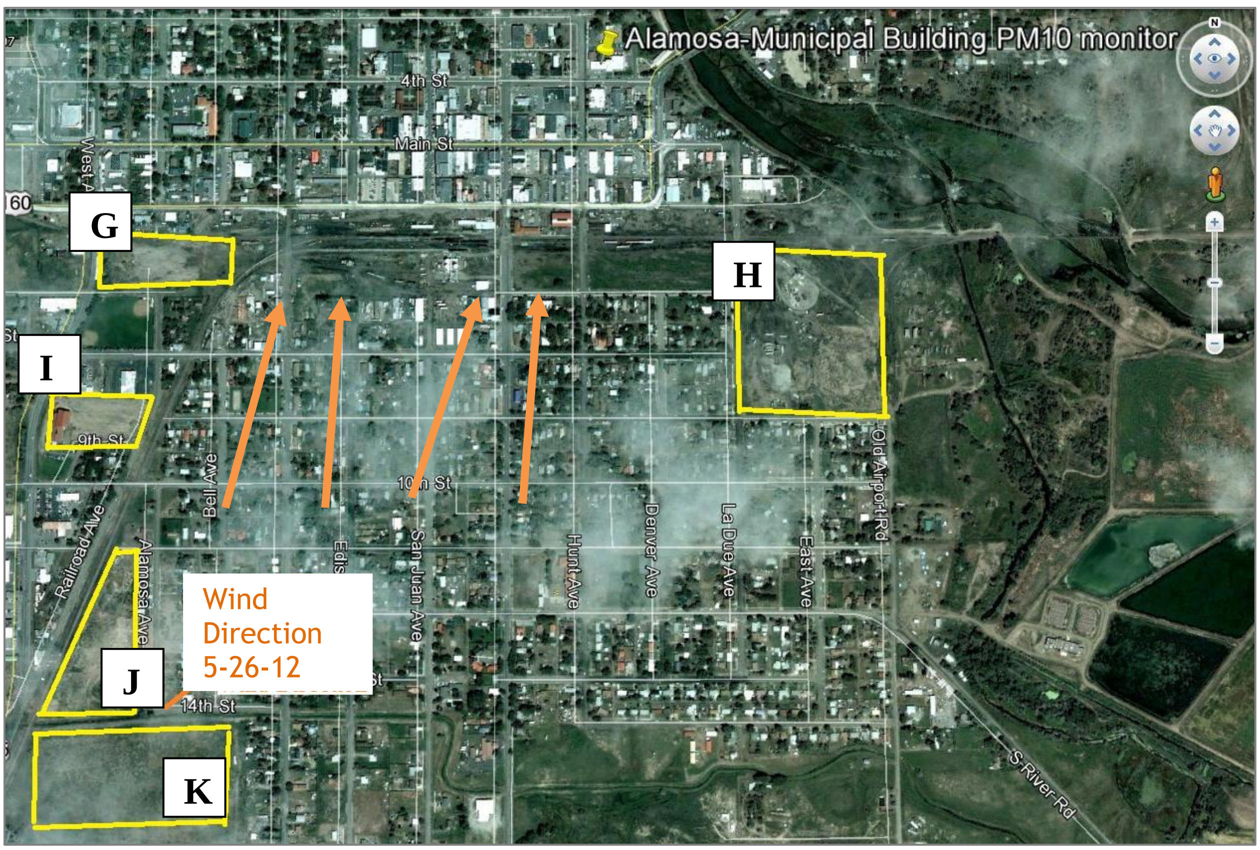


Figure 45: Relative positions of Municipal Building PM_{10} Monitor and potential disturbed soil (Google Earth 2007)

Site G in Figure 45 (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 37. The vacant land is undisturbed gravel, dirt, and is naturally vegetated as shown in Figure 46. The railroad runs through this narrow strip of land rendering it unlikely to be developed in the future.

Figure 46: Site G (CDPHE August 2013)

Site H in Figure 45 (approximately 22 acres) is east of La Due Ave, south of 6^{th} St, north of 9^{th} St, and west of Old Airport Rd. It is zoned by the city as “Commercial Business” and “Industrial” as shown in Figure 37. 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 47.

Figure 47: Site H (CDPHE August 2013)

Site I in Figure 45 (approximately 3 acres) is east of West Ave, north of 10^{th} St, south of 8^{th} St, and west of Railroad Ave. It is zoned by the city as “Commercial Business” as shown in Figure 37. Site I Figure 48 is “Friends” Park that is maintained by the City of Alamosa. 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 48: Site I - Friends Park (CDPHE August 2013)

Site J in Figure 45 (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 37. 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 49. 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 49: Site J (CDPHE August 2013)

Site K in Figure 45(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 37. Site K, as shown in Figure 50, is vacant land that is naturally vegetated and undisturbed.

Figure 50: Site K (CDPHE August 2013)

4.4 Potential areas of local soil disturbance east of Alamosa (both monitors)

Figure 51: Relative positions of Adam's State College PM_{10} Monitor and Alamosa Municipal Building PM_{10} Monitor, wind direction and potential disturbed soil (Google Earth 2013)

As show in Figure 52, there are no significant areas of potential disturbed soil within a mile of the ASC monitor. The area directly east of this monitor consists of commercial businesses and residential medium land use as shown in Figure 37. There are numerous mature trees and the area surrounding the buildings in this part of Alamosa is primarily landscaped.

Figure 52: Relative positions of Adam's State College PM_{10} Monitor (~1 mile distance), wind direction and potential disturbed soil (Google Earth 2013)

Figure 53: East of Municipal Building PM_{10} Monitor (~1mile distance) and potential disturbed soil (Google Image 2014)

Site L in Figure 53 (approximately 20 acres) is a vacant lot that is for sale as of August 2013. The undisturbed land is fenced in with barbed wire. The land is in a heavily wooded area and has dense natural vegetation as shown in Figure 54.

Figure 54: Site L (CDPHE 2013)

Site M in Figure 53 is all private undisturbed land (multiple owners) that is fenced in with barbed wire. The land has dense natural vegetation as shown in Figure 55.

Figure 55: Site M (CDPHE 2013)

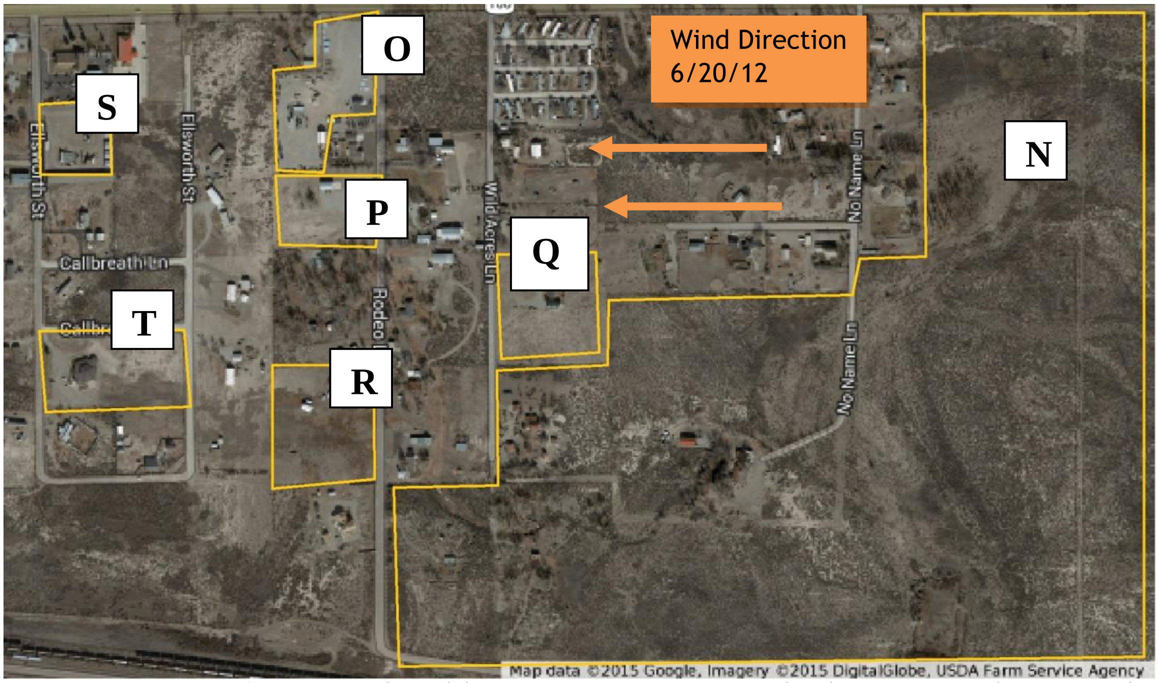


Figure 56: East of Municipal Building PM_{10} Monitor (~2mile distance) and potential disturbed soil (Google Image 2014)

Figure 57: Site N (Google Image 2012)

Site N in Figure 56 is restricted access property located just south of Highway 160. The land is naturally vegetated and largely undisturbed as shown in Figure 57. Figure 57 demonstrates that this site has minimally (if any) disturbed soil. 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.


Figure 58: Site O (Google Image 2012)

Site O in Figure 56 is a restricted access property located on the corner of Rodeo Lane and Hwy 160. As show in Figure 58, the property is gated and fenced and the gravel storage yard is well maintained. Access into and out of the property is paved, minimizing carry out of particles from the gravel yard to the road. 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.


Figure 59: Site P (Google Image 2012)

Site P in Figure 56 is a restricted access property located on Rodeo Lane. As shown in Figure 59, the property is gated and “No Trespassing” signs are posted (red arrow). Three sides of the property are fenced and large boulders are placed along Rodeo land to prevent entrance. The areas of the property that are not regularly used as a driveway are covered in weeds and the driveway is composed of well maintained gravel. 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.

Figure 60: Site Q (Google Image 2012)

Site Q in Figure 56 is a restricted access residential property located on Wild Acres Lane. As shown in Figure 60, the property is gated and fenced and the gravel yard is well maintained by grating. 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.

Figure 61: Site R (Google Image 2012)

Site R in Figure 56 Figure 56 is a restricted access property located on Rodeo Lane. As shown in Figure 61, the property is fenced and covered in weeds and native vegetation. 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.

Figure 62: Site S (Google Image 2012)

Site S in Figure 56 is a restricted access property located on Ellsworth St. As shown in Figure 62, the property is surrounded by a security fence topped with barbed wire. The speed limit while onsite is posted at 5 mph and the gravel lot is well maintained. 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.

Figure 63: Site T (Google Image 2012)

Site T in Figure 56 is the Calvary Bible Chapel property located on Ellsworth St. As shown in Figure 63, the property is landscaped with sod around the parking areas which consist of well maintained gravel. 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 APCD conducted thorough assessments to determine if the potential soil disturbances shown in **Figure 36** through Figure 63 were present during the 2012 exceedances in Alamosa. During the course of these assessments, the APCD discovered that these sites were either reasonably controlled or considered to be natural sources during the May 26, 2012 and June 20, 2012, high wind events. Therefore, these sites were not significant contributors to fugitive dust in the Alamosa area during the May 26, 2012 and June 20, 2012 high wind events.

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
In 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.

5.0 Summary and Conclusions

APCD is requesting concurrence on exclusion of the PM_{10} values from Alamosa-Adams State College (08-003-0001) and Alamosa-Municipal Building (08-003-0003) sites on May 26, 2012 and June 20, 2012.

Elevated 24-hour PM_{10} concentrations were recorded at the Adams State College and Alamosa Municipal Building monitors on May 26, 2012 and June 20, 2012. All of the noted twenty-four-hour PM_{10} concentrations were above the 90^{th} percentile concentrations for their locations (see Section 3). These events exceeded the 99^{th} percentile value of any evaluation criteria. The statistical and meteorological data clearly shows that but for these high wind blowing dust events, Alamosa would not have exceeded the 24-hour NAAQS on May 26, 2012 and June 20, 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 events were associated with measured concentrations in excess of normal historical fluctuations including background.

The PM_{10} exceedances in Alamosa would not have occurred if not for the following: (a) dry soil conditions over source regions with 30-day precipitation totals below the threshold identified as a precondition for blowing dust; and (b) meteorological conditions that caused strong surface winds over the area of concern.

Surface weather observations provide strong evidence that dust storms took place on May 26, 2012 and June 20, 2012. The meteorological conditions during these events caused regional surface winds over 30 mph with gusts exceeding 40 mph. 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 the Alamosa Blowing Dust Climatology available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2). These PM_{10} exceedances were due to exceptional events associated with regional windstorm-caused emissions from erodible soil sources over a large source outside of the monitored areas. These sources are not reasonably controllable during significant windstorms under abnormally dry or moderate drought conditions.

Both wind speeds and soil moisture in surrounding areas were conducive to the generation of significant blowing dust. Multiple sources of data for the events in question and analyses of past dust storms in this area prove that these were natural events and, more specifically, significant natural dust storms originating outside the monitored areas. But for the dust storms on May 26, 2012 and June 20, 2012, these exceedances would not have occurred.

As demonstrated in this report, the PM_{10} exceedances in Alamosa on May 26, 2012 and June 20, 2012, would not have occurred “but for” the large regional dust storms on May 26, 2012 and June 20, 2012.

6.0 References

6.1 May 26, 2012 References

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

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.*

6.2 June 20, 2012 References

Arizona Department of Environmental Quality, Maricopa County Air Quality Department and Maricopa Association of Governments, March 8, 2012. *State of Arizona Exceptional Event Documentation for the Events of July 2nd through July 8th 2011, for the Phoenix PM_{10} Nonattainment Area.*

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

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.*