Natural Events Policy Documentation of a Natural Event Due to High Winds on 10-Nov-2003 Kennewick, WA

Benton Clean Air Authority

August 10, 2004

OVERVIEW

On 10-Nov-2003 an exceedance of the primary 24-hour PM_{10} National Ambient Air Quality Standard (NAAQS) was recorded at Kennewick, WA. PM_{10} State/Local Air Monitoring Site (SLAMS). The concentration was officially reported as 164 µg/m³ at standard atmospheric conditions. The primary contributor to the exceedance was identified as fallowed and planted wheat fields, vulnerable irrigated agricultural fields, and to a lesser extent, localized urban areas, which were subjected to high wind speeds. An exact quantification of the source contributions is not available. The Benton Clean Air Authority (BCAA) believes that the 10-Nov-2003 event is a “natural event” in accordance with the EPA Natural Events Policy.

NATURAL EVENTS POLICY

The Natural Events Policy (NEP) was issued in May 1996 to provide an avenue of response to PM_{10} air quality data that are due to uncontrollable natural events. Under NEP provisions, PM_{10} attributable to a natural event can be excluded from an attainment or non-attainment decision. The NEP is applicable when PM_{10} data is due to uncontrollable natural events and the dust originates from non-anthropogenic sources or from contributing anthropogenic sources controlled with best available control measures (BACM)

The two basic requirements of the NEP are:

1) The states must develop a Natural Events Action Plan (NEAP) to deal with future PM_{10} NAAQS exceedances.

2) The states must also establish a clear and casual relationship between the observed natural event and the observed exceedance and document the event.

WASHINGTON STATE’S COLUMBIA PLATEAU WINDBLOWN DUST NATURAL EVENTS ACTION PLAN

Washington State’s Natural Events Action Plan (NEAP) to address PM_{10} from natural events occurring in the Columbia Plateau region of eastern Washington was a result of a large number of PM_{10} NAAQS exceedances in this region in the period from the late 1980’s and early 1990’s. Agricultural fields upwind of PM_{10} monitoring sites were identified as the principal sources of windblown dust. The Washington State Department of Ecology’s Air Program division developed the initial NEAP in 1998 and updated the document in 2003.

The NEAP has several purposes:

- Development of procedures for taking appropriate, reasonable measures to safeguard public health when natural events occur.
- Responsibility to assure that emission controls are applied to sources that contribute to exceedances of the PM_{10} NAAQS, when those controls will result in fewer violations of the standards. Emission controls include BACM development and implementation.
- Authorization for documentation to be submitted to request designation of an exceedance of the NAAQS for PM_{10} as being the result of a natural event.

Definition of High Wind Event in NEAP

The 2003 NEAP refined the definition of high wind event for Washington State in accordance with the provisions of the NEP allowing the states to determine this definition. This provision recognizes the multiple variables that affect the wind erosion processes that result in windblown dust and the generation and transport of PM_{10}, which geographically differs. Following is the definition of a "high wind event" from pages A1-A4 of the Washington State Columbia Plateau Windblown Dust Natural Events Action Plan (Ref 11):

"A high wind event occurs when the wind entrains and suspends dust to the extent that concentrations of PM_{10} are elevated. This occurs when the average hourly wind speed at 10m is 18 miles per hour or greater for two or more hours [18+2]; or in excess of 13 [13+2] miles per hour for two or more hours when conditions of higher susceptibility to wind erosion exist (see attachment A1). A high wind event that exceeds PM_{10} standard is a natural event."

This definition recognizes the concept that the wind speed threshold for wind erosive processes on soil to cause elevated PM_{10} concentrations in the air is variable. This variability depends on multiple variables related to soil characteristics, wind gustiness, soil surface residue cover, moisture content, and others. Attachment A1 to the Appendix A and of the Columbia Plateau NEAP documents the research and explains the logic behind this two-stage "high wind event" definition. The high wind event definition also necessarily includes the concept that the intensity of the wind event is a combination of wind speed and significant duration (sustained wind).

Relationship of High Wind Event Definition to Documentation

The amount of detail in the event documentation required by the NEAP varies with the category (18 mph for ≥ 2 hr; or 13 mph for ≥ 2 hr under higher wind erosion susceptibility) of high wind event definition. For the "18 + 2" category the documentation burden is less because of the more clear-cut association of the observed PM_{10} data and the wind speed profile. The wind speed profile contains wind speed, wind direction, and duration and essentially is a data plot of wind speed and direction against a period of time. Precipitation preceding the day of the event is also part the “18 + 2” data set. The higher wind speed event more easily meets the “clear and causal” criteria of the Natural Events Policy.

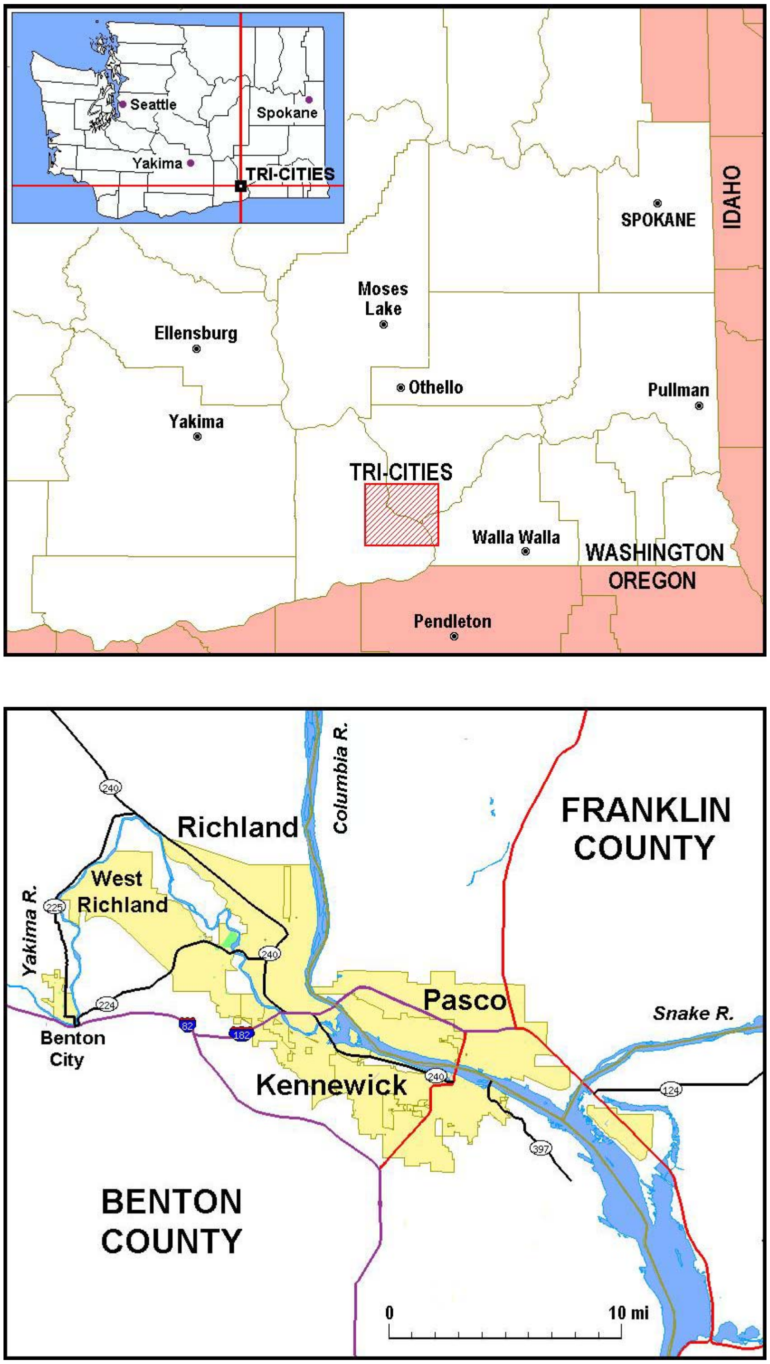
The “13 + 2” category within the high wind event definition is more complex with respect to establishing the link between the wind event and elevated PM_{10}. The meteorological phenomena driving the process are spatially and temporally more complex and the number, geographic distribution and complexity of the meteorological measurements needed to describe the event are greater. These complexities may require more sophisticated methodology to reveal the dynamics of the event. Regional scale meteorological modeling coupled with PM_{10} generation (emission) and transport modeling may be necessary and other data may be needed to link an event to remote source areas.

GENERAL DESCRIPTION OF AREA

Kennewick, Richland (including West Richland), and Pasco, known collectively as the Tri-Cities, are located in southeast Washington where the Yakima, Columbia, and Snake Rivers meet (Figure 1). The eastern half of the State of Washington lies in the rain shadow of the Cascade Mountains making the region a semi-arid desert. Average annual precipitation in the Tri-Cities region is about 6-7 inches with high rainfall intensity being very uncommon. Irrigated agriculture produces a wide diversity of crops including fruits, vegetables, alfalfa and potatoes. Dryland (non-irrigated) wheat production compliments the irrigated cropping systems. Large areas of non-agricultural range and desert lands complete the major land use areas of the region.

The Tri-Cities are located in an open-ended river basin partially bounded by low hills to the south and southwest. The terrain coupled with prevailing south and west winds limit local stagnant air pollution by ventilating the area. This coupling can also produce some extraordinary wind speeds and patterns. These winds can produce significant wind erosion events that can blanket the Tri-Cities region with dust from vulnerable agricultural fields and other areas. On rare occasions, usually during the fall and winter, strong winds can occur from the north and northwest sectors.

Figure 1: The Tri-Cities Area



EVALUATION OF 10-NOV-2003 EVENT

This section describes the major factors that affected the occurrence of the windblown dust event and an exceedance of the PM_{10} NAAQS on 10-Nov-2003 in Kennewick, WA. Analysis of the high wind event summarizes the circumstances and characteristics of the event. Best available control measures (BACM) are reviewed to demonstrate compliance with the BACM requirement of the Natural Events Policy. Landscape stability conditions are described to show what factors on the land and the activities taking place contributed to the observed windblown dust PM_{10} NAAQS exceedance.

PM_{10} Data

The Kennewick PM_{10} federal reference method (FRM) monitor operates on a 1- in - 1 day schedule. Tables A1 and A2 in Appendix A shows Kennewick PM_{10} data for 2002 and data for January through Nov-10-2003, respectively. The average PM_{10} concentration for 2002 was 23.3 ug/m^3. The only recorded exceedance of the PM_{10} NAAQS in 2002 was 186 ug/m^3 on 16-Aug-2002. The average PM_{10} concentration in the months prior to the 10-Nov-2003 exceedance was 39.1 ug/m^3 in September 2003 and 89.1 ug/m^3 in October 2003. The exceedance of the PM_{10} NAAQS in 2003 was 186 ug/m^3 on 5-Mar-2003 and 1438 ug/m^3 on 26-Oct-2003. These daily PM_{10} values in Tables A1 and A2 (Appendix A) show that the days with 24-Hour PM_{10} concentrations that exceed the NAAQS are relatively rare and are much higher than the majority of daily values and other maximums for the period. The annual average PM_{10} concentration has not exceeded the annual NAAQS standard of 50 ug/m^3 in 18 years of monitoring at the Kennewick site.

Table 1 shows the occurrence of windblown PM_{10} exceedances, which have been documented as natural events since the inception of the NEP in May 1996. The BCAA takes principal responsibility for high wind events and natural events documentation for exceedances that affect primarily Benton County. Documentation of larger regional events that affect a greater area of the Columbia plateau including Benton County is the principal responsibility of the Washington State Department of Ecology's Air Program.

Table 1: History of Documented Windblown Dust Natural Events in Benton County (BCAA jurisdiction)

YEAR	DATE	CONCENTRATION µg/m3	ACTION TAKEN
1999	September 23	180	Ecology NEP[1]
1999	September 25	305	Ecology NEP[1]
2000	July 31	218	BCAA NEP[2]
2001	March 13	351	BCAA NEP[2]
2001	September 25	284	Ecology NEP[1]
2001	October 23	267	BCAA NEP[2]
2002	August 16	186	BCAA NEP Pending
2003	March 5	186	BCAA NEP Pending
2003	October 26	1438	Ecology NEP Pending

[1] Regional event with generalized dust storm conditions from a high wind event occurring in the intermountain region east of the Cascade Mountain range, which are documented by the Washington State Department of Ecology's Air Program.

[2] Dust storm conditions from a high wind event that affected primarily Benton County documented by the Benton Clean Air Authority.

High Wind Event Analysis

Synoptic Weather Pattern

The synoptic weather pattern provides the broad view of the weather systems that set up and drive the observed wind event. The positioning of high and low pressure areas with associated air mass circulation patterns and pressure gradients help in understanding the wind speeds, direction, duration, and shifting of winds that may occur during a wind event.

Figure 2a shows that at 0400 PST on 9-Nov-2003, a well-developed low-pressure system was beginning to landfall southwest of Washington State and was moving in a easterly direction inland. The system had already begun to have effects on the local weather in the Tri-Cities as wind speeds throughout the region began to increase. In many rural areas of Benton County wind speeds were approaching 15 mph by 1100 (PST) on 10-Nov-2003. This low pressure system was bounded to the north by a high pressure system which also appeared centered over Colorado.

In this configuration, with a low-pressure system to the southwest of a weak high-pressure system, a strong pressure gradient was established across Washington State. Because winds move from areas of higher pressure to lower pressure and the mass air movements are respectively counterclockwise and clockwise around lows and highs, strong winds were blowing from the south towards the north. During the course of the day, the low pressure system pushed closer to the weak high, intensifying and combining with a pressure gradient over Montana (Figure 2b). The resulting wind speeds were high enough to cause soil particles to become airborne and generate PM_{10} emissions. These high, sustained winds continued until about 1200 PST on 11-Nov-2003. By early 11-Nov-2003, a high-pressure system had become more established across most of the western U.S. (Figure 2c).

Figure 2 a-c: Synoptic Weather Maps

Figure 2a: 9-Nov-2003

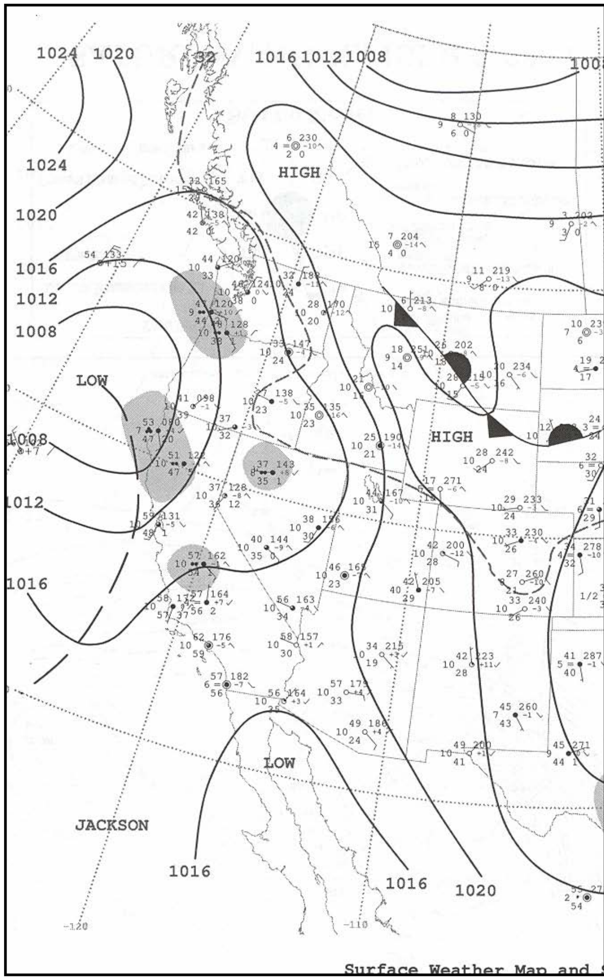


Figure 2b: 10-Nov-2003

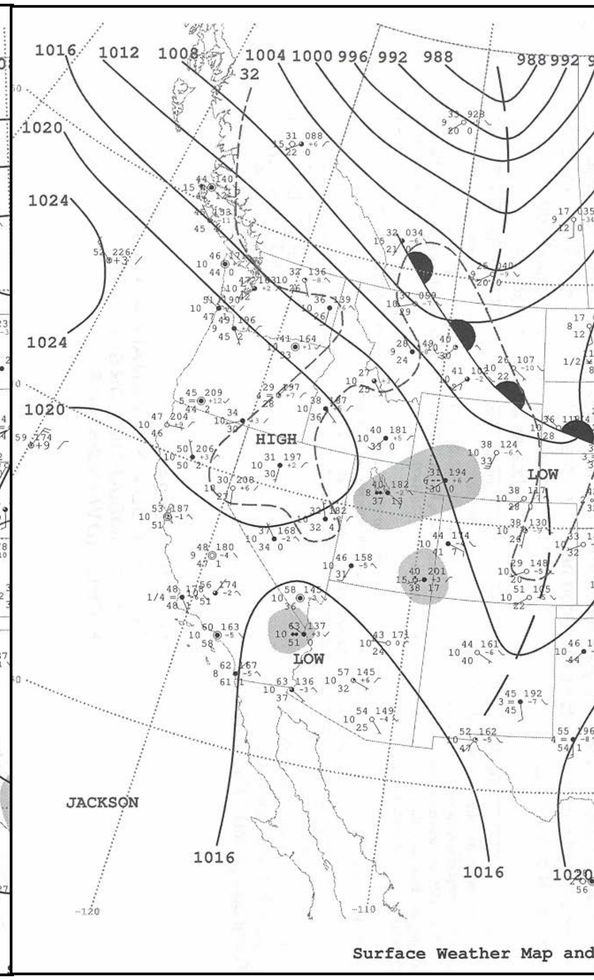
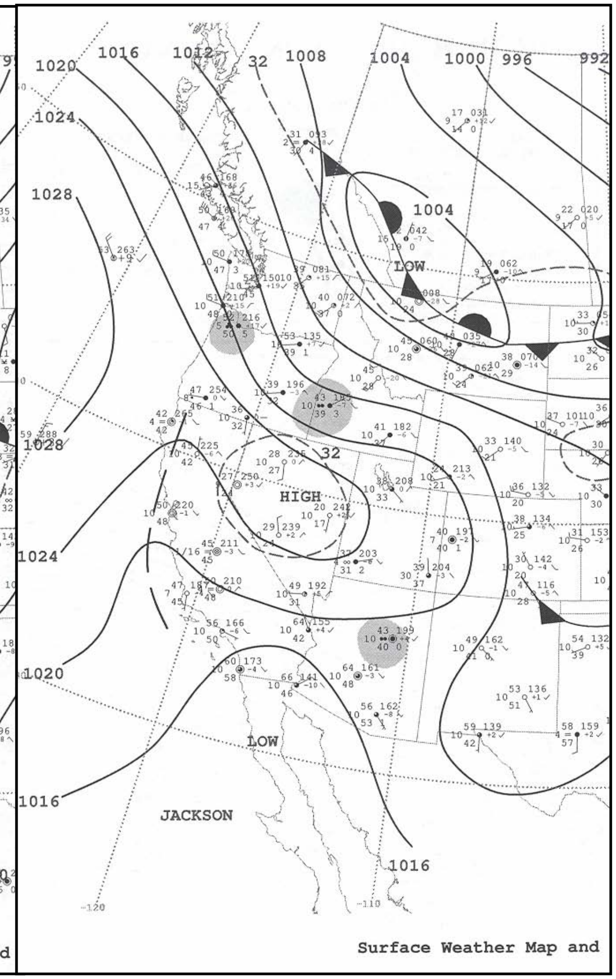


Figure 2c: 11-Nov-2003



Wind Data in the PM_{10} Source Area and the Urban Receptor Area

The following wind data shows in detail the manifestation of the larger scale synoptic circulation depicted in Figure 2. The wind direction for both urban and rural areas remained southwesterly for the duration of the highest wind speeds. Also for both areas, the wind speeds were more than sufficient for exceeding wind erosion thresholds and the wind travel (miles) was more than sufficient to accomplish transport of entrained PM_{10} generated in the wind erosion process (Appendix B).

Wind data was analyzed from the Public Agricultural Weather Station (PAWS) meteorological (MET) network in locations in Benton County (Figure 3a). Figures 3b and 3c show wind data from urban and rural MET stations to show the general trends of wind speeds and directions in these two areas from 2000 PST 9-Nov-2003 through 1200 PST 11-Nov-2003on 10-Nov-2003.

In the rural PM_{10} source area of the Horse Heaven Hills dryland wheat growing area the wind speeds were above 18 mph for an extended period at Alderdale, Horrigan and Station 4 (Figure 3c) in a steady southwesterly direction. The [18+2] criteria was also met at the Benton City and WSU Tri-Cities urban PAWS stations. The BCAA has observed this common or typical pattern on numerous dates for previous PM_{10} NAAQS exceedances. The urban and rural PM_{10} source area meets the wind data standard of [18+2] miles per hour for two or more hours when conditions of higher susceptibility to wind erosion exist.

Figure 3a: Benton County Area PAWS Stations

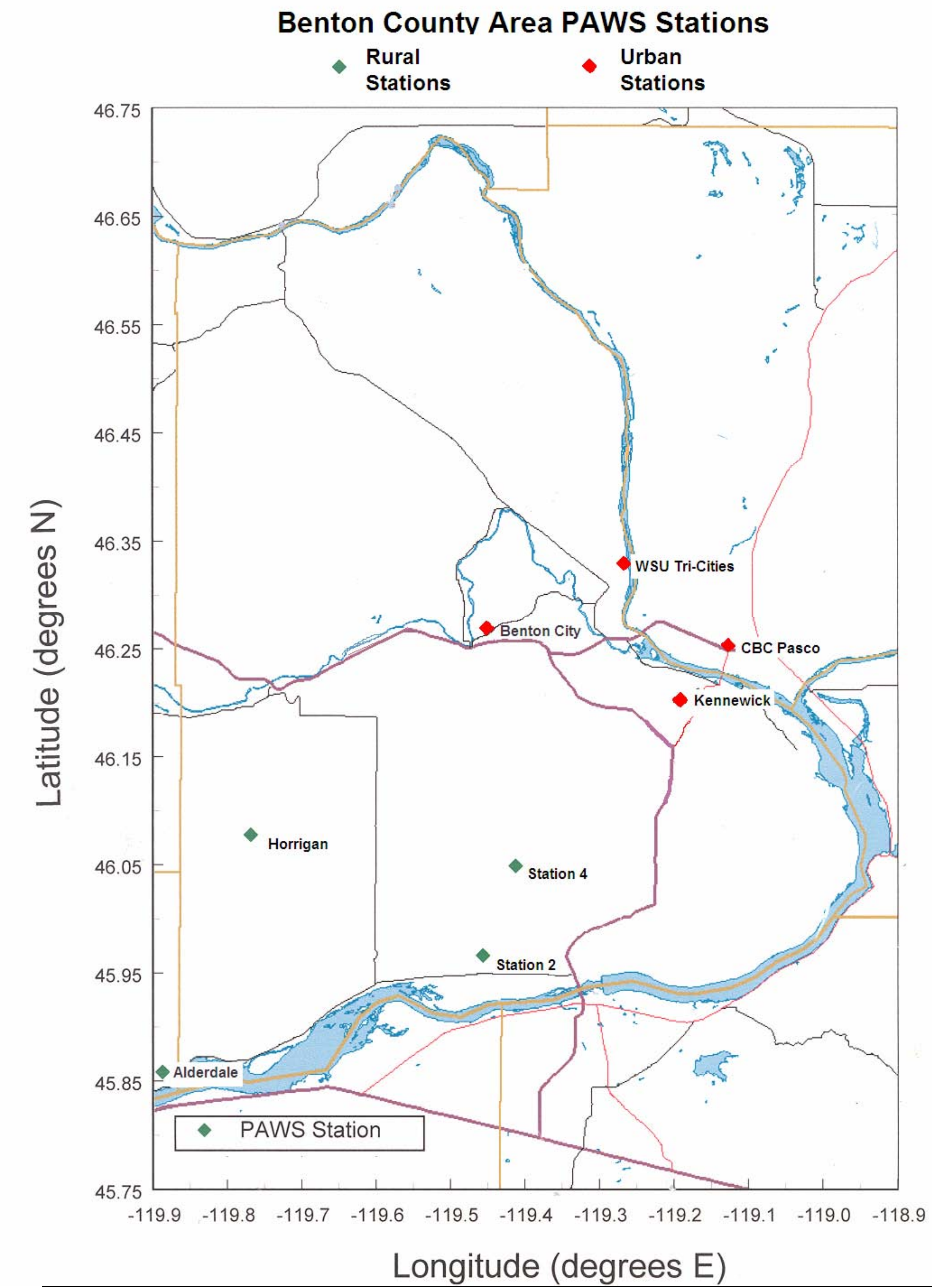


Figure 3b: Urban Wind Data (2000 PST 9-Nov-2003 through 1200 PST 11-Nov-2003)

	Kennewick		**Badger Canyon**		**Benton City**		**WSU Tri-Cities**	
Time	Wind Speed	Wind Direction	Wind Speed	Wind Direction	Wind Speed	Wind Direction	Wind Speed	Wind Direction
2000	1.8	251.1	1.9	179.2	2.4	327.1	1.0	46.8
2100	1.1	223.6	1.4	202.1	3.4	318.3	0.8	189.8
2200	1.3	148.3	0.7	36.7	4.1	338.8	0.6	179.0
2300	1.9	25.6	0.6	87.4	4.5	344.5	1.4	190.5
0000	2.5	216.8	16.0	212.6	18.6	271.1	16.8	176.7
0100	2.3	254.1	5.3	250.1	4.7	318.4	1.0	339.9
0200	2.0	254.4	12.4	214.9	5.1	359.2	0.5	352.7
0300	2.2	270.4	4.0	277.4	4.2	334.0	5.9	174.4
0400	2.0	271.5	10.1	226.1	4.6	327.0	6.3	181.6
0500	2.1	255.3	16.4	204.4	5.1	330.0	3.8	210.6
0600	1.4	214.5	17.1	204.6	6.0	306.0	5.7	200.5
0700	2.1	217.1	13.7	207.9	5.9	306.2	9.6	196.5
0800	11.7	227.2	14.4	209.3	7.0	310.3	6.4	195.3
0900	4.4	222.6	14.8	210.7	6.6	306.1	9.5	194.6
1000	5.4	228.9	12.3	218.8	5.5	341.1	9.1	221.3
1100	3.7	221.8	11.3	212.0	6.3	354.1	5.3	210.6
1200	4.3	222.4	12.8	216.7	13.9	280.2	11.3	189.8
1300	7.5	223.0	12.1	217.0	10.2	300.8	11.2	188.1
1400	8.8	224.0	11.9	216.5	8.2	311.0	10.6	197.3
1500	9.1	225.8	11.5	221.1	9.7	301.8	12.6	190.6
1600	8.6	228.0	11.4	229.8	10.6	288.4	12.5	187.6
1700	11.5	227.1	11.8	223.3	12.4	287.1	14.2	189.8
1800	11.5	225.8	13.0	224.6	10.8	286.2	14.5	187.8
1900	10.2	230.7	14.9	228.3	14.9	286.5	16.6	188.8
2000	12.2	229.5	13.8	225.0	12.8	290.0	16.9	191.9
2100	12.7	229.8	14.7	223.9	20.2	283.2	20.0	191.1
2200	12.0	225.1	14.9	217.8	18.3	272.6	22.5	191.9
2300	12.2	223.1	15.2	217.9	19.2	273.8	19.3	183.4
0000	11.0	227.1	1.0	113.2	1.0	30.7	0.7	247.8
0100	13.1	219.9	15.0	209.9	17.5	277.5	18.4	183.4
0200	12.8	214.4	14.6	207.0	16.8	289.9	15.8	184.7
0300	11.1	220.7	14.0	212.0	14.9	295.1	12.8	182.2
0400	14.0	223.8	13.7	208.4	15.3	288.0	8.9	191.7
0500	13.4	220.9	14.8	205.4	13.6	275.7	12.1	187.3
0600	14.1	215.6	14.6	206.7	6.5	286.8	10.2	188.8
0700	13.5	218.7	13.5	212.7	3.2	289.3	6.9	178.7
0800	0.9	220.4	11.6	217.5	6.2	290.2	8.6	191.5
0900	14.0	221.6	8.7	217.4	5.2	296.5	10.0	196.3
1000	11.5	231.2	6.4	222.4	6.0	315.5	8.6	228.7
1100	11.5	248.8	6.6	240.1	7.6	334.0	6.9	245.8
1200	12.0	245.8	3.1	262.6	8.5	307.5	6.5	267.8

Figure 3c: Rural Wind Data (2000 PST 9-Nov-2003 through 1200 PST 11-Nov-2003)

	Alderdale		**Horrigan**		**Station 2**		**Station 4**	
Time	Wind Speed	Wind Direction	Wind Speed	Wind Direction	Wind Speed	Wind Direction	Wind Speed	Wind Direction
2000	8.0	180.3	4.2	305.9	0.5	5.2	2.4	69.6
2100	12.9	183.3	4.1	310.4	1.2	52.6	0.6	87.9
2200	14.5	181.5	4.2	310.0	1.2	40.8	3.4	86.1
2300	15.5	180.4	3.6	315.5	3.0	55.7	4.9	65.7
0000	28.0	205.1	15.3	209.7	7.3	214.1	15.7	209.7
0100	15.5	187.5	3.6	340.7	2.7	41.6	4.9	68.4
0200	19.1	188.0	3.6	325.8	1.4	33.8	4.4	85.2
0300	19.6	194.1	3.2	329.5	1.5	52.0	3.4	102.9
0400	21.3	191.0	3.8	353.0	0.7	89.3	3.5	102.3
0500	20.3	201.5	4.1	356.8	1.5	54.9	3.0	142.0
0600	18.9	196.8	4.1	11.8	1.7	52.1	4.0	146.7
0700	19.7	205.1	4.3	7.4	0.6	134.2	5.6	190.0
0800	22.6	215.3	3.6	354.4	0.7	115.6	3.6	182.5
0900	21.8	211.5	3.2	37.1	4.1	190.4	6.9	189.4
1000	24.1	220.8	8.2	185.2	10.2	216.4	13.4	214.3
1100	22.6	216.7	15.7	213.3	13.2	212.8	15.4	206.3
1200	26.5	222.0	16.7	210.9	16.7	214.0	18.7	218.0
1300	24.9	223.8	13.3	227.6	16.5	219.4	19.4	217.1
1400	22.2	220.9	13.2	218.4	17.5	213.5	16.6	219.3
1500	23.9	220.2	13.9	232.8	16.5	210.4	16.1	218.6
1600	22.0	229.5	17.4	234.3	15.2	203.2	19.2	227.6
1700	23.7	222.6	14.2	219.0	15.2	199.9	16.1	218.5
1800	20.1	213.0	16.9	222.7	13.4	210.5	13.2	222.7
1900	23.9	219.1	19.6	226.4	13.7	211.7	12.8	223.0
2000	21.1	213.1	20.0	218.7	14.0	210.6	15.4	217.1
2100	23.9	217.6	15.9	208.9	12.7	218.2	14.8	221.3
2200	23.8	213.9	13.3	195.2	8.6	223.8	12.7	215.9
2300	23.9	209.5	12.6	190.0	6.3	229.1	14.9	216.4
0000	7.4	196.0	3.1	326.0	1.6	37.9	2.7	49.6
0100	27.9	204.2	17.9	213.3	10.0	199.4	16.0	202.3
0200	27.2	204.4	13.6	211.7	18.0	191.8	16.1	211.0
0300	27.0	209.4	12.7	199.6	20.9	214.3	16.5	224.1
0400	27.1	218.1	10.4	196.6	24.2	220.5	19.2	222.9
0500	24.4	219.0	11.0	181.2	22.5	214.8	19.0	222.2
0600	22.9	219.8	9.5	208.7	17.5	203.6	12.9	205.4
0700	22.5	220.0	11.6	209.3	19.2	205.8	13.8	207.3
0800	22.3	221.5	10.8	217.9	18.9	201.3	15.5	210.8
0900	19.4	217.5	5.8	220.4	16.0	198.9	14.6	222.5
1000	17.2	225.6	2.5	245.8	17.0	183.9	13.1	218.3
1100	17.1	232.9	2.7	254.6	18.0	176.4	15.9	218.1
1200	17.5	215.2	11.2	281.9	20.0	192.4	15.1	215.6

Because of the increased topographical surface roughness in the urban area, the hourly wind speeds were lower than the speeds in the rural areas. These wind speeds were sufficient to support transport of PM_{10} across the urban area. In addition, the pattern of wind speeds and directions were consistent among four urban MET stations and were consistent with transport from the rural areas. Furthermore, because these wind speeds in the urban area were high enough to generate dust from construction sites with highly vulnerable soil surface conditions, urban fugitive dust was most likely a contributor to the exceedances.

As described, the necessary and sufficient conditions for wind conditions occurred on 10-Nov-2003 to cause an exceedance of the PM_{10} NAAQS at the Kennewick monitoring station in the Tri-Cities. Since there are many irrigated and dryland fields that are located relatively close to the Kennewick monitoring site (within 5-40 miles), the wind speeds and duration necessary to transport dust from the fields to the population center are relatively low. This close proximity of agricultural fields to the populated areas (and the PM_{10} SLAMS) makes the Tri-Cities distinct from other agricultural windblown dust situations, which typically have more remotely located source areas.

Direct Observational Information on the High Wind Event

The arid climate in the wheat-producing land in the areas of the Horse Heaven Hills makes fallow farming a necessary water harvesting method. In the fallow system, one-half the land is allowed to collect a year's amount of precipitation without growing wheat plants on that land. The other half of the land has actively growing wheat, which is using the moisture collected in the previous year's fallow land plus the current year's precipitation.

The exposed soils in fallow areas were potentially susceptible to wind erosion on 10-Nov-2003. The degree of susceptibility depended on the dryland wheat yields in the previous year, which determines the amount of straw residue available for holding the soil against the wind. The overall contribution from just-planted areas would also vary according to available surface residue left on the surface after planting. The landscape stability of the rural PM_{10} source area on 10-Nov-2003 was sufficiently low to allow wind erosion with the combined effects of below-normal antecedent precipitation and necessary agricultural operations disturbing the soil.

Recently planted winter wheat fields were vulnerable because crop cover was not sufficient to decrease wind speed at the soil surface below wind erosion threshold speeds and were subject to wind erosion and PM_{10} emissions. Sustained winds blowing across these unprotected and unstabilized soil surfaces cause soil particles to become airborne and transported into the Tri-Cities urban area even when BACM and BMP are being used. Planted wheat fields where seedlings were emerging very sporadically across the field didn't prevent the soil from blowing. The saltation creep effect was clearly seen in several areas, as a number of the fields that were blowing were being impacted by the blowing dust and the movement of soil from adjacent fields. Fallow fields with sufficient residue from previous wheat harvest were also being subjected to high wind speeds. Planted wheat fields and fallowed fields with good residue on 10-Nov-2003 were holding very well and exhibited little or no soil movement.

Windblown dust can come from construction sites at wind speeds substantially less than that needed to generate and transport dust from the agricultural areas to the urban areas. Based primarily upon direct observational evidence by BCAA staff and generally confirmed by the BCAA complaint records, often wind speeds of 5-10 mph can produce dust from extremely disturbed and vulnerable soil surfaces present on construction sites. On construction sites in and around the urban areas, extreme soil disturbance, an almost total lack of vegetative residue, and frequent mechanical activity make these construction sites vulnerable to wind erosion. On 10-Nov-2003, construction site dust may have contributed somewhat, but the data and our observations show that dust from agricultural areas was the dominant contributor.

Landscape Stability Conditions in the PM_{10} Source Area

The largest source area for PM_{10} in the 10-Nov-2003 event was the Horse Heaven Hills dryland wheat growing area. Precipitation and its effects on wheat culture are the principal determinants of landscape stability. The effects of precipitation, both the amount and timing are two-fold and operate on different time scales. One is a cropping cycle time-scale (long-term, 12 to 24 months or more) and the other is an event time-scale (short-term, 24 to 72 hours).

Precipitation on an event time-scale can modify the susceptibility of the soil surface to particle detachment. Such precipitation effects are operative in the period of a few days prior to the wind event that causes the wind erosion. Recent precipitation within a few days prior to the wind event can suppress the amount of PM_{10} emissions and lack of precipitation could have the opposite effect. Sufficient precipitation can suppress emissions to the point that no exceedance occurs.

Precipitation on a cropping cycle time-scale affects residue production, which is more important for landscape stability than short-term, event time-scale precipitation. From June 2002 to April 2003 precipitation was above average (approx. 8.9 inches) (Table A4). Therefore, the amount of water stored in the soil profile during the fallow period was above average, which increases the probability of establishing a winter wheat crop and increases the potential for supporting its growth. However in this case the problem was with the deficit of precipitation in the six months prior to 10-Nov-2003. Because of this risk, grower management decisions range from fall seeding with hope for near-future rain, waiting to plant until after fall precipitation occurs, or waiting until spring to plant a spring variety of wheat. Some growers may have attempted seeding operations one or more times in the fall as they gamble on rains coming in time to support seedling development. Each re-seeding further disturbs the soil, buries surface residue, and degrades the soil physical condition. All these activities result in a lower landscape stability and increases vulnerability to wind erosion. The amount of land area where planting of winter wheat was intended, but failed, the amount of surface residue coverage, and the amount of farming operations on the land determines the overall landscape stability.

Daily precipitation measurements from four Public Agricultural Weather System (PAWS) stations in rural Benton County and four (PAWS) stations in urban Benton County showed no precipitation for 26 consecutive days prior to the 10-Nov-2003 wind event. (Figure 4). Therefore, bare soil and low residue areas, which are highly vulnerable to wind erosion, received no stabilizing effects of precipitation for over two weeks before the wind event. (Appendix B)

Figure 4: Precipitation Prior to 11-Nov-03 Exceedance

	Alderdale	Horrigan	St. 2	St. 4	WSU TC	CBC Pasco	Badger Canyon	Kenn-ewick
16-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
17-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
18-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
19-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
20-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
21-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
22-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
23-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
24-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
25-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
26-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
27-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
28-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
29-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
30-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
31-Oct-2003	.00	.00	.00	.00	.00	.00	.00	.00
1-Nov-2003	.00	.00	.00	.00	.00	.00	.00	.00
2-Nov-2003	.00	.00	.00	.00	.00	.00	.00	.00
3-Nov-2003	.00	.00	.00	.00	.00	.00	.00	.00
4-Nov-2003	.00	.00	.00	.00	.00	.00	.00	.00
5-Nov-2003	.00	.00	.00	.00	.00	.00	.00	.00
6-Nov-2003	.00	.00	.00	.00	.00	.00	.00	.00
7-Nov-2003	.00	.00	.00	.00	.00	.00	.00	.00
8-Nov-2003	.00	.00	.00	.00	.00	.00	.00	.00
9-Nov-2003	.00	.00	.00	.00	.00	.00	.00	.00
10-Nov-2003	.00	.00	.00	.00	.00	.00	.00	.00
11-Nov-2003	.00	.00	.00	.00	.00	.00	.00	.00

The effect of the 2002 to 2003 precipitation deficit was that a significant acreage of fall wheat seeding operations occurred just before the 10-Nov-2003 windblown dust event. Most likely, the largest sources of dust on 10-Nov-2003 were from dryland fields disturbed by recent seeding of winter wheat. These winter wheat fields are particularly vulnerable to wind erosion during preparation for planting and following planting because of the disturbed soil condition. Any tillage that prepares the fields for planting and the planting operations themselves reduce surface residue. This reduction combined with an overall reduced supply of residue from low wheat yields in the previous crop cycle further increases susceptibility to wind erosion.

Dryland fields continue in this vulnerable condition after planting until a sufficient cover of new crop growth can be established. Depending on weather conditions and soil temperature during this period, seedling and stand establishment emergence can take several weeks. Once the crop cover is established, the soil surface is increasingly protected as the crop grows and wind erosion potential decreases and approaches zero.

In summary, the combined effects of deficit and lack of rainfall for over 26 consecutive days (greater than 72 hours) prior to 10-Nov-2003 resulted in a vulnerable unstable landscape that was susceptible to wind erosion when the 10-Nov-2003 wind event occurred.

Agricultural BACM Assessment

For agricultural sources, BACM is more commonly referred to as Best Management Practices (BMPs). A variety of management practices to control wind erosion and associated PM_{10} emissions were one of the expected outcomes of the Columbia Plateau PM_{10} Project. To qualify as a BMP, the practice must be proven to reduce wind erosion significantly below that which would occur with bare and tilled soil under similar weather conditions. Meteorological and climatological conditions strongly affect effective wind erosion or dust control on agricultural lands. Maintaining soil stability on agricultural fields is a problem in the Tri-Cities region principally during the most vulnerable times, such as crop planting and harvesting, or for other tillage operations that leave the soil vulnerable to wind erosion.

In the 2003 NEAP, Washington State found that BACM is implemented throughout the Columbia Plateau, which includes Benton County. Washington State evaluated BACM implementation for agricultural fields using Core 4 data. The Core 4 data shows 68% of total farmable acres of the Columbia Plateau are either part of a USDA conservation program, use one of several minimum till practices, or have 15 to 30% residue on the soil. Based on this evaluation, Washington State views these levels of wind erosion control as sufficient to fulfill BACM criterion of the Natural Events Policy.

In addition to currently implemented BACM there are on-going efforts to enhance wind erosion controls on the Horse Heaven Hills in Benton County. A $65,000 grant from EPA has made it possible for the Washington Department of Ecology to contract with the Benton Conservation District to carry out a project as an extension of the Columbia Plateau Wind Erosion/Air Quality Project (formerly CP3). The goals of the project are: 1) To provide immediate, temporary treatment to critical areas and 2) To promote other options for longer term or permanent wind erosion control measures. Specifically, a new six-bale Newhouse straw mulcher was purchased to apply straw on highly erodible areas. During parts of the last two cropping cycles, approximately 700 tons of surface residue was applied to protect against the occurrence of windblown dust from these areas. Conservation Reserve Program (CRP) acres have also increased over 100% since the latest USDA CRP signup, which brings the total CRP acres in the Horse Heaven Hills to 25,136 acres.

SUMMARY AND CONCLUSIONS

From the evidence presented, the following conclusions can be drawn:

1. The Tri-Cities area and outlying agricultural areas were subjected to high wind speeds on 10-Nov-2003.

2. Agricultural fields, which were highly susceptible to wind erosion during the 10-Nov-2003 wind events, included fallowed wheat fields, recently planted winter wheat fields, and recently harvested irrigated potato fields with insufficient crop residue were blowing most severely.

3. The combination of the wind event, which had the necessary wind speed, duration, and direction to generate and transport PM_{10}, and the vulnerable landscape, caused the 10-Nov-2003 exceedance. Although the agricultural fields have BACM applied, there were certain conditions present including residue due to extended drought and recent wheat planting – that allowed the wind to overcome BACM. In addition, any unprotected area of soil surface at construction sites or elsewhere in the landscape would have had potential to contribute to the exceedance.

4. In light of the previous statements and the acknowledgment that the Columbia Plateau is, in general, highly susceptible to high wind events, show that windblown dust is the most probable source of the PM_{10}.

5. Based upon these conclusions, the BCAA considers the PM_{10} concentration recorded on 10-Nov-2003 to have been caused by a high wind natural event and requests that the data for this date be flagged as such in the AIRS database.

ABBREVIATIONS AND ACRONYMS

BACM................Best Available Control Measures

BMP ....Best Management Practices

SLAMS..............State and Local Air Monitoring Station

EPA...................U.S. Environmental Protection Agency

BCAA ....Benton Clean Air Authority

BFWWCAPCA ..Benton Franklin Walla Walla Counties Air Pollution Control Authority, renamed BCAA in 1995

MET...................Meteorological

NAAQS.............National Ambient Air Quality Standard

PM_{10}..................Particulate Matter, 10 microns in diameter

Ecology ....Washington State Department of Ecology

PST ....Pacific Standard Time

NEP...................Natural Events Policy

NEAP ....Natural Event Action Plan

MOA..................Memorandum of Agreement

RACM................Reasonably Available Control Measures

FDP...................BCAA Fugitive Dust Policy

HMN..................Hanford Meteorological Network

PAWS................Public Agricultural Weather System operated by Washington State University

CFR...................U.S. Code of Federal Regulations

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APPENDICIES

Appendix A

Table A1: Daily PM_{10} Concentration (ug/m^3) for 2002

STATION:	KENNEWICK, VSC	POLLUTANT:	PM10	YEAR:	2002
SITE #:	0340003J	POLLUTANT CODE:	81102	DECIMAL POS.:	0
PROJECT	1	METHOD:	63	UNITS:	µg/m³

CA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	MAX	NO
1	12	6	20	18		17	12	42	21	15	33	13	19.0	42.0	11
2	8	15	18	20	149	14	18	25	28	25	36	11	30.6	149.0	12
3	14	9	16	24	18	20	35	24		12	38	13	20.3	38.0	11
4	11	13	48	29	21	19	12		23	13		16	20.5	48.0	10
5	15	19	51	34	68	67	15	16	27	13	51	21	33.1	68.0	12
6	13	21	9	30	11	12	20	25	24	9	56	6	19.7	56.0	12
7		7	12	11	12	16	41	19	38	16	63	11	22.4	63.0	11
8	4	4	9	23	17	9	17	21	14	21		15	14.0	23.0	11
9	15	9	13	28	15	6	20	23	27	17	7	18	16.5	28.0	12
10	19	11	12	17	17	10	26	16	34	15	4	12	16.1	34.0	12
11	21	7		8	19	11	39	29	37	16	9	11	18.8	39.0	11
12	19	15	17	26	24	20	35	28	45	26		15	24.5	45.0	11
13	11	18	9	56	68	28	65	26	37		8	10	30.5	68.0	11
14	12	26	7	22	13	30	37	29			14		21.1	37.0	9
15	17	16	10		18	27	25	34	62	39	24	5	25.2	62.0	11
16	12	16	5	23	28	44	34	186	40	42	43	24	41.4	186.0	12
17	18	24	12	8	25	14	31	89	14	49	9	12	25.4	89.0	12
18	14	24	12	12	14	15	29	19	16	58	9	10	19.3	58.0	12
19	2		72	13	17	11	26	34	29	36	81	14	30.5	81.0	11
20	12	14	20	13	12	23	32	20	19	15	14	10	17.0	32.0	12
21	2	16	22	57	11	25	31	14	21	26	23	4	21.0	57.0	12
22	7	13		57	15	29		18		36	22	11	23.1	57.0	9
23	9	5	26	16	12	24	78	21		32	12	18	23.0	78.0	11
24	10	10	18	19	18		56	27	50	41	12	16	25.2	56.0	11
25	5		10	31	21	28	50	39	29	45	21	19	27.1	50.0	11
26	2	13	23	29	12	34	49	15	49	40	28	8	25.2	49.0	12
27	6	27	33	5	14	46	30	29	24	51	28	7	25.0	51.0	12
28	12	14	37		6	16	39	31	19	28	23	2	20.6	39.0	11
29	12		12		11	17	22	38		52	25	2	21.2	52.0	9
30	15		13	22	13	10	52	75	11	12	14	5	22.0	75.0	11
31	5		27		19		35	26				7	19.8	35.0	6
AVG	11.1	14.3	20.4	24.1	23.9	22.1	33.7	34.6	29.5	28.6	26.2	11.5	23.3		
MAX	21.0	27.0	72.0	57.0	149.0	67.0	78.0	186.0	62.0	58.0	81.0	24.0		186.0	
DAYS	30.0	26.0	29.0	27.0	30.0	29.0	30.0	30.0	25.0	28.0	27.0	30.0			341

Table A2: Daily PM_{10} Concentration (ug/m^3) for 2003

STATION:	KENNEWICK, VSC	POLLUTANT:	PM10	YEAR:	2003
SITE #:	0340003J	POLLUTANT CODE:	81102	DECIMAL POS.:	0
PROJECT	1	METHOD:	63	UNITS:	µg/m³

CA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	MAX	NO
1	8	5	22	10	11	16	23	32	36	48	40		22.8	48.0	11
2	12	5	17	6	21	25	18	26	58	49	26		23.9	58.0	11
3	7			32	28	24	24	21		56	17		26.1	56.0	8
4	5	13	11	11	33	25	21	47	75	53	22		28.7	75.0	11
5	6	21	186	10	14		20	45	49	47	40		43.8	186.0	10
6	13	26	126	4	13	34		19	86	59			42.2	126.0	9
7	11	27	21	10	17	27		18		19	39		21.0	39.0	9
8	12	20	7	16	18	36	36	16	15	84	37		27.0	84.0	11
9	11	22	33	13	20	27	27	80	13	30	32		28.0	80.0	11
10		22	17	17	17	33		15	29	14	164		36.4	164.0	9
11	14	20	34	7	15	19	42	14	5	16			18.6	42.0	10
12	14	18		11	13	28	69	16	16	138			35.9	138.0	9
13	14	16	60	9	16	37	25	30	22				25.4	60.0	9
14	13	22	19		34	15	22	34	27	14			22.2	34.0	9
15	9	17		9	39	17	30	62		13			24.5	62.0	8
16	12	4			8	28	25	41	54	1			21.6	54.0	8
17		4		11	9	34	22	17	14	15			15.8	34.0	8
18	10		12	7	9	65	29		24	23			22.4	65.0	8
19	12	15	10	15	14	50	33	50	81				31.1	81.0	9
20	6	14	36	14	18	17	23	41	20	22			21.1	41.0	10
21		9	6	13	16	20	25	54		14			19.6	54.0	8
22	5	5	9	17	27	9	43	40	33	42			23.0	43.0	10
23	12	10	11	16	72	16	36	21	36	22			25.2	72.0	10
24	19	14	11	15	24	19	39	16	43	22			22.2	43.0	10
25	21	27		4	13	22	34		40	24			23.1	40.0	8
26	4	25	19	2	9	30	35	31	45	27			22.7	45.0	10
27	6	25	16	3	10	22	29	17	41				18.8	41.0	9
28	9	19	13		22	22	37	24	38	1438			180.2	1438.0	9
29	10		14	5	21	32	40	55	61	40			30.9	61.0	9
30	11		20	5	28	43	44	45	55	126			41.9	126.0	9
31	6		29		17		35	40		39			27.7	40.0	6
AVG	10.4	16.3	30.4	10.8	20.2	27.3	31.6	33.3	39.1	89.1	46.3	--	31.4		
MAX	21.0	27.0	186.0	32.0	72.0	65.0	69.0	80.0	86.0	1438.0	164.0	--		1438.0	
DAYS	28.0	26.0	25.0	27.0	31.0	29.0	28.0	29.0	26.0	28.0	9.0	0.0			286

Table A3: Hanford Precipitation Data

	Actual	Normal	Difference
June-02	0.65	0.41	0.24
July-02	0.16	0.27	-0.11
August-02	0.01	0.27	-0.26
September-02	0	0.33	-0.33
October-02	0.12	0.49	-0.37
November-02	0.38	0.98	-0.6
December-02	2.36	1.11	1.25
January-03	1.87	0.87	1
February-03	0.82	0.68	0.14
March-03	0.26	0.58	-0.32
April-03	2.23	0.44	1.79
May-03	0.08	0.55	-0.47
June-03	0	0.41	-0.41
July-03	0	0.27	-0.27
August-03	0.46	0.27	0.19
September-03	0.24	0.31	-0.09
October-03	0.07	0.49	-0.42
November-03	0.15	0.98	-0.83