DEPARTMENT OF
ECOLOGY
State of Washington

2013 Exceptional Event Demonstration

PM_{10} Exceedances due to High Winds at Kennewick

"Sunday Night Dust Storm," 9/15/2013

by Heather Wegant, published on nbcrightnow.com

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Acronyms and Abbreviations

AAQ ..... Affects Air Quality
AQS..... Air Quality System
ARS..... Agricultural Research Service
BACM..... Best Available Control Measures
BCAA .....Benton Clean Air Authority
BCD .....Benton Conservation District
BLM.....Bureau of Land Management
BMP ..... Best Management Practices
BPKEN .....Bonneville Power's Kennewick monitor
BPHOR .....Bonneville Power's Horse Heaven Hills monitor
CAA .....Clean Air Act
CCR .....Clear Causal Relationship
CFR ..... Code of Federal Regulation
CP3 .....Columbia Plateau PM10 Project
CRP..... Conservation Reserve Program
CSP .....Conservation Security Program
CTIC ..... Conservation Technology Information Center
EER .....Exceptional Events Rule
EPA..... U.S. Environmental Protection Agency
EQIP.....Environmental Quality Incentives Program
FEM .....Federal Equivalent Method
FRM .....Federal Reference Method
FSA .....Farm Service Agency
GIS .....Geographic Information System
GMT..... Greenwich Mean Time
HAURL..... Human Activity Unlikely to Recur at a Particular Location
HEL..... Highly Erodible Land
HELC.....Highly Erodible Land Compliance
HF .....Historical Fluctuations
HHH .....Horse Heaven Hills
KENMETA .....Monitoring Station at Kennewick, Metaline Avenue
MODIS .....Moderate Resolution Imaging Spectroradiometer
mph ..... miles per hour
nRCP .....Not Reasonably Controllable or Preventable
NAAQS .....National Ambient Air Quality Standards
NAMS .....North American Mesoscale (forecast system model)
NCDC .....National Climatic Data Center
NASS .....National Agricultural Statistics Service

NEAP .....Natural Events Action Plan
NEBF .....No Exceedance 'But For' the event
NEP ..... Natural Events Policy
NSR..... New Source Review
NOAA ..... National Oceanic and Atmospheric Administration
NRCS .....Natural Resources Conservation Service
NWS ..... National Weather Service
PDSI..... Palmer Drought Severity Index
PDT .....Pacific Daylight (Savings) Time
PM .....Particulate Matter
PM_{10} ..... Particulate matter with an aerodynamic diameter of less than 10 micrometers
$PM_{2.5}$ ..... Particulate matter with an aerodynamic diameter of less than 2.5 micrometers
PST .....Pacific Standard Time
RACM .....Reasonably Available Control Measures
RAWS .....Remote Automated Weather System
SLAMS .....State and Local Air Monitoring Station
TEOM .....Tapered Element Oscillating Microbalance
USDA ..... United States Department of Agriculture
UTC.....Coordinated Universal Time
WAC .....Washington Administrative Code
WRAP ..... Western Regional Air Partnership
WSU ..... Washington State University

Difference Between Public Comment Draft and Final Draft

The following are the clarifying or clerical corrections made to the public comment draft version.

- Public Process Information was added as Appendix I.
- Comments and Response to Comments was added as Appendix J.
- Text correction in 1st paragraph on page 23; corresponding correction to Footnotes 33 and 122. See Ecology's Response to Ginger Wireman for details.
    - Text added to page 23: *Land in Farms not the same as Total Farmable Acres. Steve Anderson with the National Agricultural Statistics Service (NASS) says Total Cropland is likely the most similar to Land In Farms.*
    - Benton County Zoning text correction on page 23:

      To further demonstrate the dominance of agricultural activity in Benton County, Figure 8 below shows that a majority of the land in the county is zoned for agriculture. Agriculture zoning is denoted by the green shading covering more than half of the county. *According to the 2014 National Agricultural Statistics*

Service, Benton County has ~~703,505~~ 519, 123 acres or 50% ~~65%~~ of its land classified as Total Cropland.

- Footnote 33 text correction on page 23 to replace acres of Land In Farms with Total Cropland acre values.

  Tom Vilsack, Secretary, National Agricultural Statistics Service, Cynthia Z.F. Clark, Administrator United States Department of Agriculture, *2012 Census of Agriculture*, issued May 2014, ~~705,505 (land in farms from 2012 Ag Census) /1,036,975 (acres in Benton county) = 65%.~~ *519,123 (Total Cropland from 2012 Ag Census)/1,036,975 = 50% of land as farms.* (Land In Farms includes include pasture, woodland, farmsteads, waste, etc.)

- Footnote 122 correction on page 102.

  Text added: *Total farmable acres is likely most similar to Total Cropland Acres, according to Steve Anderson from the National Agricultural Statistics Service, email "definition of Total Cropland please?" 11/23/2015.*

- Corrected references on page 105, Information in the bullet points on this page came from either the main document, NRCS-CEAP's *Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Pacific Northwest Basin*, July 1, 2014, or the *Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Pacific Northwest Basin - Summary of Findings*, June 2014.
  - footnote 128 came from page 24 in the main document: moved footnote 128 to the end of bullet point 1
  - new footnote 129 corresponds to page 7 in the main document
  - new footnote 130 comes from Table 14 on page 51 in the main document
  - new footnote 131 comes from page 9 in the Summary of Findings document
  - Rest of footnotes reordered

Executive Summary

Several high wind events caused particle pollution (particulate matter) to exceed national air quality standards in Kennewick in the fall of 2013. We are required to document these events and ask for EPA's agreement that the values were caused by natural events and shouldn't count against the area. Agricultural lands were identified as the main source of the dust. Voluntary federal programs are relied upon to control dust from farming.

The three unusual weather events created strong, high speed winds that caused dust storms that impacted Eastern Washington. These storms triggered National Weather Service warnings and media reports throughout the region. These winds overwhelmed the many existing erosion control measures and caused the three air quality exceedances on September 15, October 28, and November 2, 2013.

The 24-hour National Ambient Air Quality Standard (NAAQS) for coarse particulate matter or PM_{10} is 150 micrograms per cubic meter ($\mu g/m^{3)}$, and cannot be exceeded on more than three days over a three-year period. An exceedance of this health-based standard occurs when a monitor logs a value above 150 $\mu g/m^3$; a violation occurs when the standard is exceeded more than three times in three years. PM_{10} – or particulate matter ten microns or less – are particles smaller than the diameter of a human hair <*http://airnow.gov/index.cfm?action=aqibasics.particle*>.

During these events, the Kennewick monitor on Metaline Road recorded unusually high amounts of particle pollution. In fact, the amount of pollution generated by these three events was more than is allowed — an exceedance —of federal air quality laws for coarse particulate matter or $PM_{10.}$ The PM_{10} standard focuses on smaller particles since these are likely to be responsible for harmful health effects because of their ability to reach the deep into the lungs.

The federal Exceptional Event Rule (EER) allows qualifying air monitoring data that exceeds the standards because of natural events to be flagged specially in the official record. If the events qualify, the high pollution values caused by the natural event can be coded so they do not count against the area's compliance record. EPA must agree with our analysis before the values can be discounted. Without EPA agreement, Kennewick could be in violation of the standard, which would have impacts on business air quality permitting and other consequences for the area. Because the exceedances occurred due to natural events, it's important to document them appropriately.

This Exceptional Event demonstration:

- Provides detailed information about the large regional wind/dust storms that caused the excessive air pollution.
- Presents evidence that the elevated particulate matter or PM_{10} values measured in Kennewick were due to regional natural events that overwhelmed dust controls.
- Describes how the events qualify under the EER.

Dust generated from farming, roads, and construction sites poses a hazard to motorists, reduces soil productivity, and pollutes air in downwind communities. Particle pollution can cause respiratory health issues, especially for children and the elderly. Eastern Washington's Columbia Plateau is highly susceptible to windblown dust because of its semi-arid nature and it's very fine soils. Agriculture is the dominant activity on the Columbia Plateau. Farm lands in Washington and Oregon were identified as the likely main source of dust for these events.

The way to control soil erosion from agricultural activities is through incentive-based conservation programs overseen by the United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS). Growers take precautions, when appropriate and feasible, and engage in conservation practices year round. But, there are key times and stages in crop cycles where lands are vulnerable to soil erosion by high winds. Drought and soil conditions in the months leading up to the events contributed to the vulnerability of the soil to erosion.

Ecology evaluated the agricultural control measures in place, found them to be reasonable and concluded that if these events had not happened, the exceedances would not have occurred. Ecology determined that despite the fact that 'reasonable and appropriate' controls were in place for agriculture, the winds from these three events overwhelmed these controls and caused the three air quality exceedances.

We ask EPA to agree with our assessment and exclude the PM_{10} values for September 15, October 28 and November 2, 2013, when making compliance determinations for Kennewick, Washington.

1 Introduction

Three exceedances of the federal PM_{10} standard occurred in the fall of 2013 in Kennewick, Washington. This document presents evidence — and requests EPA's concurrence — that the events described qualify for treatment under the Exceptional Event Rule (EER). EPA's concurrence with this demonstration will allow these values to be excluded from regulatory compliance determinations for the area.

Thunderstorms created the high winds that caused the elevated particulate matter concentrations observed in Kennewick on these days.

Kennewick is one of the Tri-Cities, located with Pasco and Richland, on Eastern Washington's Columbia Plateau. The Columbia Plateau includes most of Washington — Adams, Grant, Benton, Franklin, Douglas, Walla Walla and Lincoln counties — and some of western Idaho.

The Kennewick, Metaline monitoring station (AQS site number 53-005-0002, POC 3) was the monitor that recorded the exceedances. The days and concentrations that exceeded the 24-hour PM_{10} NAAQS in 2013 are:

Dates (2013)	*Values, µg/m³*
September 15	227
October 28	224
November 2	620

The 24-hour National Ambient Air Quality Standard (NAAQS) for PM_{10} is 150 µg/m³, not to be exceeded more than three times over a three-year period. An exceedance of the 24-hour standard occurs when an official monitor logs a value above 150 µg/m³; a violation occurs when the standard is exceeded more than three times in a three year period.

The dominant land use and source of PM_{10} in the area is agriculture. Growers use incentive-based National Resource Conservation Service (NRCS)[1] practices to mitigate

[1] The Natural Resources Conservation Service (NRCS) helps people help the land through scientifically based, locally led voluntary conservation efforts and improve natural resources on private lands. NRCS work results in productive lands and a healthy environment through reduced soil erosion; water and air quality; energy conservation; restored woodlands and wetlands; enhanced fish and wildlife habitat; and reduced upstream flooding. < http://www.usda.gov/documents/about-usda-quick-reference-guide.pdf>.

soil erosion. Drought and soil conditions in the Columbia Plateau in the months leading up to the events, contributed to the vulnerability of the soil to erosion. Because of the sequence of weather events and the drought in the area leading into the fall of 2013, agriculture fields were unusually vulnerable. These three events impacted much of the region and overwhelmed controls on agricultural lands.

An exceptional event is defined as a 'natural event' in which human activity plays little or no direct causal role.[2] A high wind event is a type of natural event that can cause air pollution exceedances.[3] Exceptional events can be caused by or contributed to by human activities that are unlikely to recur at a particular location. Events may recur, even frequently, and still be considered natural events[4] that qualify for exclusion under the Exceptional Event Rule (EER).

The EER was finalized in 2007.[5] This rule was developed so that exceedances of air quality standards would be appropriately represented in the official record so adequately controlled areas will not be unfairly penalized for events beyond their control. The event must meet the requirements of the rule to be excluded from compliance determinations. The EER provides criteria and a process for states and EPA to follow for these circumstances. Events must meet the requirements of the rule for the data to qualify for exclusion.

In the late 1980s, Wallula (near Kennewick), parts of Spokane, and Yakima were in violation of the PM_{10} NAAQS. Actions taken by growers to reduce soil erosion helped these areas to return to compliance with the standard by 2001.

In 1998, Ecology developed the *Columbia Plateau Windblown Dust Natural Event Action Plan* (NEAP) to address windblown dust issues for this part of the state. Ecology's NEAP describes conservation programs and practices that reduce or minimize wind erosion. The USDA programs— supplemented by incentive based wind-erosion conservation practices. — are the best available control measures (BACM) and the best management practices (BMPs) for agriculture.[6]

Ecology's NEAP describes the extensive research by WSU and their partners and documents the conditions when controls can be overwhelmed. Ecology relied upon the

[2] 72 FR 13563
[3] 72 FR 13565
[4] 72 FR 13566
[5] 72 FR 13560, March 22, 2007
[6] Ecology, Natural Events Action Plan, 2003 Update, <https://fortress.wa.gov/ecy/publications/publications/0302014.pdf >, 2003; 1998 NEAP provided as Appendix C, March 1998.

research efforts of WSU and their partners and NRCS conservation practices in developing the NEAP.

Ecology requests that EPA concur with our determination that these events qualify as exceptional events under the EER and should be excluded from calculations when determining compliance with the PM_{10} standard for Kennewick, and nearby Wallula, Washington.

1.1 Document Contents

This document's content and structure is as follows:

- Section 1. Introduction – provides brief explanations of the purpose of the document, PM_{10} standard, exceptional event rule and the three exceedances
- Section 2. Regional Information – Area, Climate and Soils – provides geographic characteristics of the area, climate and soils information
- Section 3. Monitoring Locations – provides detail for monitoring stations used in the analysis
- Section 4. Sources – provides review of potential sources and rationale for Ecology's conclusion that agricultural sources were the largest contributing sources
- Section 5. Event Day Summaries – includes details of the events, conceptual models, monitoring and meteorological data
- Section 6. Exceptional Event Rule criteria – lists criteria, shows how events meet rule criteria, Natural Resource Conservation Service (NRCS) controls
- Section 7. Conclusion – reviews evidence, requests EPA concurrence
- Section 8. Bibliography – list sources consulted, cited
- Section 9. Appendixes – contains more detail and supporting information for each Event Day, meteorological data, media and warnings, agriculture background information and Washington Natural Events Action Plan updates

1.2 Exceptional Events Rule Requirements

The Treatment of Data Influenced by Exceptional Events, known as the Exceptional Events Rule was finalized in 2007.[7] This rule was developed so that air quality data is appropriately represented in the official record – EPA's Air Quality Data System (AQS)[8] — and adequately controlled areas are not unfairly penalized for events beyond their control.

[7] 72 FR 13560, March 22, 2007
[8] <http://www.epa.gov/ttn/airs/airsaqs/>

Technical elements:

- The event is not reasonably controllable or preventable;
- There is a clear causal relationship between the measurement and the event;
- There is evidence that the event concentration is in excess of normal historical fluctuations, including background;
- The event affects air quality– is a combination of historical fluctuation and clear, causal relationship;
- The event was caused by human activity unlikely to recur at a particular location, or was a natural event; and
- The exceedances or violation would not have occurred 'but for' the event.

States must fulfill the following procedural requirements:

- Flag data in EPA's Air Quality System (AQS) before July 1 of the year following the exceedance;
- Provide opportunity for public comment; and
- Submit the demonstration by the deadlines in the rule.

EPA evaluates the exceptional event demonstration to make sure that it fulfills EER requirements based on a weight of evidence. More detail on EER requirements and how the Kennewick events meet the criteria are in Section 5.

2 Regional Information: Area, Climate, Soils

2.1 Geographic Setting

The three regional events affected eastern Washington's Columbia Plateau. Two of the events came from Oregon; one from Montana. The exceedances were recorded by the monitor at Kennewick in Benton County. Kennewick is located in the Columbia Basin of Washington State and, together with Pasco and Richland, forms the metropolitan area known as the Tri-Cities. This metropolitan area straddles Benton and Franklin counties.

Figure 1 shows the Washington's portion of the Columbia Plateau – a 50,000 square mile region covering eastern Washington, northeastern Oregon, and the Idaho panhandle.

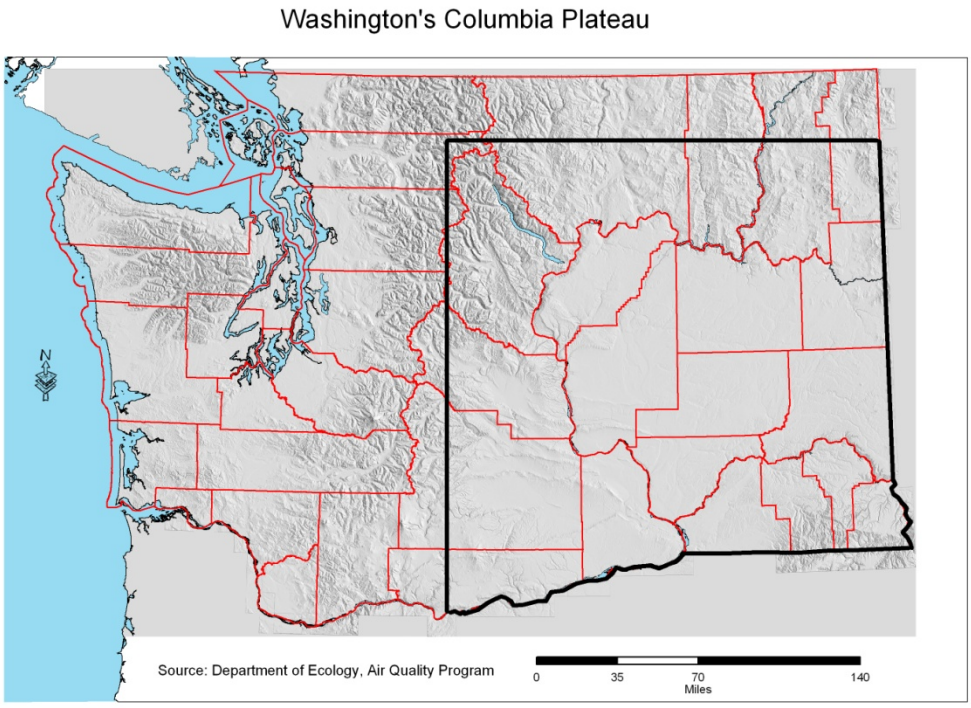

Figure 1. Eastern Washington's Columbia Plateau

The Columbia Plateau contains one of the driest as well as the most productive rainfed wheat regions in the world. The Columbia Plateau, and its irrigated counterpart, the

Columbia Basin are defined by the U.S. Department of Agriculture as Major Land Resource Areas.[9]

The Washington portion of the Columbia Plateau includes most of the eastern Washington counties. During the development of Washington's Natural Event Action Plan in the late 1990s, the counties initially identified as the five priority counties most susceptible to wind erosion were Adams, Douglas, Franklin, Grant, and Lincoln. Benton and Walla Walla counties were added later, bringing the total of priority counties to seven.

Two of the events came from southwest of Kennewick from central to northeastern Oregon. This area is also dominated by agricultural activity. Since Washington does not have authority over Oregon sources, it is appropriate that this demonstration focus on Washington's Columbia Plateau.

Geographic Area: The Plateau includes nearly 500 miles of the Columbia River, as well as the lower reaches of major tributaries, which includes the Snake and Yakima rivers and the associated drainage basins. The arid sagebrush steppe and grasslands of the region are flanked by moister, predominantly forested, mountainous ecoregions on all sides.

This area occupies about 500 square miles in Benton County. Upper parts of the Plateau are generally planted in dryland wheat and use a summer fallow system;[10] lower parts of the plateau include more irrigated farmland.[11]

South and east of Kennewick lay the Horse Heaven Hills, a dominant feature of the area. The Horse Heaven Hills rise abruptly from the Yakima Valley. They then slowly drop to the southeast and gradually slope to the Columbia River on the south and the Cascades on the west. To the east, lie the Rattlesnake Hills.

Figure 2 shows Eastern Washington, including the Tri-Cities, topographical elements and the Kennewick monitoring site.

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[9] Saxton, Chandler and Schillinger, Pacific Northwest Major Land Resource areas, B7 and B8, *Wind Erosion and Air Quality Research in the Northwest U.S. Columbia Plateau: Organization and Progress*, 1999.

[10] See page 27, "Times when fields are vulnerable", for more on the summer fallow system.

[11] A.E. Kocher, Field Operations Bureau of Soils, *Soil Survey of Benton County, Washington*, 1916.

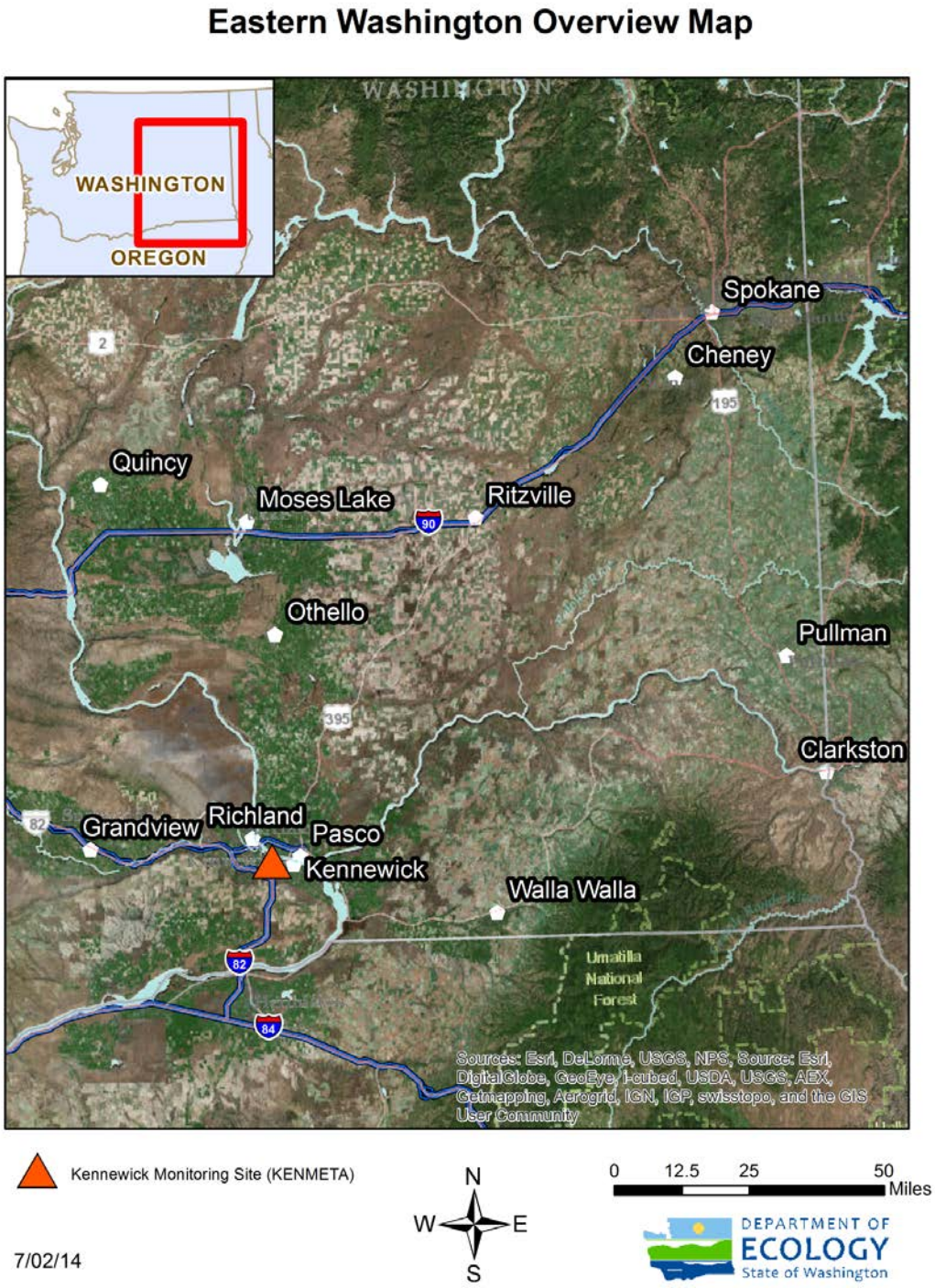

Figure 2. Eastern Washington Overview Map

2.2 Climate

Because the eastern half of Washington State lies in the rain shadow of the Cascade Mountains, the region is a semi-arid desert.

Average annual precipitation in this region ranges from 10 to 12 inches to below 8 inches. About 60 to 70% of annual precipitation occurs between November and April. During the summer, high pressure systems dominate, which create warm, dry conditions and low relative humidity. The mean annual temperature is approximately 48° F, and the frost-free season is about 140 days.[12]

The terrain coupled with prevailing south and west winds limit local stagnant air pollution by ventilating the area. However, this coupling can also produce some extraordinary wind speeds and patterns. These winds can produce significant wind erosion events that can impact the Tri-Cities area with dust from vulnerable agricultural fields and natural areas.

Figure 3 shows the irrigated and dryland cropping areas and denotes the three average annual precipitation zones on the Columbia Plateau.[13] The three zones are:

- low–less than 12 inches of precipitation;
- intermediate–12 to 18 inches of precipitation; and,
- high–18 to 24 inches of precipitation.

[12] U.S. Department of Agriculture-NRCS, Washington Annual Precipitation, 1961-1990.
[13] W.F. Schillinger, R.I. Papendick and D.K. McCool. 2010. Soil and water challenges for Pacific Northwest Agriculture. Soil and Water Conservation Advances in the United States. SSSA Special Publication 60. T.M. Zobek and W.F. Schillinger (eds.).

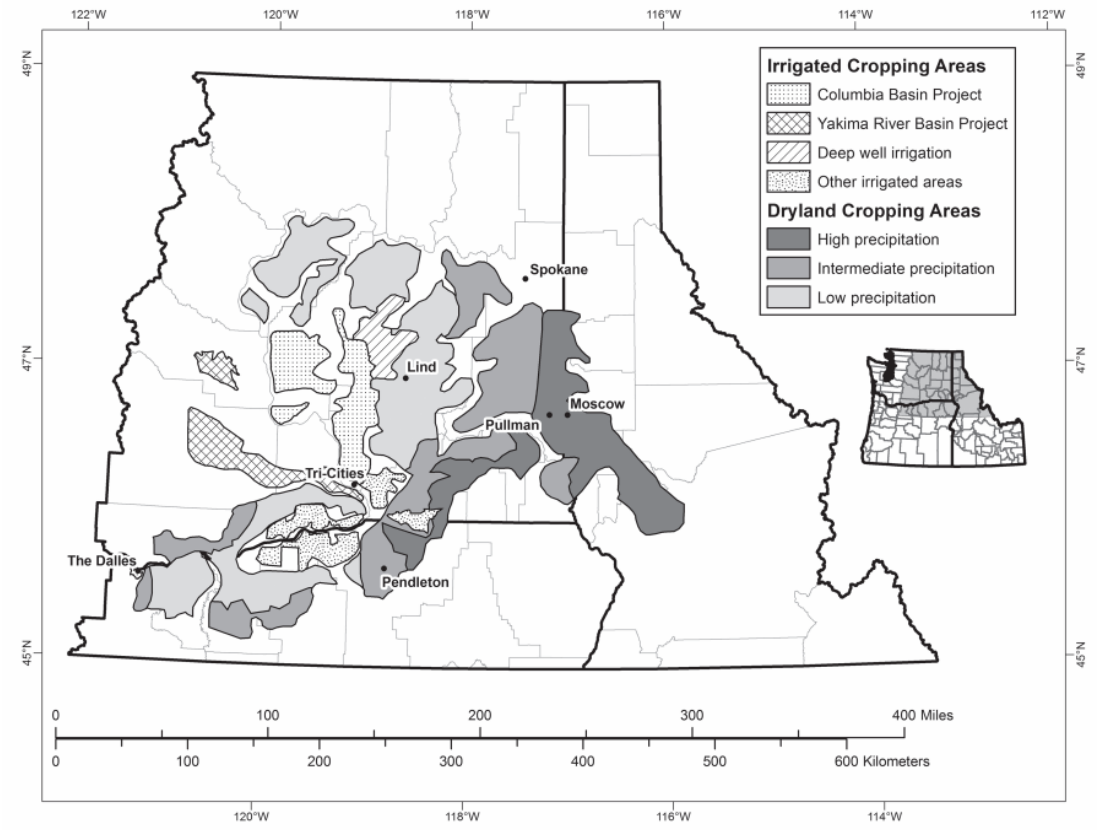

Figure 3. Columbia Basin Precipitation Zones

The areas noted to the southwest of the Tri Cities and to the northeast — the sources of the three high wind events — fall in the low precipitation zone.[14]

Benton County: Benton County — the driest of the Columbia Plateau counties — receives approximately 6 inches of precipitation at a 500-foot elevation and about 15 inches at 3,500 feet. Precipitation is generally gentle showers, but can also be light snow during the dormant season.

Benton County has both marine and continental characteristics. It is influenced by moist air moving in from the Pacific Ocean and by cold air moving southward from Canada. The weather systems are modified by the Rocky Mountains to the east and north and by the Cascade Mountains to the west. The summers are hot, and the winters are clear, dry and cold. Occasional cold snaps late in spring or early in fall can cause extensive damage to crops. In summer, the afternoon temperature can reach the nineties, and the nighttime

[14] W.F. Schillinger, R.I. Papendick and D.K. McCool, 2010. *Soil and water challenges for Pacific Northwest Agriculture. Soil and Water Conservation Advances in the United States*. SSSA Special Publication 60. T.M. Zobek and W.F. Schillinger (eds.).

temperature falls to about 60° F. In an average summer, the temperature exceeds 90° on 50 to 60 days and 100° on 8 to 12 days. The relative humidity ranges from approximately 50 percent at sunrise to about 25 percent in the afternoon.

Drought and lack of precipitation are key factors contributing to the conditions leading into the fall of 2013. Those two elements are the ingredients for large dust storms. Parts of Washington and Oregon were in exceptional to severe drought, according to the U.S. Drought Monitor.[15] See drought and precipitation maps and more information in the Common Factors section.

2.3 Soils

The Columbia Plateau soils erode easily. The dominant soil type characteristics create very weak soil structure (lack of the ability to form clods), which results in breakdown of the soil into individual particles when mechanically disturbed from tillage, planting operations, or traffic. These soils break up easily since soil crusting forces are weak. Soils are the most susceptible when soil surface:

- is dry,
- has no surface vegetative cover and
- has been mechanically disturbed.

These soil characteristics coupled with low precipitation and high temperatures result in very dry soils that are highly susceptible to wind erosion.

2.3.1 Soil Classification and Characteristics:

A survey done by the NRCS in 1971 classified the soils in the Columbia Plateau and the Horse Heaven Hills as part of the Ritzville-Willis association. These fine-grained soils are excellent for farming; soils that are shallow, stony or steep are used for grazing. The underlying basalt on the Plateau is up to 2 miles (3 km) thick and partially covered by thick loess. Loess soils are fine -grained, windblown deposits, composed mainly of silt-sized particles and can be up to 40 inches deep.[16]

[15] Seasonal drought monitor, http://droughtmonitor.unl.edu/, May 16 to August 31, 2013.
[16] Jack J. Rasmussen, *Soil Survey Benton County Area, Washington*, July 1971, page 2, <http://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/washington/WA605/0/wa605_text.pdf>. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

Figure 4 below shows that the Ritzville Soil Series[17] covers not only Benton County but also the areas to the northeast and to the southwest of Kennewick, in northeastern Oregon. The darker color denotes a greater density of this soil type. Benton, Walla Walla, Franklin and Adams counties have the greatest density of these soils.

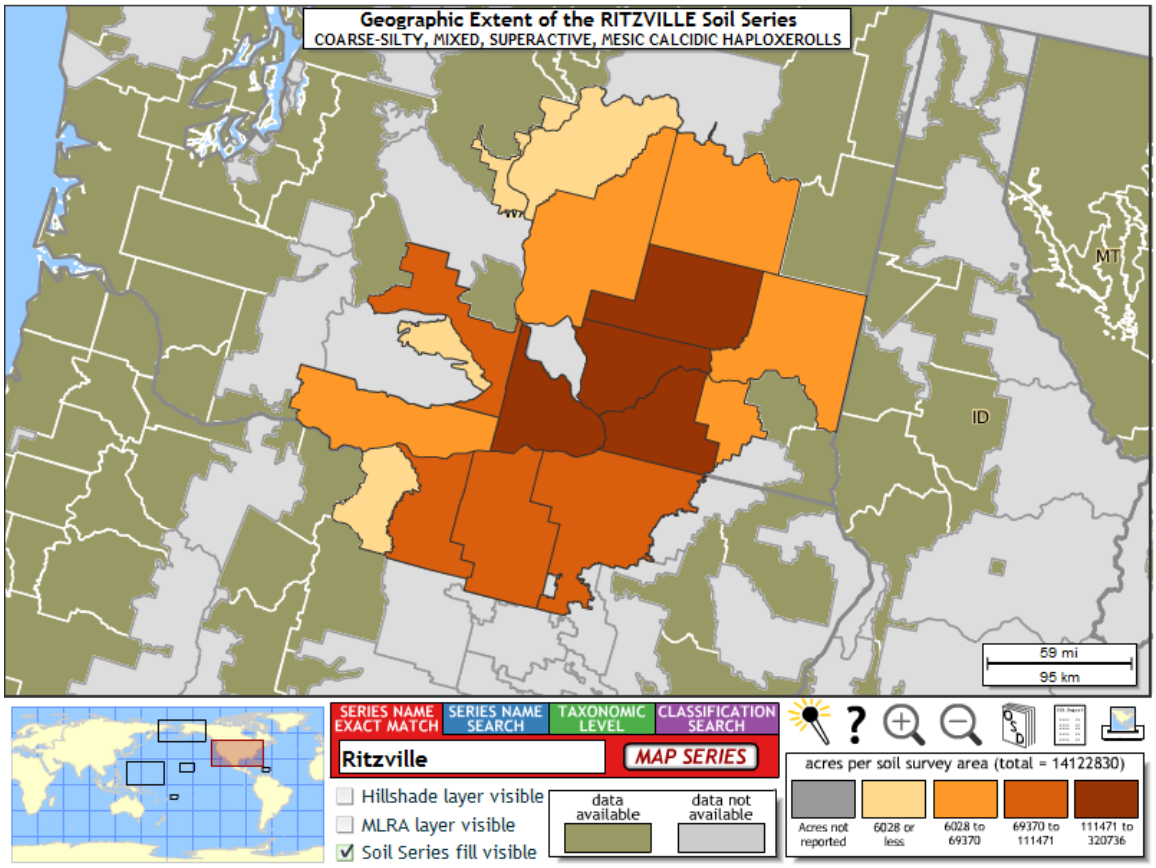

Figure 4. Geographic Extent of Ritzville Soils, USDA-NRCS Official Soil Series Descriptions

The light precipitation in Benton County rarely saturates the soils. Consequently, the amount of clay and other particles that moves downward in the soil is insufficient to form a strong lower horizon in the soil profile and therefore, unable to contribute to the stabilization of the soil column.[18]

[17] Soil Survey Staff, USDA-NRCS, *Official Soil Series Descriptions*, Conservation Service Soil Map," USDA-NRCS, Lincoln, NE. Accessed by Robin Priddy, October 1, 2014, <http://apps.cei.psu.edu/soiltool/semtool.html?seriesname=RITZVILLE>.
[18] Jack J. Rasmussen, *Soil Survey Benton County Area, Washington*, July 1971.

It is well established that the soils on the Columbia Plateau are extremely vulnerable to erosion (i.e., highly erodible land or HEL), making it a focus area of the NRCS. These areas are given more weight in ranking systems for grower eligibility for NRCS funding sources to apply soil erosion preventative measures.

2.3.2 Soil Entrainment Mechanisms

Wind erosion is a dynamic and highly complex process. In 2003, Ecology evaluated the scientific literature in order to refine a workable high wind event definition for an update to the Columbia Plateau Natural Event Action Plan (NEAP). Threshold velocity, gusts, previous moisture levels, soil types, crusts and transport of previously lofted material are all important factors to consider when developing a high wind definition. Ecology was particularly interested to find what wind speeds are sufficient to loft dust into the air (threshold velocity) in the Plateau.

Ecology's high wind definition as documented in the NEAP is described in the Controls Analysis Section 6.2.1. Essentially, a high wind event can occur when wind entrains and suspends dust and PM_{10} levels are elevated. Generally, this when the hourly wind speed at 10 meters is 18 mph or greater for two or more hours, or more than 13 mph, when conditions of higher susceptibility to wind erosion exists (see Appendix G, 2003 NEAP, Attachment A1).

Gusts: Short-term fluctuations contain significant amounts of wind energy not seen when using longer-term (hourly) averages.[19] The long-term mean wind speeds are generally much lower than the intermittent short-period gusts which actually produce the dust. This is particularly evident when considering wind speeds associated with meteorological events such as thunderstorms, microbursts and fast moving fronts. Wind speeds measured in five-minute increments may show 30-40^{+} mph gusts. However, the corresponding hourly average wind speed may be as low as 10 mph due to winds calming after the storm passes.

Precipitation and Soil Surface Stability: Precipitation prior to high wind events also affects soil vulnerability and wind erosion. Soil moisture is directly related to formation of surface crusts and surface crust strengths are related to wind erosion vulnerability.

If high winds overcome surface crust formation, they generate dust. The phenomenon of surface crust formation is directly related to variations in soil composition and moisture. The texture of a particular soil is determined by the relative amounts of sand, silt or clay in the soil. Generally, soils with high clay content tend to develop a stronger surface

[19] Stetler and Gaylord, 1999; Watson and Chow, 2001. Cited in Ecology's 2003 NEAP update, page A25.

crust than soils with low clay content. Sandy textured soils such as loamy sands and sandy loam can produce dust virtually regardless of moisture content because they do not form strong surface crusts.[20] Columbia Plateau soils are very fine and so have a weak surface crust.

Because of the preexisting drought conditions, previous winter wheat and cover crop kill, the soils of the Columbia Plateau were particularly susceptible to erosion from high winds in the fall of 2013.

3 Monitor Locations

The monitoring site that exceeded the standard was Kennewick's Metaline Avenue site. Other sites' meteorological and particulate measurements — such as sites operated by the Bureau of Land Management (BLM), Bonneville Power Administration (BPA), Hanford Meteorological Center[21], 25 miles NW of Richland, Washington, and airports Pasco (KPSC), Hermiston (KHRI), Spokane (KGEG) and Oregon Department of Environmental Quality (DEQ) sites— were used to evaluate the storm path and provide supporting information for the demonstration. Data from Washington State monitors can be accessed from Ecology's website.[22] All other meteorological data other than that from Ecology's network can be accessed on Utah's MesoWest site.[23] Oregon DEQ data for the named sites is available through EPA's AirData interface or registered users can query EPA's Air Quality System's (AQS) website.[24]

Kennewick Monitor: The Kennewick, Metaline monitoring site is located in Benton County at the Kennewick Skills Center, 5929 W Metaline, Kennewick, WA, (Lat 46.28135, Long 119.2152). This monitor is a Federal Equivalent Method (FEM) continuous ambient particulate Tapered Element Oscillating Microbalance monitor (TEOM)™, AQS site number 53-005-0002, POC 3, and measures midnight-to-midnight

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[20] D.A Gillette, T.R. Walker, T.R., 1977. *Characteristics of airborne particles produced by wind erosion of sandy soil, high plains of west Texas.*, Soil Science 123 97-110, 1977, cited by Ecology's Columbia Plateau Natural Events Action Plan, 2003, page A-24.

[21] Department of Energy's Hanford nuclear reactor facility meteorological station, <http://www.hanford.gov/page.cfm/hms/weatherCharts/Historical>, accessed July 14, 2015.

[22] <https://fortress.wa.gov/ecy/enviwa/Default.htm>, accessed July 1, 2015.

[23] For example, the download page < http://mesowest.utah.edu/cgi-bin/droman/download_ndb.cgi?stn=BPKEN&hour1=23&min1=27&timetype=LOCAL&unit=0&graph=0, from Bonneville Power's Kennewick site is accessed using its code: BPKEN. Replace the 5-digit station ID to get another station. Or you can select from the map.

[24] AirData <http://www.epa.gov/airquality/airdata/, accessed July 13, 2015; AQS <http://www.epa.gov/ttn/airs/airsaqs/>.

1-hour average PM_{10} concentrations. Since 2004, the site has also had meteorological equipment. This monitor is the official monitor for the Wallula maintenance area [25].

[25] Once the Burbank monitor was discontinued, the Kennewick monitor became the representative monitor for the Wallula maintenance area. Wallula was out of compliance with the 1987 PM_{10} standard but has been redesignated to attainment. The last Wallula maintenance plan was approved on August 26, 2005 (70 FR 50212).

Figure 5. shows Kennewick and its immediate surroundings, topographical elements and the Kennewick Monitoring Site (KENMETA).

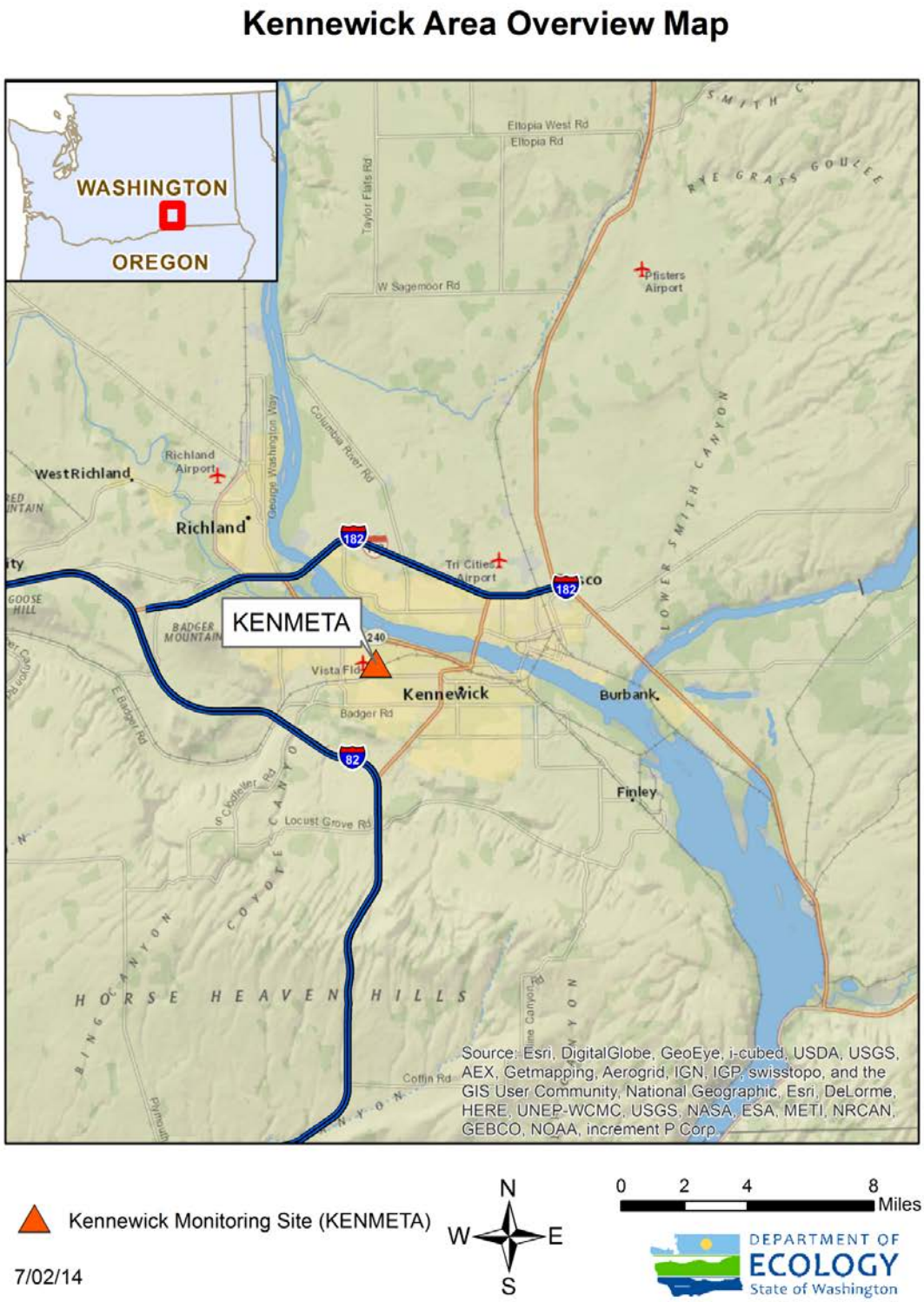

Figure 5. Kennewick area overview map

BPA and BLM monitors: Four regional meteorological monitoring sites operated by the Bonneville Power Administration (BPA) and the Bureau of Land Management (BLM) were compared to Kennewick to identify broader regional patterns in wind speeds during these high wind events. These sites are located in areas of agricultural land and open space between 10 and 50 miles from Kennewick. For each of the three events, at least one of these sites was located near the trajectory of the storms that reached the Kennewick monitor and can be considered reasonably representative of the dust entrainment area for that event. All sites are shown in the map in Figure 6.

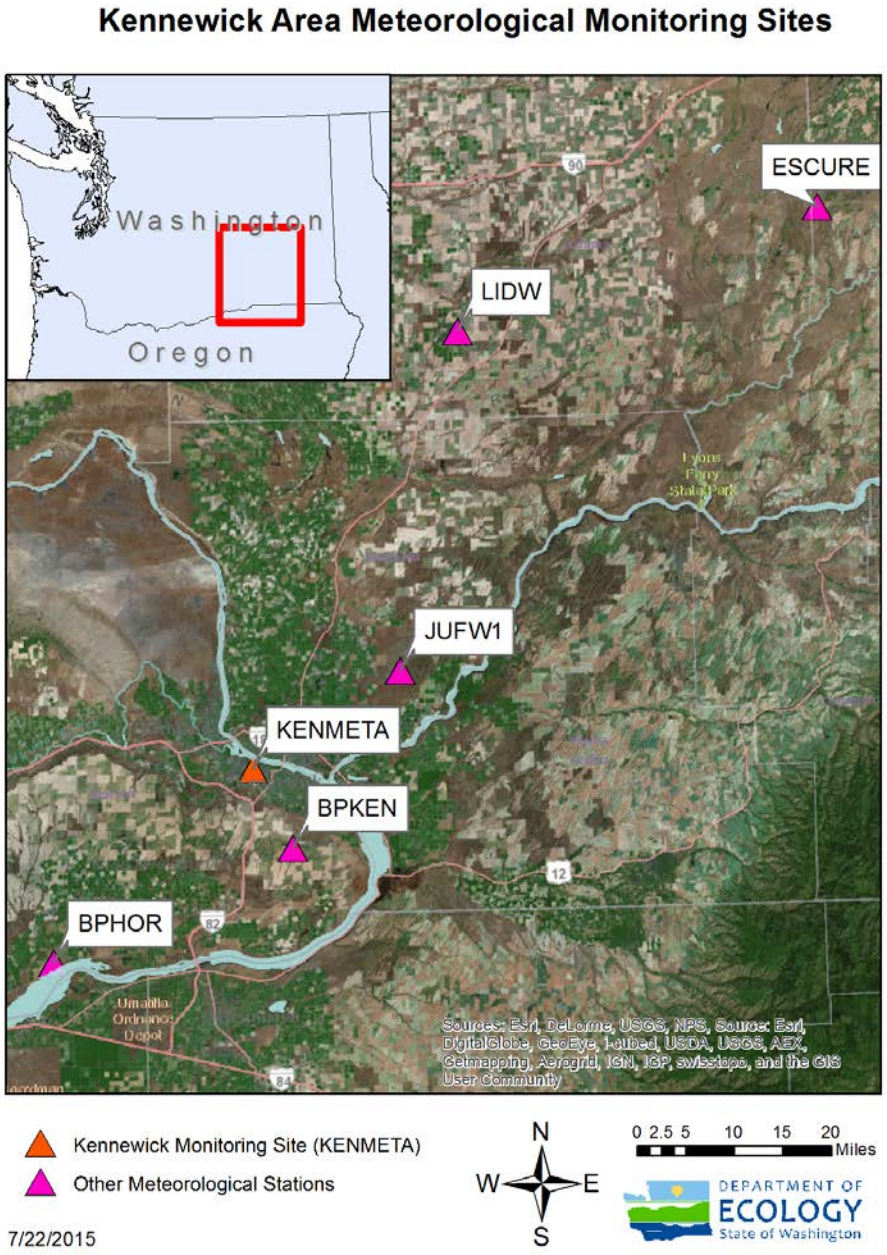

Figure 6. Kennewick area meteorological monitoring stations

The meteorological monitoring stations shown in Figure 6 are listed in Table 1 below.

Table 1. Kennewick and Surrounding Area Meteorological Stations

Station Abbreviation	Station Name	Location
KENMETA	Kennewick - Metaline	Kennewick Technical Skills Center, 5929 W. Metaline Avenue
BPKEN	BPA, Kennewick	On the ridgeline approximately 10 miles SSE of KENMETA
BPHOR	BPA, Horse Heaven Hills	Approximately 30 miles SW of KENMETA, within one mile of the north shore of the Columbia River
JUFW1	Juniper Dunes Wilderness	20 miles NE of KENMETA
LIDW	Lind	Near the town of Lind, WA along U.S. Highway 395 between Connell and Ritzville, approximately 50 miles NNE of KENMETA
ESCW1	Escure	Located approximately 50 miles SW of Spokane and 80 miles NE of Kennewick

The Bonneville Power Administration's Kennewick monitor (BPKEN) is located atop a ridgeline approximately 10 miles SSE of KENMETA in an area of agricultural land and open space. At an elevation of 1990 feet, it is near the highest point in the segment of Horse Heaven Hills nearest Kennewick, which reach approximately 2000 feet at their peak. This site reports wind speed, wind direction and peak wind gust every 5 minutes. *BPKEN is the nearest monitor to a suspected dust entrainment area for the high wind events on 9/15/2013 and 11/02/2013.*

The Bonneville Power Administration's Horse Heaven Hills Monitor (BPHOR) is located approximately 30 miles SW of KENMETA, within one mile of the north shore of the Columbia River. Its elevation is approximately 500 feet, relative to the elevation of 265 feet at the nearest point on the Columbia River. *Due to its lower elevation and proximity to the river, this site represents the wind patterns through the Columbia River Gorge that preceded the dust events on 9/15/2013 and 11/02/2013.*

The Remote Automated Weather Station (RAWS[26]) located within the Juniper Dunes Wilderness (JUFW1) preserve is managed by the Bureau of Land Management (BLM) approximately 20 miles NE of KENMETA at an elevation of 1000 feet. The Juniper Dunes Wilderness is an undeveloped open space preserve. This site reports instantaneous wind speed and wind direction once per hour as well as the hourly maximum wind gust.

[26] http://www.wrcc.dri.edu/wraws/waF.html

The Lind, WA site (LIDW) is located near the town of Lind, WA along U.S. Highway 395 between Connell and Ritzville. It is approximately 50 miles NNE of KENMETA at an elevation of 1475 feet in an area of predominantly agricultural land. The site is operated by the Bureau of Reclamation (BLM) and reports maximum wind gust, mean wind speed and mean wind direction at 15-minute intervals. The RAWS site in Escure, Washington is approximately 50 miles SW of Spokane and 80 miles NW of Kennewick in a largely agricultural areas. This site reports 10-minute average wind speed, once an hour. *This site represents the area between Spokane and Kennewick.*

*The Lind (LIDW, Juniper Dunes (JUFW1)and Escure (*ESCW1*) sites are the best available meteorological monitoring stations to represent a suspected dust entrainment area along the path of the storm for the 10/28/2013 event.*

Airport Monitors: Supporting meteorological information was obtained from the Pasco, Spokane and Hermiston airports. National Weather Service stations at airports typically report two-minute average wind speed observations near the end of each hours. Occasionally, multiple two-minute averages are available within a single hour. However, true one hour averages are not available from these sites.

4 Sources

Particulate matter sources that contributed to the Fall 2013 exceedances are described in this section. For the three events, thunderstorms originated or passed over many miles of land composed of mostly agriculture lands, both dryland and irrigated operations. Two of the three events originated southwest of Kennewick in Oregon. A significant portion of the particulate matter could have been entrained north of the Columbia River on the Washington side. We were unable to rule out the possibility that a significant portion of the particulate matter could have originated in Oregon. This is because while there are meteorological sites in central and northeastern Oregon, there are no air quality monitors in this area. Oregon land use in the storms' paths is similar to the Washington side; agricultural activity and controls are similar.

A number of exceedances of the 24-hour standard for PM_{10} were recorded in eastern Washington in the late 1980s and early 1990s. Examination of the exceedances during this period showed a close correlation to high wind events — upwind agricultural fields were identified as the chief source of the wind-blown dust.[27] Based on this earlier work, it is well established that agriculture fields are the primary source of PM_{10} during high wind events on the Columbia Plateau.[28]

4.1 Potential Source Categories and Areas

Washington's Columbia Plateau is well-characterized. This area has been studied by WSU and their partners for over 20 years. Ecology reviewed 2011 emission inventory information, and emissions from agricultural activities (tilling and harvest) are still the largest source of PM_{10} on the Plateau. We considered whether fires may have contributed to the air pollution exceedances. We checked with the local agencies (BCAA and SRCAA) to see if there were any identified upsets from industrial sources or other unusual activities. We determined that fires or industrial sources did not contribute.

Based on our knowledge of conditions under which soil is entrained, the land use of the area over which the winds blew and our review of the monitoring data, Ecology concluded the main source of the dust for all three events was agricultural lands.

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[27] NEAP, page 5; also see "Documentation of Natural Event Due To High Winds, June 13, 1994, Wallula, Washington," Washington *State Department of Ecology, December 18, 1996.*

[28] *B.S.* Sharratt, B.S. and G. Feng, G., *Windblown dust influenced by conventional and undercutter tillage within the Columbia Plateau,* USA. Earth Surface Processes and Landforms, 34, 1323-1332 (2009), John Wiley & Sons, Ltd.

Source area character: The three wind events originated or passed over a mosaic of land, mostly composed of agriculture – both dryland and irrigated operations. Winds also traveled over some natural deserts and rangelands. These areas have soil surfaces that are generally stable due to established vegetation anchoring the soils and so were not likely the majority contributor of dusts to the exceedance.

September 15 and November 2 - SW events sources: A local source of the dust for the two events from the SW is likely the Horse Heaven Hills, an area in dryland and irrigated farming production. However, some contribution from Oregon could not be ruled out.

The nearest upwind monitors that show an absence of PM dust are in John Day 124 miles to the south of Kennewick, Bend 182 miles to the SW, and The Dalles 107 miles to the WSW. Hence, the available evidence suggests that the dust source region is not more than 100-180 miles upwind of the Kennewick monitor. While the particulate matter values were not elevated in Oregon at Pendleton and The Dalles, the storms' paths pass over more than a hundred miles of land before crossing the Columbia River to the Washington side. Therefore, some particulate matter may have been transported from Oregon and contributed to the exceedances. A contribution from Oregon could not be ruled out due to a lack of air quality monitoring stations along the path of the two southwest storms. Ecology considered that some of the dust could have come from a 51,000 acre fire scar left by the Oregon Sunnyside Turnoff Fire of July 23, 2013 (see graphic from 7/23/2013[29]). While fire recovery efforts generally include planting vegetation to stabilize soil, drought conditions may have prevented seeds from sprouting or taking root.[30]

Central and northeastern Oregon is similar to the Washington side, i.e., comprised of natural and agriculture lands. See Figure 17. Controls on Oregon agricultural lands are similar, that is, Oregon growers have access to the same federal conservation measures funding as Washington growers.

October 28 - NE event sources: The majority of land over which the storm traveled from the NE for the October 28 event was also agricultural lands. The winds traveled down most of Washington's Columbia Plateau on this day and so also likely picked up some dust from this area as well.

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[29] Sunnyside Turnoff IR Map, OR-WSA-000058, Map Date: 07/25/13, Imagery Date, 07/25/13, Imagery Time: 0306, NAD 83 - UTM Zone 10, Interpreted Acres: 47,153, IRIN: J. Grace/T. Stauffer (t), <http://inciweb.nwcg.gov/photos/ORWSA/2013-07-23-0000-Sunnyside-Turnoff-Fire/picts/2013_07_25-11.20.20.427-CDT.pdf>.

[30] Jay Carmony, Ecology Central Regional Office, email "Re: CRO visit", dated 4/6/2015.

Satellite Photo: The photo in Figure 7 below shows how on a basin-wide scale, agriculture is the dominant activity. The green areas are irrigated agriculture; the beige squares are dryland farming. Kennewick is in the bottom left corner.

Figure 7. Columbia Plateau, Land Use visual

Emission Inventory: Ecology's 2011 statewide triennial emission inventory supports that emissions from agricultural activities (tillage and harvest) are the largest contributor of PM_{10} to the state total.[31] Tillage and harvesting contributed 36% to the statewide annual total. Annual emissions from roads, construction activities and fires are minimal for 2011 in the counties most susceptible to wind erosion. These priority counties are bolded in
Table 2.[32] The 2011 inventory for these activities report PM_{10} emissions from agriculture represent over half of the total for these counties. See Regional Info Appendix B for complete emissions data for 2011.

Table 2. 2011 PM_{10} Emissions for Columbia Plateau Counties for Select Emission Categories

2011 PM_{10} Emissions by Emission Category, percent				
	Tilling and Harvesting	Roads	Ag and Silvicultural burning	Construction
Adams	**78**	**19**	**0.5**	**0.17**
Benton	**76**	**9**	**0.5**	**7.3**
Douglas	**52**	**44**	**0.1**	**1.3**
Franklin	**63**	**21**	**4.7**	**6.6**
Grant	**54**	**38**	**1.0**	**4.0**
Klickitat	40	28	4.4	2.5
Lincoln	**78**	**20**	**0.3**	**0.16**
Spokane	23	37	0.5	26
Walla Walla	**65**	**11**	**12**	**2.1**
Yakima	19	54	0.7	12.0

Agricultural lands are the generally the largest source of particulate matter that contributed to the exceedances based the dominance of agricultural activity in the area. The type of agricultural that dominates a county is a factor. For example, orchards are less prone to dust than wheat fields. The 2011 inventory shows that for Spokane and Yakima, roads are a larger source of particulate matter than tilling and harvesting. These areas are influenced more by cars than from farms, simply due to the amount of traffic. Construction activity is also important in these counties due to urbanization/land use changes.

[31] Washington State Department of Ecology, *Comprehensive 2011 County Emission Inventory*, issued April 25, 2014, Table 4-1, 4.2 and 4.3.
[32] Initially listed in the Ecology Natural Events Action Plan (2003, A-14). Later, Benton and Walla Walla were added in NEAP update (2006), see Appendix.

Benton County Zoning: According to the National Agricultural Statistics Service 2012 Census, Benton County has 519,123 acres or 50% of its land classified as Total Cropland.[33]To further demonstrate the dominance of agricultural activity in Benton County, Figure 8 below shows that a majority of the land in the county is zoned for agriculture. Agriculture zoning is denoted by the green shading covering more than half of the county.

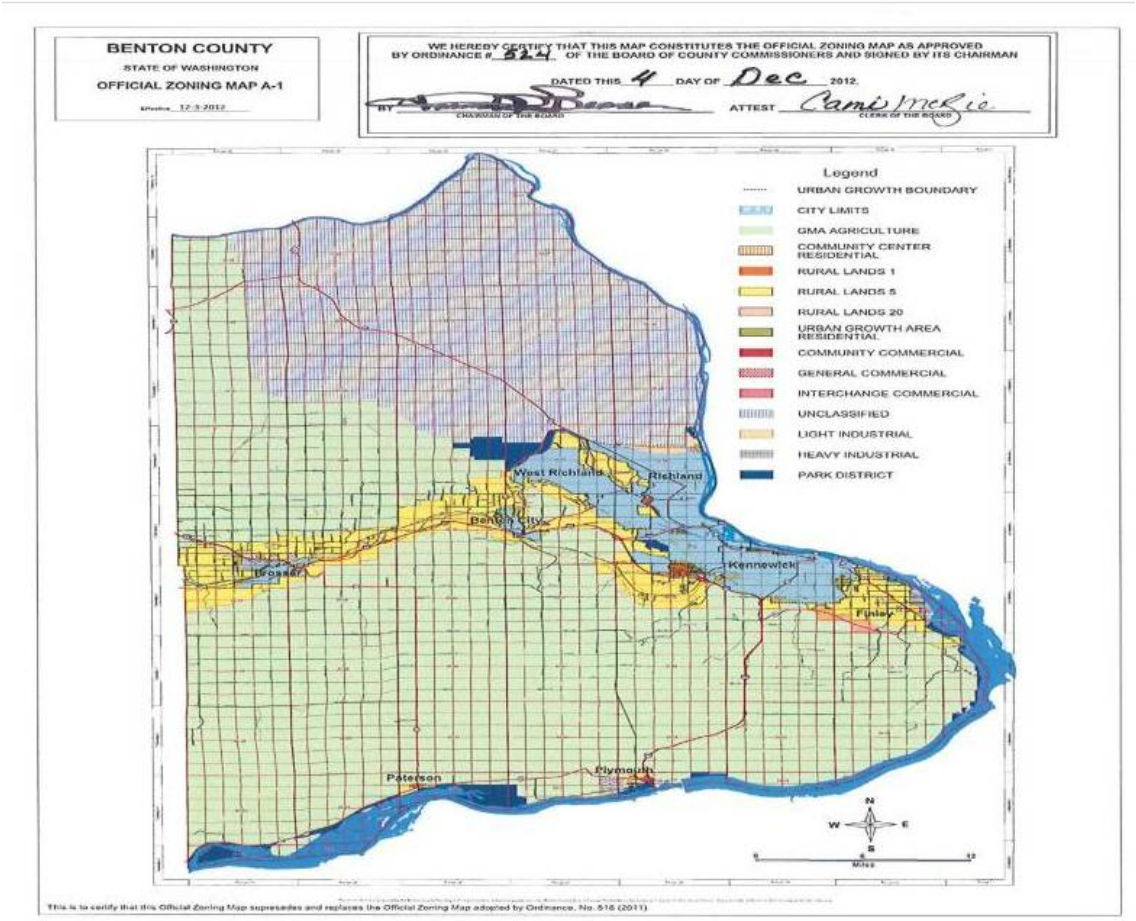

Figure 8. Benton County Zoning map

[33] Tom Vilsack, Secretary, National Agricultural Statistics Service, Cynthia Z.F. Clark, Administrator United States Department of Agriculture, *2012 Census of Agriculture*, issued May 2014, 519, 123 (Total Cropland from 2012 Ag Census) /1,036,975 (acres in Benton county) = 50%. The USDA defintion is "Total Cropland includes areas used for the production of adapted crops for harvest. Two subcategories of cropland are recognized: cultivated and non-cultivated. Cultivated cropland comprises land in row crops or close-grown crops and also other cultivated cropland, for example, hay land or pastureland that is in a rotation with row or close-grown crops. Non-cultivated cropland includes permanent hay land and horticultural cropland".

Agricultural Burning: We also considered Washington agricultural fires as a potential source of particulate matter but ultimately decided that fires were not a contributor to the event-day exceedances. This is based on emission information as shown above, the particle size contribution of smoke and whether or not burning was being conducted on the event days.

Smoke Contribution and Particle Size: Emissions from Agricultural and Silvicultural burning are a generally very small part of annual emissions as shown in the table above. While fires can contribute to the overall particulate pollution total, generally 85% of particulate matter in smoke from fires is fine particulate matter ($PM_{2.5}$).[34] The coarse portion ($PM_{10} - PM_{2.5}$) from smoke is minimal. Therefore, even if there had been a smoke contribution to the PM_{10} total on the three days, it would have not been significant. In any case, burning was restricted during the three days as described below.

Ecology's Burn Calls: Ecology's Eastern Washington Burn Team makes daily 'burn calls'[35] restricting burning to specific time periods or areas based on meteorology, air quality and permitted acreage. Ecology does not allow burning when high winds are forecast. Burn permits contain a provision that burning is not to occur if winds are over 15 mph for field burning and 25 mph for pile burning and must be extinguished if winds create an unsafe or nuisance condition. A review of the burn calls for the three event days shows Ecology did not allow or severely restricted burning on the three days. See the event-day appendixes for the Ecology burn call text.

Benton Clean Air Agency Burn Calls: Benton Clean Air Agency checked records from the three days and did not find evidence that agricultural burning occurred,[36] ruling out fire in Benton County as the source of the particulate matter for the three events.

Spokane Regional Clean Air Agency (SRCAA) Burn Call: For the 10/28 event, wind was from the northeast. While SRCAA did allow burning on October 28, their records show no one with a permit called in. Permit holders are required to call in before burning. Regardless, Spokane County only has a small amount of acreage that could qualify for agricultural burning. SRCAA deems it unlikely that any significant burning occurred on that day. SRCAA concludes that any smoke that may have impacted the Kennewick

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[34] EPA, AP42, Volume I, Fifth Edition, Chapter 13 Miscellaneous Sources, Development of Emissions Inventory Methods for Wildland Fire, Final Report, February 2002, Equation 10: ($PM_{10} = 1.18 \times PM_{2.5}$), which means that 85% of PM_{10} from fires is $PM_{2.5}$.

[35] <http://www.ecy.wa.gov/programs/air/aginfo/dailyburncallpage.htm>

[36] Email from Alex Sligar, Benton County Clean Air Agency, "RE: do we have info on Ag fires for the fall of 2013", March 2, 2015.

monitor on that day from Spokane County, ~130 miles away, would have been minimal.[37]

Since burning was either not allowed or severely restricted in the area on the three event days and smoke from fires is comprised of more $PM_{2.5}$ than PM_{10}, agricultural burning was ruled out as the source of the particulate matter for the three events.

Other Sources Ruled Out: There are no other known sources that contributed to the exceedances. There were no known unusual emissions from other sources, such as industries, impacts from fires, etc. Benton Clean Air Agency reviewed their files and there was no record of upsets during any of those times. Also, no phone calls from sources or the public, emergency response organizations or facility contacts were recorded.[38] There was no other cause other than the high winds created by thunderstorms identified for the three events. So, while other sources in Washington or Oregon may have contributed some particulate matter to the exceedances, these contributions are recognized as minimal.

In conclusion, Ecology believes the main source of the dust for all three events was agricultural lands. We came to this conclusion based on:

- previous research done on the Columbia Plateau, including conditions under which soil is entrained
- satellite photos and zoning maps that show the dominance of agriculture lands
- the most recent available emission inventory

Other than the three storms, there were no other known incidents that occurred at the same time as the exceedances, and no other sources were identified as contributing to the dust pollution.

[37] Mark Rowe, Spokane Regional Clean Air Agency, phone message April 23, 2015
[38] Per Robin Priddy, Benton Clean Air Agency, (phone interview, reconfirmed July 25, 2015)

4.2 Agricultural Source Areas

Agriculture in eastern Washington is a major economic activity. Potatoes, apples, wheat and hay are among the crops grown.

The 2012 Dept. of Agriculture census reported that agriculture contributed 13% to the state's economy. Eastern Washington counties ranked highest in the country for bushels of wheat, acres growing apples and sweet corn, and fifth in the country for number of acres growing vegetables.[39] Table 3 shows which counties in Washington are the nation's top growing counties for wheat, apples and sweet corn.

Table 3. Nation's Top Growing Counties for Wheat, Apples and Sweet Corn, 2012

Top Apple Growing Counties	*Top Wheat Growing Counties*	*Top Sweet Corn Counties*
Yakima	Whitman	Grant
Grant	Lincoln	Benton
Okanogan		
Benton		

Times When Fields are Vulnerable: Although growers take precautions when appropriate and feasible and engage in conservation practices year round, there are key times and stages in crop cycles where lands are vulnerable to soil erosion. Spring field preparation activities, fall harvest, winter wheat and cover crop planting, and when fields are fallow, are all potential situations where the soil is vulnerable to erosion. Soils were particularly vulnerable in the fall of 2013 because of the winter wheat kill in the spring of 2013 and the fall freezes in October 2013.

For dry-land farming, fields are particularly vulnerable to erosion during late summer and early fall. Crops are commonly harvested in the late summer. After harvest, fields are vulnerable if the remaining plant material has been removed and either the field is left fallow or before the winter crop has emerged and the first snows have covered the fields. Dry-land agriculture, since it relies on natural precipitation, is especially susceptible to erosion during period of drought.

Irrigated lands are particularly vulnerable during two periods:

1) In the spring, fields can erode while they are being tilled in preparation for seeding or have been seeded before crops have sufficiently developed to anchor the soils.

[39] Washington State Department of Agriculture, http://agr.wa.gov/AgInWA/

2) Fields are also vulnerable in the fall after harvest, especially when crops are harvested too late to establish a new crop.

For the September 15 and November 2 events, while some of the particulate matter could have been entrained further upwind,[40] some likely came from fallow or vulnerable agricultural fields in the Horse Heaven Hills (HHH). The October 28 thunderstorm traveled from the northeast over most of the length of the Columbia Plateau entraining dust from a mosaic of lands, the majority of which is agriculture, but also included rangeland, natural desert all along the way to the Kennewick monitor.[41]

The Horse Heaven Hills, located southwest of Kennewick, is a 300,000-acre mix of irrigated and dryland farming as shown in Figure 9. The dominant dryland crop is winter wheat, but other crops, such as barley and triticale[42], are also grown without irrigation. Irrigated crops include a wide variety, including grapes, fruits, onions, potatoes and other vegetables. Areas where soil is shallow, stony or hillsides that are steep are used for grazing. Grass and sagebrush comprise the vegetation in uncultivated areas. Figure 9 shows visually that the Horse Heaven Hills is composed mainly of agricultural lands. The round, green areas are irrigated agriculture. The dry, square areas correspond to dryland farming and the areas with lines are the hills.

[40] Some contribution from Oregon could not be ruled out.
[41] Shown in Figure 24.
[42] Heather Wendt, Benton/Franklin Conservation District, email message, "RE: what other crops are grown without irrigation in HHH", February 26, 2015. According to the Agricultural Marketing Service, triticale is a hybrid small grain produced by crossing wheat and rye. <http://www.agmrc.org/commodities__products/grains__oilseeds/triticale>

Figure 9. Horse Heaven Hills, Benton County, WA (AgWeatherNet)

Fallow Fields: Available water – precipitation and stored soil moisture - allows for crop production in low rainfall areas. Leaving the land fallow allows water in the soil to be stored for use by a later crop.[43] However, when lands are left fallow, they are vulnerable to erosion, unless the crop has been harvested using a method that leaves vegetation or residue on the fields. If a crop does not have adequately dense growth or is killed off by weather or disease, it may not have enough root depth or leave enough residue to stabilize the field

Before the three events in fall 2013, a portion of the HHH was fallow. While some fallow fields may have field residue if harvested using conservation or conventional methods,

[43] L. Pikul Jr. and J.K. Aase, *Water Infiltration Into A Glacial Till Soil Following Subsoiling and Secondary Tillage*, <http://eprints.nwisrl.ars.usda.gov/1084/1/938.pdf.>

and if the crop growth was adequate, many may have bare soil and be vulnerable to erosion.

Dryland Farming: Winter wheat is the largest crop grown in the HHH. This type of wheat needs the winter cold temperatures to chill the seed, which shortens the wheat's growing time. Producers use a winter wheat-summer fallow system for the majority for wheat grown in the region.[44] A crop is produced every two years. Wheat is planted in September or October every other year and is harvested the next summer. Fields are left fallow in the alternate years to absorb precipitation over the winter. However, dryland wheat planting can be delayed some years, leaving lands fallow into November or December. The planting time depends on when enough rain falls to replace depleted soil moisture needed to grow the new crop.

Much of the dryland wheat that was planted in the fall of 2012 died due to the late frost in May 2013. This meant that these fields lacked typical amounts of residue and the residue that was present was very fragile unlike residue from a crop that reaches maturity making the fields more vulnerable to erosion.

Irrigated Agriculture: For irrigated agriculture, the intent is to maximize soil's ability to hold moisture by leaving cover crops and minimizing disturbance of the soil to retain moisture and prevent erosion. For annual irrigated crops, spring planting and tillage practices can disturb soil, but moisture stored from the previous winter helps to suppress most dust. Harvest and post-harvest field preparation is another active time. After harvest, a cover crop is generally planted. However, between the time that crops are harvested and the cover crop takes root, fields are vulnerable.

In the fall of 2013, much of the cover crop just planted by growers failed due to the freezes in October. These fields were also vulnerable.

Vineyards: During the initial planting of vineyards, which may be preceded by clearing of brush or removal of other fruit crops, soil can be exposed which could result in blowing dust. New vineyards are generally irrigated by drip systems which cannot be completely installed until after the plants are in. Once the grape vines are in, they provide cover and are supported by the irrigation. As there is incentive to bring the vineyard quickly into production, this time period is generally quite short. However, dust can be generated during planting and until the cover is established. An annual cover crop can planted if there is a delay in planting the grapes, when a short term solution is needed.

[44] Columbia Plateau PM_{10} Project, <http://www.pnw-winderosion.wsu.edu/>.

The three exceedances in 2013 occurred during in the fall — after harvest and before cover crops could take root — when soils were vulnerable. There were more vulnerable lands because of the winter wheat kill the previous spring and the freezes in October.

5 Events Summary

This section describes those conditions that are common to all three events. More details for each event are described in the later sections for the specific event dates. However, several elements are common to all three events. High winds that came in front of the thunderstorms caused all three exceedances. Drought and soil conditions in the Columbia Plateau in the months leading up to the events contributed to the vulnerability of the soil to erosion in the region. This section describes the conditions common to all three events.

5.1 Common Factors

As discussed in the previous sections, circumstances leading into the fall of 2013 contributed to the vulnerability of the soils to erosion in the region. The winter wheat and cover-crop kill of the previous season and long-term, ongoing drought set up these conditions.

The mechanism that created all three events was thunderstorms that generated high winds. For the September 15 event, thunderstorms created a particularly extreme meteorological phenomenon, a haboob, which is characterized by a rolling wall of dust. The other events' (October 28 and November 2) high winds were also caused by thunderstorms.

5.1.1 High Winds and Wind Patterns

High wind events — short-term gusts or over a sustained period — caused the exceedances.

The National Weather Service defines a thunderstorm as a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder. Thunderstorms form when an air mass becomes unstable which means that the air in the lowest layers of the

atmosphere becomes too warm and humid. When unstable air is joined by moisture, warm air rises and cold air sinks, and this overturns, or convects, the air mass.[45]

A severe thunderstorm created a haboob —a severe type of desert thunderstorm — on September 15. The mechanism that creates this weather feature is explained in Figure 10 below.[46]

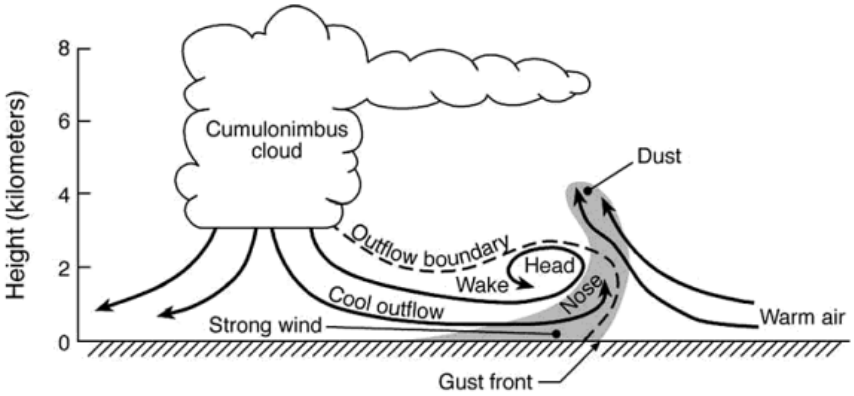

Fig. 16.10 Cross-section schematic of a haboob caused by the cool outflow from a thunderstorm, with the leading edge that is propagating ahead of the storm called an outflow boundary. The strong, gusty winds that prevail at the boundary are defined as a gust front. The leading edge of the cool air is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

Figure 10. Cross-section of a thunderstorm creating an outflow boundary and haboob

September 15 event was the only one that qualified as a haboob.

Wind Patterns: Figure 11 shows typical wind patterns in the Kennewick area (KENMETA) since meteorological data collection began at the site in 2012. This figure shows winds in this area have most frequently come from the southwest for the last few years.

[45] National Weather Service:< http://w1.weather.gov/glossary/index.php?word=thunderstorm>, <;ucar.edu - http://eo.ucar.edu/kids/dangerwx/tstorm4.htm>; <http://www.weatherquestions.com/What_causes_thunderstorms.htm>, accessed July 1, 2015

[46] Thomas T. Warner, *Desert Meteorology*, Cambridge University Press, New York, 2004, Figure 16.10

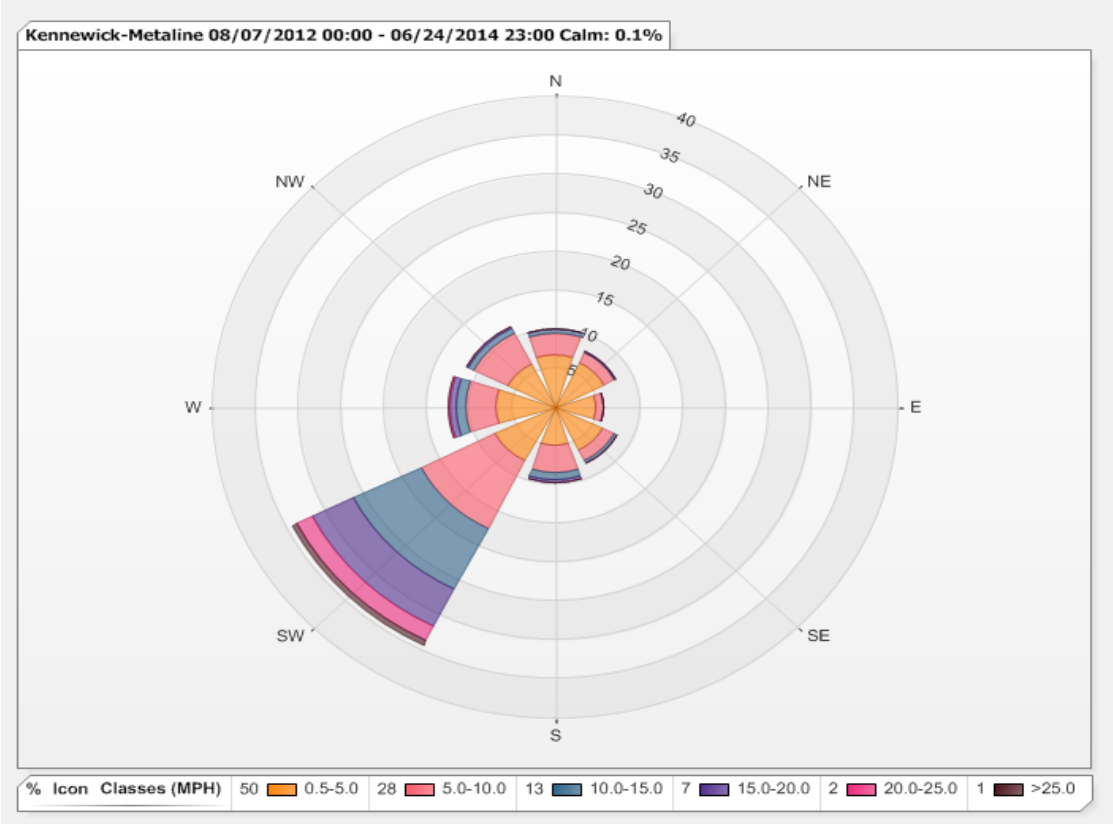

Figure 11. Kennewick typical wind patterns, August 2012 - June 2014.

Data from the Pasco Airport (KPSC) supports this dominant southwesterly pattern and is shown in Figure 12 below. Note that when wind speeds are over 20 to 25 mph and above range, winds are most frequently from the southwest.

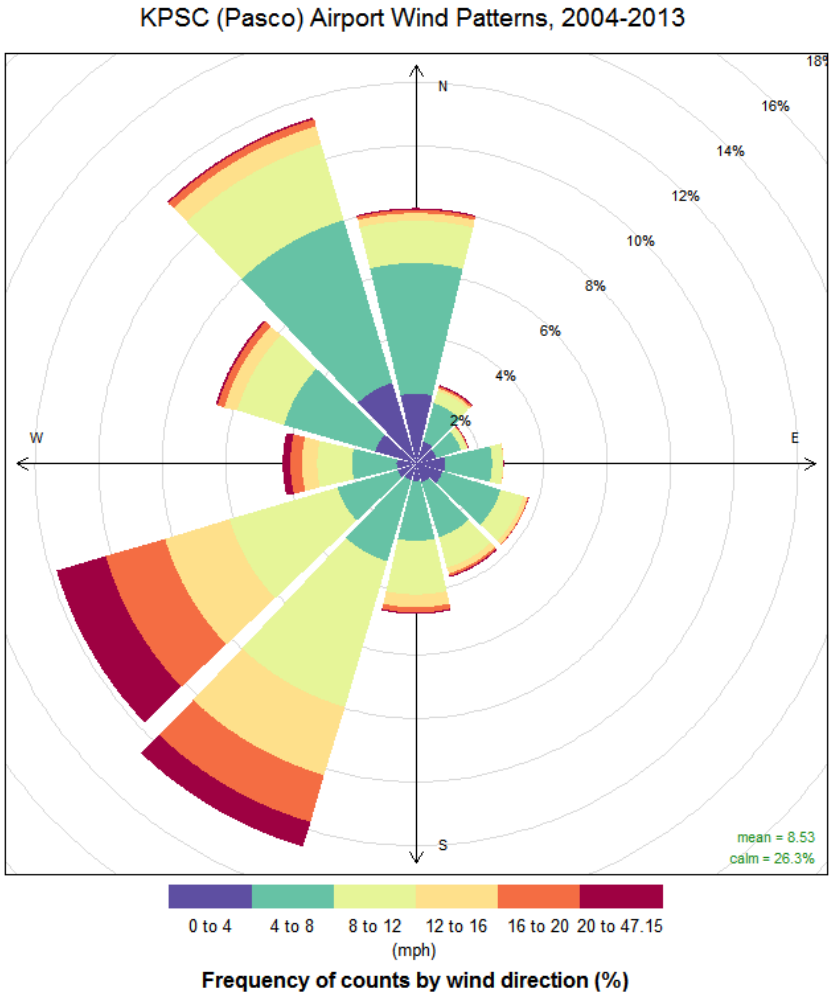

Figure 12. Pasco Airport typical wind patterns, 2004 -2013

National Oceanic and Atmospheric Administration (NOAA) reports[47] for this area show that prevailing winds are from the southwest or west for most of the year; northeasterly winds occur most frequently in the fall and winter. On rare occasions, usually during the fall and winter, strong winds can occur from the north and northwest. Winds over 25 mph are rare, occurring only approximately 1% of the time.
Wind velocities range from:

- 4 to 12 mph 60 to 70 % of the time,
- 13 to 24 mph 15 to 24 % of the time and
- 25 mph or higher one to two percent

[47] National Oceanic and Atmospheric Administration, Narrative Summaries, Tables and Maps for Each State with Overview of State Climatologist Programs, Third Edition, Volume 2: New York-Wyoming, 1985 - Gale Research Company,< http://www.wrcc.dri.edu/narratives/WASHINGTON.htm>.

Highest wind velocities are from the southwest or west and frequently associated with rapidly moving weather systems. Extreme wind velocities at 30 feet above the ground can be expected to reach:

- 50 mph at least once in two years
- 60 to 70 mph once in 50 years and
- 80 mph once in 100 years.

In their High Wind Guidance, EPA notes there may be areas where wind speeds thresholds lower than 25 mph may produce dust, but recognizes that, most areas can expect that controls are overwhelmed and soils can become entrained at this speed.[48] Ecology developed a high wind event definition from extensive research on localized characteristics that identifies speeds below 25 mph at which controls can be overwhelmed on the Columbia Plateau.[49] Ecology's NEAP provides evidence that stable surfaces can be overwhelmed at wind speeds below this level. However, for this demonstration, since all three of these events had 1-hour wind speeds over 25 mph, we will use 25 mph instead.[50]

All three events had at least one full hour where wind speeds exceeded the 25 mph threshold. Maximum sustained wind speeds for each hour of each event can be found in each Event Day Appendix. The number of periods above the high wind threshold are in each Event Day description in the document below[51]

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[48] Environmental Protection Agency, Attachment 2, Interim 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 (PDF), May 2013, pages 3, 17.

[49] Ecology's high wind definition for the Columbia Plateau as documented in the NEAP. Essentially, a high wind event can occur when wind entrains and suspends dust and PM_{10} levels are elevated. Generally, this when the hourly wind speed at 10 meters is 18 mph or greater for two or more hours, or more than 13 mph, when conditions of higher susceptibility to wind erosion exists (see Appendix G, 2003 NEAP, Attachment A1).

[50] EPA, "*Interim 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*", May 2013. While the NWS defines sustained winds as a 2 minute average, later in this document EPA defines sustained winds as a 1-HR average as follows: section 6.3.2.2: "Generally, the EPA will accept that high winds could be the cause of a high 24-hour average PM_{10} or $PM_{2.5}$ concentration if there was at least one full hour in which the hourly average wind speed was above the area-specific high wind threshold, p 41,

[51] EPA, High Wind Guidance, section 6.3.2.2: Potential issues arise when determining the hourly average wind speed if wind speeds are not recorded at specified intervals throughout each hour. While some sources of wind speed data use hourly averages, other data sources employ 1 - 5 minute ("short-period") averages. When the available wind speed data consist of only the wind speed during a fixed short period of each hour (e.g., the first or last five minutes of each hour) or the wind speed during the variable short period when wind speed was at its maximum during the hour, the EPA will generally accept that the hourly average wind speed was above the threshold if the reported short-period wind speed was above the

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5.1.2 **Conditions Before Events:**

Drought conditions and newly-planted wheat and cover-crop kill before the fall of 2013 contributed to conditions that left the soils vulnerable. In addition, this lack of precipitation in combination with high temperatures contributed to soil dryness.

High temperature records were set in September in the area. Records were also set for the least amount of rainfall in October; it was the driest month on record since 1945. November rainfall was sparse as well.

Monthly climate conditions: Information for the highlights below came from the Washington State Climatologist monthly summaries.

September - High temperature records for the year were set on September 14 and 15. Generally, the warmest weather in Washington is during July or August. [52]

Much of the rain in September came all at once on the 15th. The total for the month was 0.42"; 0.18" fell on September 15.[53] The area was very dry and had record high temperatures before the storm.

October - October was very dry statewide. A lack of precipitation record was set at Pasco. Only 0.04" of rain fell; this was the driest October since recordkeeping began in 1945.[54] National Weather Service Forecast Office in Pendleton, Oregon, reported that total precipitation was well below normal across the northeast Oregon and Southeast Washington for the month.[55]

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threshold. Where wind speed is recorded at specified intervals throughout each hour, agencies should use all recorded data to calculate the hourly average wind speed. The EPA may, however, consider multiple occurrences of high wind measured at these shorter averaging times as part of the weight-of-evidence demonstration. At a minimum, demonstrations should include the maximum sustained wind speed for each hour of the event and also the number of periods above the high wind threshold, page 41.

[52] Office of the Washington State Climatologist, *September Event Summary*, Volume VII, Issue 10, October 2, 2013, <http://www.climate.washington.edu/newsletter/>

[53] Hanford Meteorology Station, September 2013, <

[54]Office of the Washington State Climatologist, *October Event Summary*, Volume VII, Issue 11, November 4, 2013,

[55] National Weather Service, Pendleton, Oregon, *Month in Review for Northeast Oregon and Southeast Washington for the Month of October 2013*, Public Information Statement, 9:40 am PDT, Monday, November 4, 2013.

November – The November Event Summary[56] reports that the first weekend of the month saw eventful weather and included gusty winds. Pasco recorded only 0.04" of rain again in November. This November ranked among the top ten driest months for several stations.

Seasonal Precipitation: Precipitation throughout the Columbia Basin and beyond was 50% below normal for the period October 1, 2013 – February 3, 2014 (Water Year Summary, Northwest River Forecast Center). The widespread nature of this trend is shown in Figure 13.

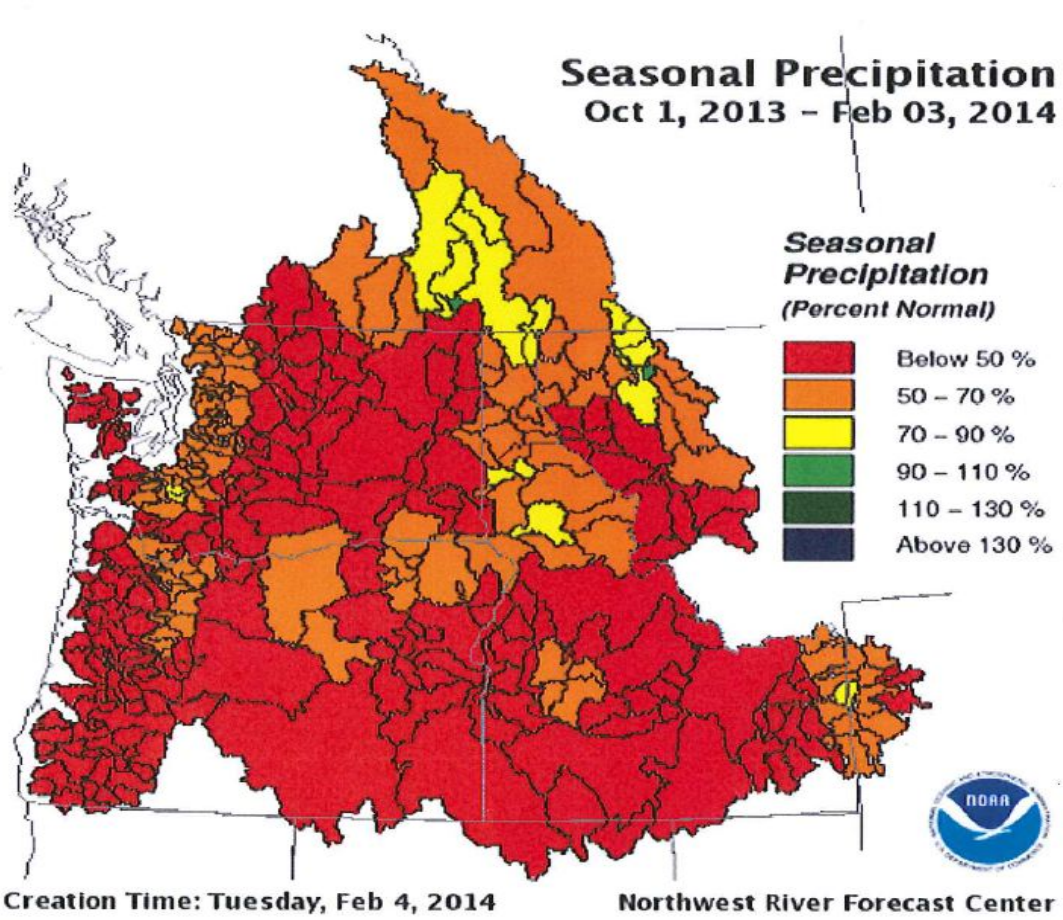

Figure 13. Regional Seasonal Precipitation, October 1, 2013-February 3, 2014

[56] Office of the Washington State Climatologist, *November Event Summary,* Volume VII, Issue 12, December 3, 2013.

Normally the precipitation in September, October and November in Kennewick is 0.30, 0.60, 1.00 inches, respectively.[57]

Temperatures and precipitation deviated from the norm for September, October and November. There was more precipitation in August and September, but far less than normal in October, November and December. (Note that most of the rainfall for September came with and directly behind the September 15 event). Temperatures in 2013 were consistently higher than normal, based on 1980 to 2010 values.

Drought: Long term lack of precipitation leads to drought conditions. The amount and frequency of precipitation received over the previous winter and spring, and high temperatures can make the surface of the soils very dry and vulnerable to disturbance.

Drought conditions existed in the Columbia Plateau leading up to the fall of 2013, when the exceedances occurred. Drought conditions had been severe in much of the West over the previous several seasons.

U.S Drought Monitor: Before the three events, northeast Oregon and southeast Washington were rated at 'Abnormally Dry' to 'Moderate Drought' conditions in September 2013, according to the U.S Drought Monitor reports, as shown in Figure 14 below.

[57] Mean precipitation, 1981-2010 Monthly Normals from NCDC, Western Regional Climate Center, <http://www.wrcc.dri.edu/CLIMATEDATA.html>

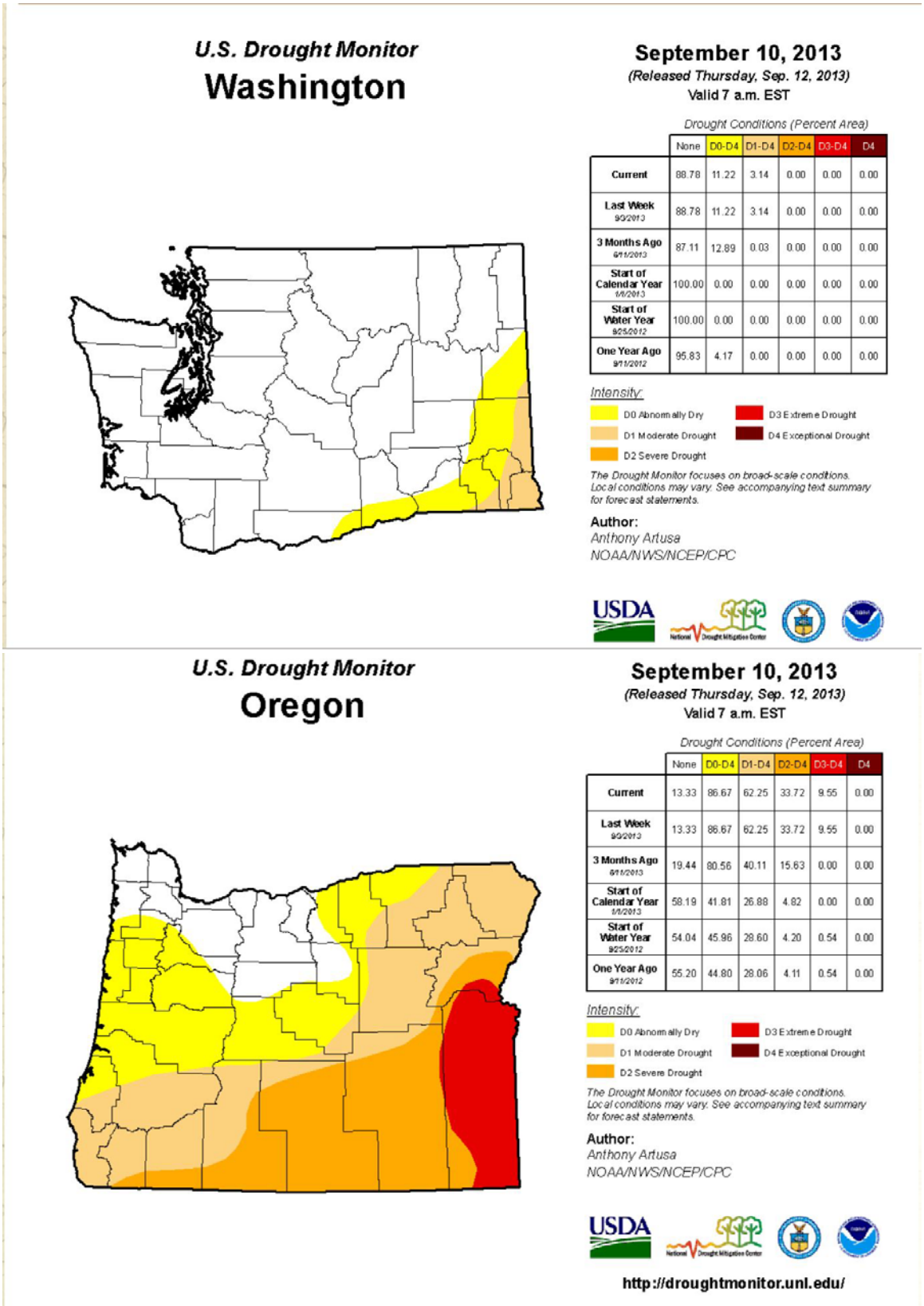

Figure 14. Washington and Oregon U.S. Drought Monitor maps for September 10, 2013

Palmer Index Drought Index: Potential drought conditions were also evaluated using the Palmer Drought Severity Index (PDSI).[58] The PDSI uses available temperature and precipitation data to estimate relative dryness.[59] In other words, it estimates soil moisture through changes in evapotranspiration.[60]The PDSI is generally used to measure the duration and intensity of long-term drought-circulation patterns. Long-term drought is cumulative— intensity of the drought during the current month depends on current weather plus the cumulative patterns of previous months.

Table 4 shows the PDSI values and PDSI anomaly values[61] for the months of August through November of 2013. The difference or anomaly compares a particular month against a chosen base period. These monthly anomalies are compared to the same months during the base period 2008-2012.

Table 4. Palmer Index Drought Values

Month	**PDSI value**	**PDSI anomaly**
August	0.05	-0.46
September	0.80	1.40
October	-0.48	-0.58
November	-0.96	-0.69

PDSI values for September 2013 suggest the area was entering a developing wet spell.[62] Moreover, the anomaly value (1.40) shows that this particular month was wetter than the average September during the other Septembers of the base period. However, further review shows that the majority of the rainfall for September 2013 occurred as result of the storm immediately after the extreme winds that led to the haboob and exceedance.[63] Therefore, August PDSI value better represents the conditions before the first dust event.

The August PDSI indicates that drought conditions were near normal, but the PSDI anomaly indicates that August 2013 were below average, suggesting a drier month when compared to the previous Augusts from the 2008-2012 period.

[58] http://www.ncdc.noaa.gov/oa/climate/research/prelim/drought/palmer.html
[59] <https://climatedataguide.ucar.edu/climate-data/palmer-drought-severity-index-pdsi>
[60]Evapotranspiration is the process by which water is transferred from the land to the atmosphere by evaporation from the soil and plant surfaces.
[61] The time scale used is 1-month. For instance, September is compared to the average September during the base period, <http://www.ncdc.noaa.gov/cag/time-series/us>
[62] <http://drought.unl.edu/Planning/Monitoring/ComparisonofIndicesIntro/PDSI.aspx>
[63] See Hanford Weather Chart, <http://www.hanford.gov/files.cfm/Aug13Nar.pdf >

The PDSI data describes near normal conditions for October and a developing dry spell for November. The anomaly values show that both months were abnormally drier compared to the same months in the base period (2008-2012).

Hanford Climate Information: Hanford climate analysis shows that August precipitation levels were above average (+33%), but, with 25 days with maximum temperatures ≥90°F, August 2013 was warmer than normal. A normal August has only 18 days under those conditions.[64] In other words, even though it rained more than usual in August and September, the higher temperatures caused rapid evaporation which led to a drier soil surface prior to the event in September.

Hanford seasonal precipitation data also gives further insight into the soil moisture conditions. The autumn 2013 season (September-November) had a below than average precipitation: 1.16 inches compared to a normal year of 1.76 inches.[65] October had 78% of the normal precipitation while November had only 38%. These conditions provide further evidence to the fact that soils were under vulnerable conditions leading to the dust events.

Winter Wheat and Cover Crop Kill: The exceedances were not caused solely by drought conditions and lack of precipitation; winter wheat and cover crop kill before the events also contributed to the vulnerability of the soil. Benton-Franklin Conservation District[66] reported some sudden temperature drops in the spring of 2013 — as well as reported freezes in October — that reduced the vegetative cover on the fields, leaving lands vulnerable in the region.

Spring Frost: The sudden temperature drops that occurred in the spring of 2013 (4/17, 4/30, 5/1) killed or stunted the wheat planted the previous fall which reduced the amount of residue in fields that were fallow during the wind events. Dryland fields that would have been anchored by residue were more susceptible to wind erosion.

Fall Freezes: Cover crops planted after harvest of annual irrigated crops were killed by the cold snaps that occurred in late October, 2013 (October 14, 15, 29, 30). When young wheat plants are killed, they leave virtually no residue to stabilize and protect the soil. These cold snaps also killed newly planted winter wheat. Then, the lack of Growing

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[64] Hanford Narrative Summary, September 2013, <http://www.hanford.gov/files.cfm/Sep13Nar.pdf >
[65] See Hanford Seasonal Precipitation data, <http://www.hanford.gov/page.cfm/hms/products/seaprcp>; Normal corresponds to a 30 year average, in this case, 1981-2010.
[66] Heather Wendt, Benton/Franklin Conservation District, "Re: Conservation Measures for Air Quality", email message, 7/28/2014.

Degree Days[67] that followed prevented the wheat that did survive from growing enough to provide adequate soil cover. Many farmers in the HHH had to reseed with spring wheat, which did not do well either and was affected by the 2013 late spring frost. The entire region's wheat crop was adversely impacted. It is estimated that for Dryland Winter Wheat alone, 50-60% of the crop that was expected to be harvested in 2014 failed.[68] When crops fail, there is not enough vegetation to hold down the soil. In addition, any residue which would have been left after harvesting that could also have stabilized soil is not present.

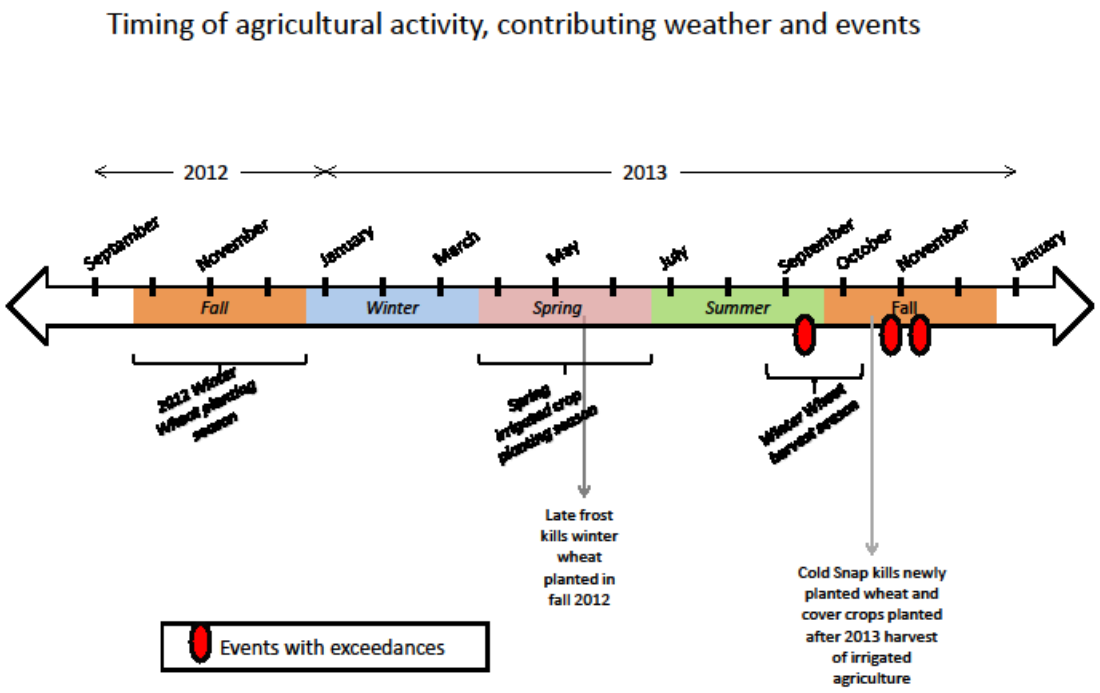

Figure 15. Timing of Agriculture Activity, Exceptional Events

Conditions before the events contributed to soil vulnerability in the fall of 2013.

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[67] Growing Degree Days - the number of temperature degrees above a certain threshold base temperature, which varies among crop species. The base temperature is that temperature below which plant growth is zero. GDs are calculated each day as maximum temperature plus the minimum temperature divided by 2 (or the mean temperature), minus the base temperature. GDUs are accumulated by adding each day's GDs contribution as the season progresses (NRCS website) <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/wa/people/employees/?cid=nrcs144p2_036547>

[68] Benton County Growers, per Heather Wendt, Assistant manager, Benton & Franklin Conservation Districts, per Farm Service Agency, "Re: Conservation Measures for Air Quality", email message, 5/29/2014.

5.2 September 15, 2013

The information on elements common to all three events is covered in previous sections High winds created by thunderstorms, overcame controls, entrained particulate matter and caused exceedances for all three events. Conditions contributing to the vulnerability of the soils in the region before the events are outlined in detail in the Climate, Soils and Common Factors sections.

Conceptual Model/Overview: On September 15, thunderstorms and strong winds created a dramatic dust storm, called a haboob that affected much of the region. High winds originated in central to northeastern Oregon, approximately 30 and 180 miles southwest of Kennewick, crossed the Columbia River and impacted Kennewick and points north on the Columbia Plateau. Several thousand homes lost power in Eastern Washington.[69]

This storm — classified as a severe desert storm called a haboob — caused wind gusts over 90 mph on the nearby Horse Heaven Hills (HHH) ridgeline. These winds likely picked up particulate matter from agricultural lands in the hills starting approximately ten miles southwest of the Kennewick monitor, overwhelming agricultural controls and causing an exceedance. Some portion of measured dust may also have come from Oregon. The Kennewick monitor recorded its peak wind speed and PM_{10} concentration about 5:30 pm. Both wind speed and PM_{10} returned to typical levels by around 6 pm.

This event-day section for September 15 is separated into three parts:

1. Upwind from Oregon
2. At or Near Kennewick
3. Downwind beyond Kennewick

For Warnings and Advisories, see the September 15 Appendix.

Figure 16 shows gusts (left) and hourly wind speeds (right) at National Weather Service (NWS) and Remote Automated Weather Station (RAWS) sites across the region during the hour ending at 6:00 pm (18:00).[70] The reported wind speeds are 2-minute averages at NWS sites and instantaneous values at RAWS sites, collected once per hour. This figure

[69] Cliff Mass blog reported, "A wind shift to the south showed strong gusts in the 50 mph range just after 9 pm, causing several thousand homes to lose power in some areas of eastern Washington", Cliff Mass Blog – Tuesday, September 17, 2013, *Haboob Hits Eastern Washington*, <http://cliffmass.blogspot.com/2013/09/haboob-hits-eastern-washington.html>

[70] MesoWest times in Coordinated Universal time (UTC) format, which is 8 hours later than Pacific Standard Time.

shows how this event impacted the area. Note the gusts at Walla Walla and Kennewick are in the 40 to 50 mph range; hourly wind speeds are over 25 mph.

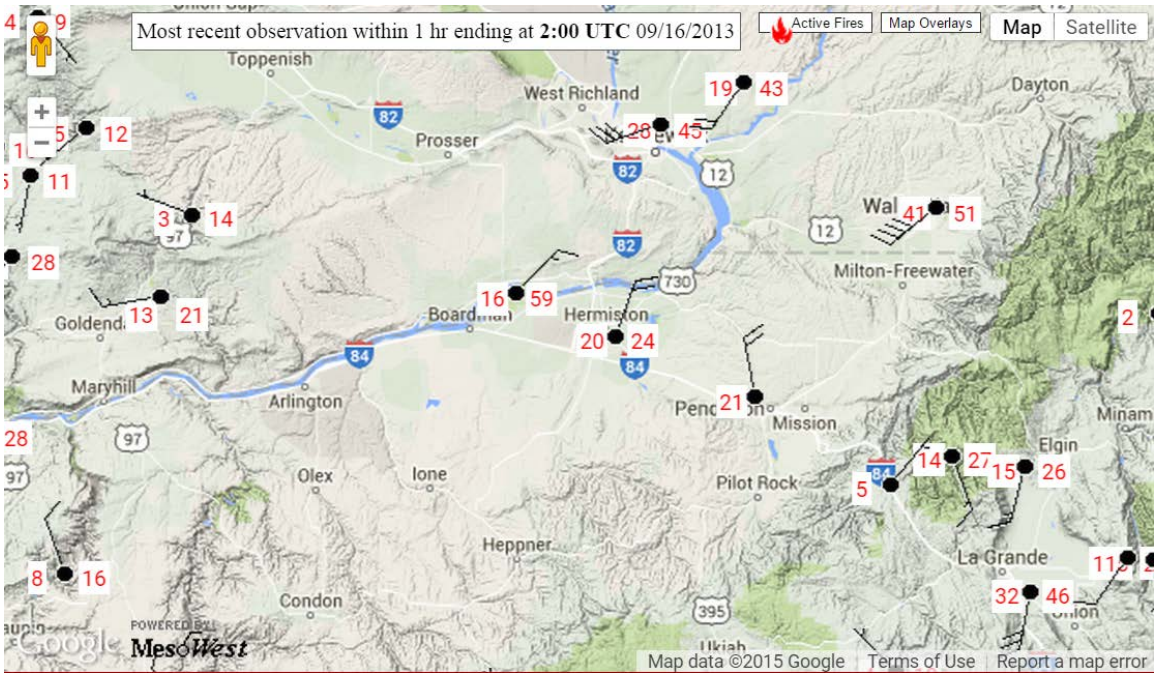


Figure 16. Close up of hourly wind speeds and gusts around Kennewick, 6 pm (18:00), 9/15/2013, (MesoWest)

Path and Timeline:

1. *Upwind from Oregon:*

The September 15 event started in the afternoon when strong winds and thunderstorms developed over central and northeastern Oregon, approximately 30 and 180 miles southwest of Kennewick). This area is shown in Figure 17. The arrow indicates the approximate direction of the storm. Land use in northeast Oregon is similar to the area around Kennewick – agriculture dominates the landscape.

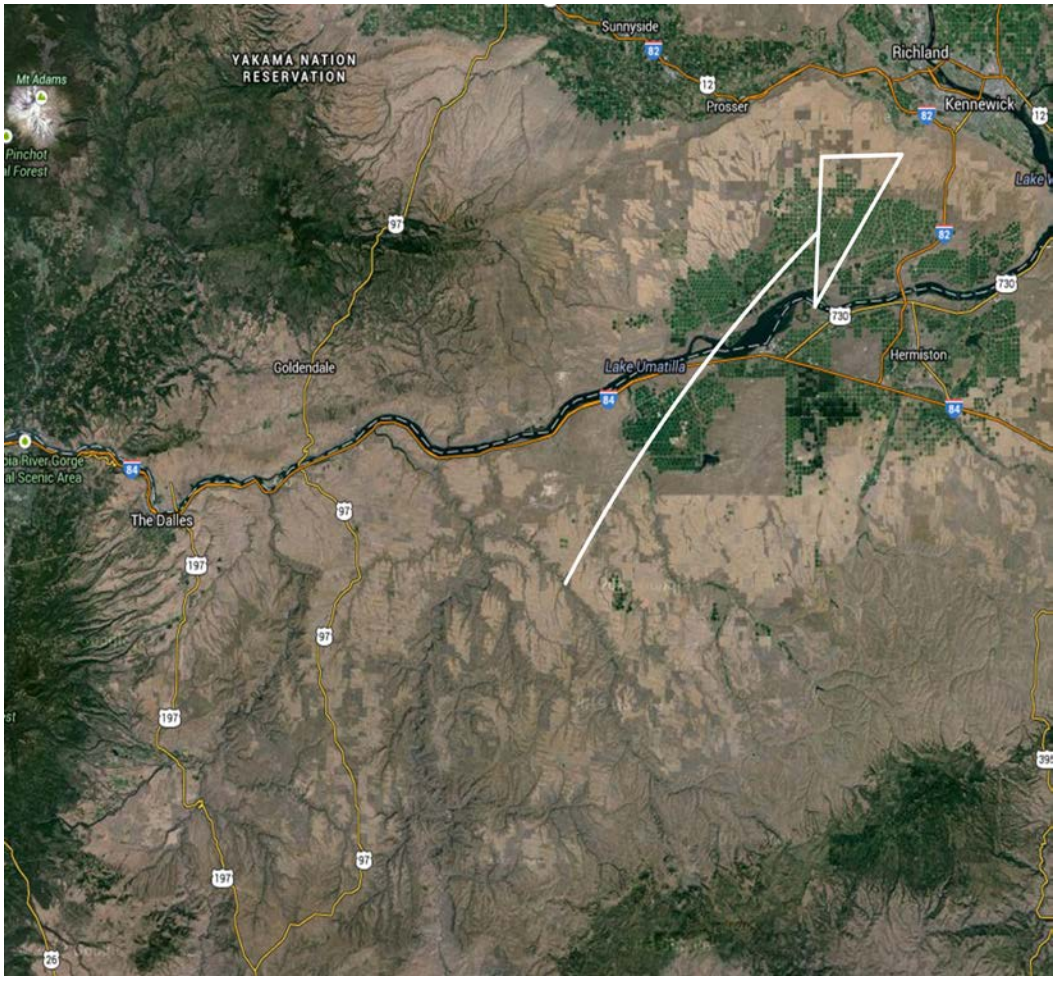


Figure 17. Area southwest of Kennewick, Direction of 9/15 Storm

Measurements of particulate concentrations at nearby monitors were also evaluated in order to assess the temporal extent of the haboob. Although there is no continuous PM_{10} data available from central or eastern Oregon, several sites use nephelometers to report fine particulate matter ($PM_{2.5}$) concentrations, which provide a reasonable surrogate.[71] Although dust usually contains a larger percentage of coarse particulate matter ($PM_{2.5}$-PM_{10}), fine particulate matter readings are still a useful surrogate. This is because generally as PM_{10} values increase, so do $PM_{2.5}$ values. Using $PM_{2.5}$ readings, the impact and direction of the storm can be inferred.

The Pendleton, La Grande, John Day, The Dalles and Bend sites are located near the trajectory of the elevated winds south of Kennewick. None of these five sites reported an hourly $PM_{2.5}$ concentration above 15 µg/m^3 on 9/15/2013. These monitors are 100-180

[71] A nephelometer is a monitor that measures light scatter – an indirect measure of particulate matter.

miles from Kennewick and well into Oregon. There is a possibility that some of the particulate matter could have been entrained as the storm crossed the northeastern area of Oregon on its way to Kennewick. While wind speeds were elevated over central and eastern Oregon earlier in the day, there were no corresponding elevated $PM_{2.5}$ levels at the available monitors approximately 100 – 180 miles south of the Columbia River Gorge (CRG).[72]

Oregon Department of Environmental Quality collects the data at these sites; the data is available through EPA's AQS website for registered users. Meteorological data was obtained from the Eastern Oregon Regional Airport in Pendleton (KPSC) and the Wasco Butte RAWS [73] site outside of The Dalles as well.

Monitoring and meteorological data for this event is in the September 15 Appendix. The time-series graphs in Figure 18 show hourly $PM_{2.5}$ concentrations as well as wind speed, wind gust, and wind direction at Pendleton and The Dalles. At the airport in Pendleton, wind speed and direction values are two-minute averages collected hourly that represent the hour. The Dalles wind speed and direction are instantaneous values collected hourly. Wind gusts shown are the maximum gusts reported during each hour when wind speeds exceed 18.4[74] mph, the speed at which NWS measures gusts.

[72] This also effectively rules out the fire scar from Sunnyside Turnoff fire as the source of the dust. See footnote 40 for more information on the Sunnyside Turnoff fire from 7/23/2013.
[73] Other sites available at <http://www.wrcc.dri.edu/wraws/waF.html>
[74] NWS defines gusts as when the peak wind speeds are above 16 knots (~18.4 mph).

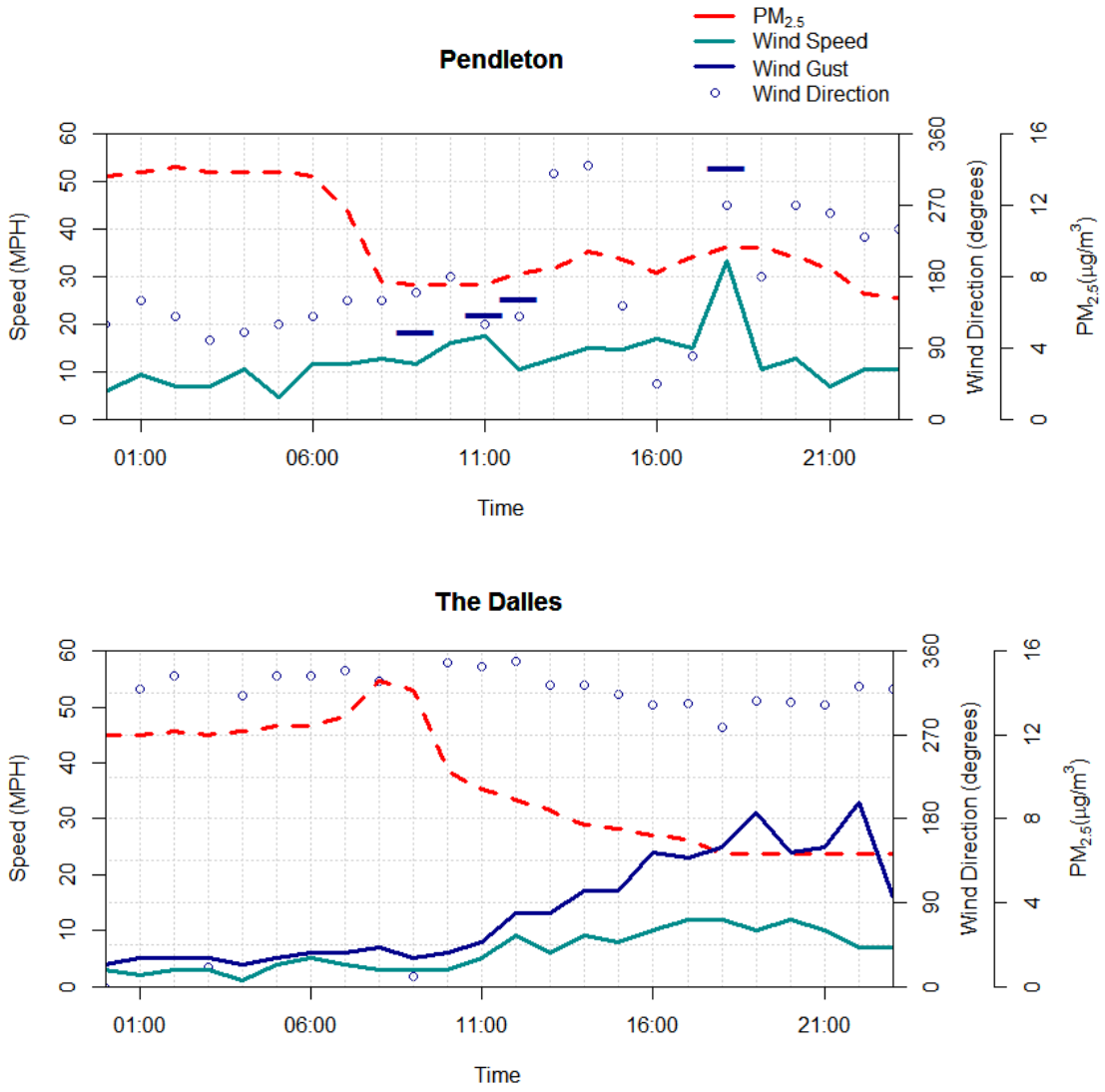


Figure 18. Time-series graphs of wind speed, wind gust, wind direction and $PM_{2.5}$ concentrations at monitoring sites upwind of Kennewick, 9/15/2013

In Pendleton, peak hourly wind speed of 33 mph and maximum wind gust of 53 mph were reported during the 6:00 (18:00) hour. There was no coincident increase in $PM_{2.5}$ concentrations. During this hour, the average $PM_{2.5}$ concentration reported in Pendleton was 9.6 µg/m^3.

In The Dalles, the maximum hourly wind speed of 12 mph was reported during the 5, 6 and 8 o'clock hours (17:00, 18:00 and 20:00) hours. Peak wind gusts of 31 mph and 33 mph were reported during the 7 and 10 pm (19:00 and 22:00) hours, respectively. In spite of the increase in wind gusts and wind speed during the evening of September 15, $PM_{2.5}$ concentrations declined steadily at The Dalles from 8:00 am through 11 pm

(23:00). All hourly $PM_{2.5}$ concentrations reported at The Dalles after 12:00 on September 15 were below 10 µg/m^3.

Though strong winds were measured in The Dalles and Pendleton on the evening of the 15th, the absence of any increase in $PM_{2.5}$ concentrations at those sites indicates that the storm did not begin picking up dust until it had passed these monitors, demonstrating a clear causal relationship.

Satellite Images: This event was so short that no satellite images captured the storm.

Back Trajectories: Ecology used the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model[75] from the National Oceanic and Atmospheric Administration (NOAA) to generate back trajectory plots to further assess the spatial origins of dust observed at the Kennewick monitor. The HYSPLIT model uses hourly modeled meteorology to approximate the trajectory of air parcels at different elevations. Back trajectories use archive model meteorology to trace air parcel trajectories backward in time from a given end location, for a set number of hours prior to the end time. They provide an estimate of the locations of sources of pollution measured at the end location at the end time.

The back trajectories displayed below were generated using the North American Mesoscale Forecast System Model (NAM) at a grid resolution of 12 km. All back trajectories were computed with the Kennewick monitor as the end location at heights of 50, 100 and 500 meters. All back trajectories span 24 hours prior to the end time(s).

No back trajectory for the 9/15 event is included because the scale of the wind event was too fine to be adequately captured by the courser modeling resolution in the trajectory model. The spatial resolution of the 12km NAM is likely not fine enough to capture the topography of the Columbia and Snake River valleys where they intersected with the haboob's path near Kennewick. Given the consistency and quantity of surface wind data showing the approach of SSW winds, these observations provide the strongest evidence of the direction of the storm's origin.

2. *At or Near Kennewick:*

A ridge of high pressures settled over the state and caused September to be unseasonably warm in the 2nd week.[76] At Hanford, temperatures were over 90 degrees for ten of the

[75] Draxler, R.R. and Rolph, G.D, *HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory)* Model access via NOAA ARL READY Website, <http://www.arl.noaa.gov/HYSPLIT.php>. NOAA Air Resources Laboratory, College Park, MD, 2013.

[76] Hanford Climatology report for September, 2013, <http://www.hanford.gov/HMS>

first 15 days of the month and reached 99 degrees on the 13th. There were 11 days in September with maximum temperatures over 90; normally there are only six. This time of year the maximums are typically in the 70s and 80s. High maximum temperature records were set or tied for the 11th through the 15th. The Hanford meteorological data and the State Climatologist Report is in the September 15 Appendix.

While precipitation for the month ended up higher than normal at 0.42 inches, there was no rain for a week before the event. Because of the high temperatures and abnormally dry drought conditions (see Figure 14. Washington and Oregon U.S. Drought Monitor maps for September 10, 2013), the soils were very dry and vulnerable.

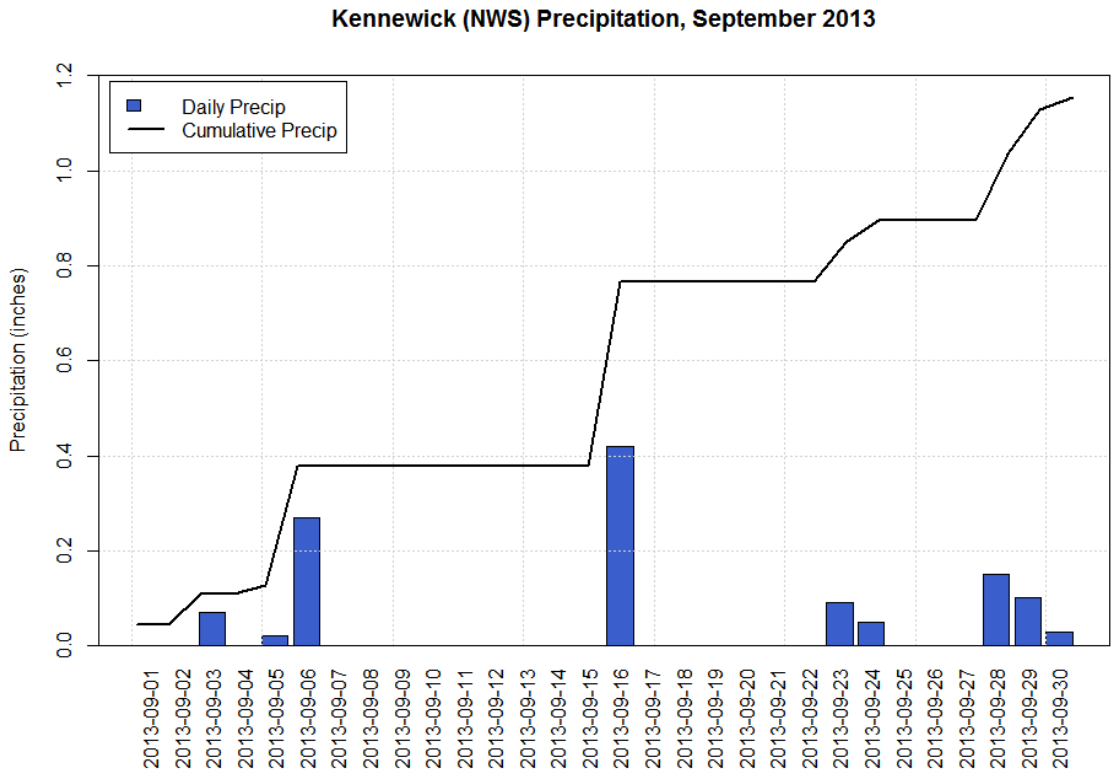


Figure 19. Kennewick Precipitation, NWS, September 2013

Warnings and Advisories: See September 15 Appendix for warnings and advisories. NWS also issued a Severe Thunderstorm Warning for north eastern Oregon and south central Washington, including Benton County at 6:12 PM PDT that was expected to last until 7:15 pm.

Hanford also issued a warning for their site that strong thunderstorms may begin to impact their site as early as 4:00 pm and that thunderstorms might bring heavy rain and gusty winds to 35 mph.

Cliff Mass Weather Blog collects and comments on NWS reports and other observations. In the September 15 entry titled "Thunderstorms Are Back" [77]he reports, "…several convective (thunderstorm) lines are moving through western Washington around 6 PM on Sunday ….But far more impressive are the storms moving northward from eastern Oregon into eastern Washington right now."

The Event: Winds came from the SW, which is the dominant wind direction for the Kennewick area. When the storm passed NNE over Northern Oregon and Southern Washington, the haboob formed and generated a wall of dust from fallow and vulnerable agricultural lands southwest of Kennewick at between 5 and 6 pm.

Figure 20 below shows that when PM_{10} concentrations were over 150 µg/m^3 on September 15, wind was from the southwest - the direction the haboob was coming from,demonstrating a clear causal relationship.

[77] < http://cliffmass.blogspot.com/2013/09/thunderstorms-are-back.html>

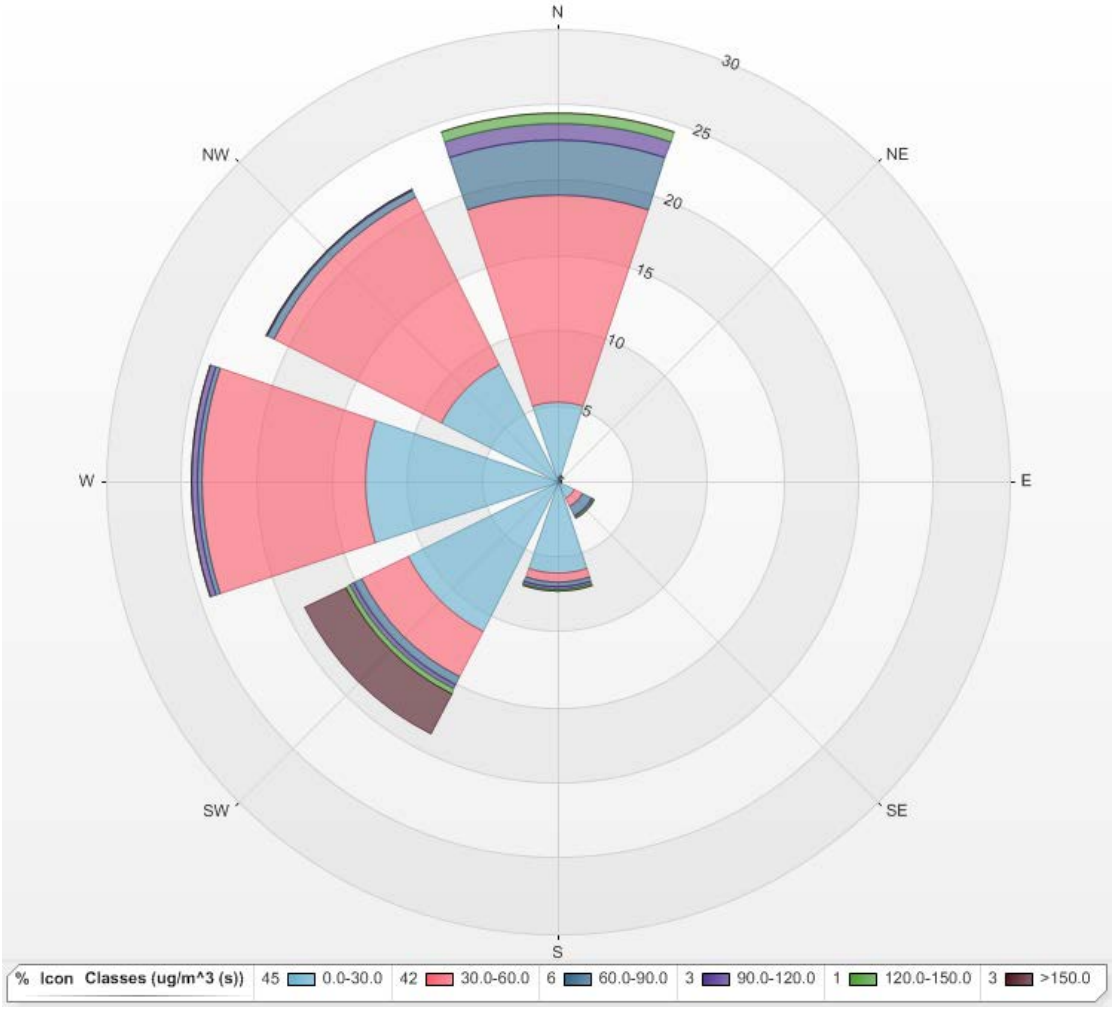


Figure 20. Pollution rose for Kennewick PM_{10} (1-minute), 9/15/13.

Exceedance: While wind direction was fairly well distributed from north to southwest throughout the day, all PM_{10} values above 150 µg/m^3 at Kennewick originated from the southwest during the brief-but-intense spike in wind speed and windblown dust between 5:15 and 6 pm.

Wind Speeds: One-minute average wind speeds first rose above 25 mph[78] at KENMETA at 5:17 (17:17). A peak 1-minute wind speed of 43.3 mph was observed at 5:24 pm (17:24). Wind speed dropped back below 25 mph at 5:47 (17:47). A time-series graph

[78] EPA's Interim 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 identifies 25 mph as the speed at which most areas can see soil become entrained and most controls measures overwhelmed, page 3.

of 1-minute average PM_{10} concentrations, wind speed and wind direction at the Kennewick monitor on 9/15/13 is shown in Figure 21.

Figure 21 shows the 1-minute wind speeds and PM_{10} concentration from September 12 through September 18, illustrating the sudden and short term nature of the event.

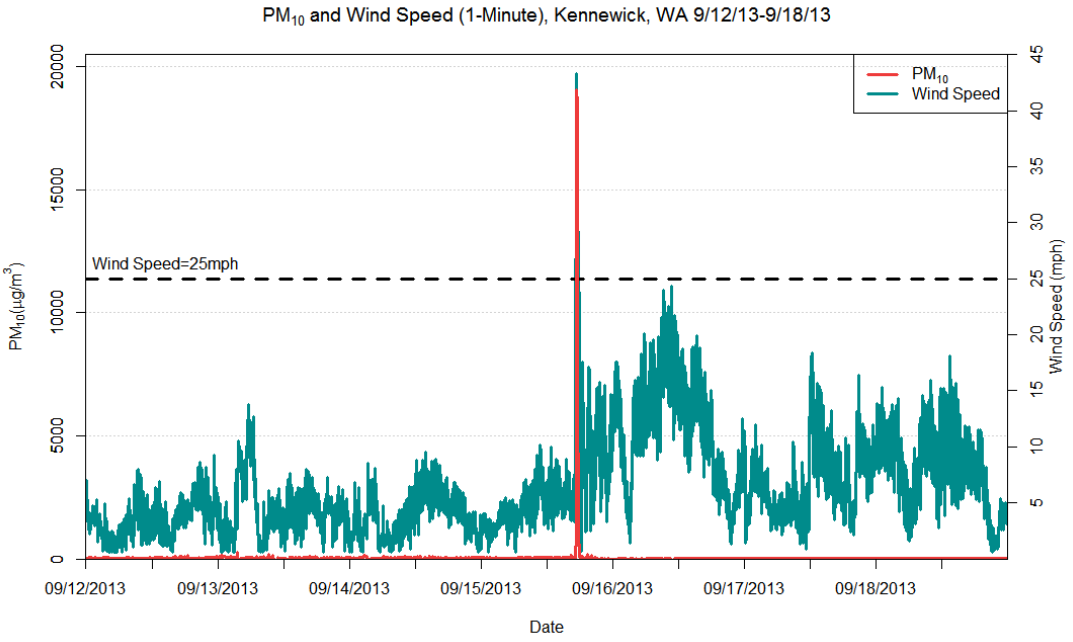


Figure 21. Time-series graph of 1-minute wind speeds and PM_{10} concentrations, 9/12/13-9/18/13.

Sustained Winds: The NWS defines sustained wind as an average wind speed over a period of two minutes.[79] There was only one hour on 9/15 where 2-minute periods showed sustained winds over 25 mph. As described above and shown in

[79] Sustained Wind- Wind speed determined by averaging observed values over a two-minute period. <http://w1.weather.gov/glossary/index.php?letter=s>

Table 5 documents the short-term PM_{10} spike occurred between 5:00 and 6:00 pm (in the 17:00 hour), when there were ten 2-minute periods over 25 mph.

Table 5. Number of 2-minute periods with sustained wind speeds over 25 mph by hour at KENMETA, 9/15/2013

Date, Time	#		Date, Time	#
9/15/2013 0:00	0		9/15/2013 12:00	0
9/15/2013 1:00	0		9/15/2013 13:00	0
9/15/2013 2:00	0		9/15/2013 14:00	0
9/15/2013 3:00	0		9/15/2013 15:00	0
9/15/2013 4:00	0		9/15/2013 16:00	0
9/15/2013 5:00	0		9/15/2013 17:00	10
9/15/2013 6:00	0		9/15/2013 18:00	0
9/15/2013 7:00	0		9/15/2013 19:00	0
9/15/2013 8:00	0		9/15/2013 20:00	0
9/15/2013 9:00	0		9/15/2013 21:00	0
9/15/2013 10:00	0		9/15/2013 22:00	0
9/15/2013 11:00	0		9/15/2013 23:00	0

Observed wind speeds reached higher peaks in the area of dust entrainment in the Horse Heaven Hills as evidenced by readings at nearby monitors.

Nearby Monitors: Bonneville Power's Kennewick site (BPKEN) is near the highest point[80] in the segment of Horse Heaven Hills nearest Kennewick and approximately 10 miles SSE of KENMETA. This site reports instantaneous wind speed, instantaneous wind direction and peak wind gust every 5 minutes. It is the nearest monitor to the dust entrainment area for the high wind event on 9/15/2013. The haboob caused wind gusts of over 90 mph at this site. There were 4 total hours over 25 mph at BPKEN, but since the haboob was over Kennewick for only 45 minutes, there was actually only one hour over 25 mph during the actual event.

BPA's Horse Heaven Hills (BPHOR) monitor is located approximately 30 miles SW of KENMETA, within one mile of the north shore of the Columbia River. This site also reports instantaneous wind speed, instantaneous wind direction and peak wind gust every 5 minutes. Due to its lower elevation[81] and proximity to the river, this site *represents the wind patterns through the Columbia River Gorge that preceded the dust events on 9/15/2013*.The BPHOR station recorded a 5-minute peak wind speed of 40.3 mph at 5:45 PDT (17:45), shortly before the dust event in Kennewick. The maximum gust observed at this station was 58.5 mph at 5:40 (17:40). The BPKEN monitor recorded even higher

[80] HHH are approximately 2,000 feet at their peak.
[81] Elevation is approximately 500 feet, relative to the elevation of 265 feet at the nearest point on the Columbia River.

peak wind speeds slightly later, with a 5-minute maximum wind speed of 77.3 mph at 5:25 PDT (17:25) and a peak gust of 94.4 mph at 5:20 (17:20).

The difference in magnitude between peak wind speeds at the BPKEN and KENMETA monitors indicates that dust had the opportunity to settle once the storm reached lower elevation areas in and around Kennewick. Time-series graphs of wind speed, wind, direction, and PM_{10} (Kennewick only) at the three monitors are shown in Figure 22.

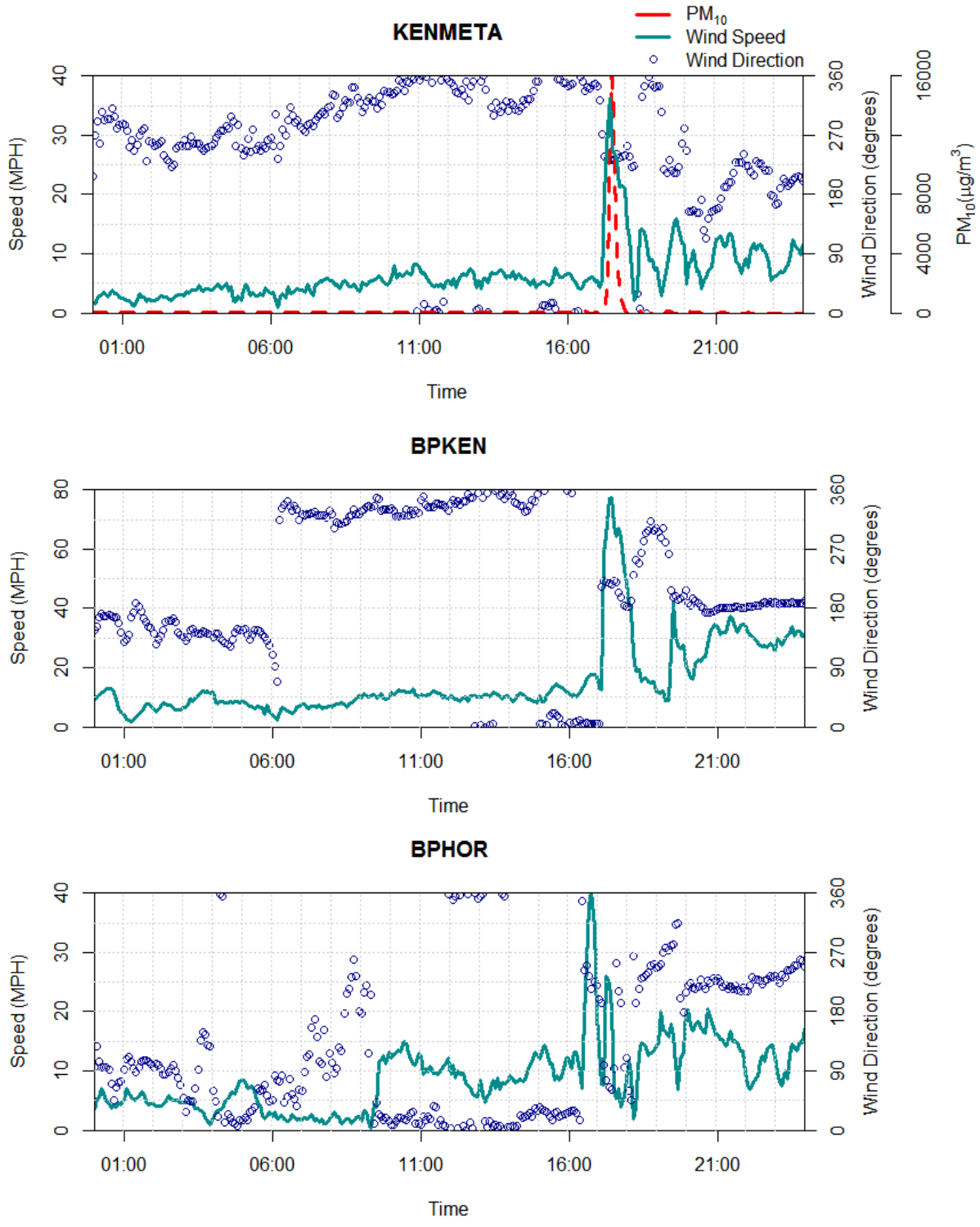


Figure 22. Time-series graphs of wind speed, wind direction and PM_{10} concentrations at relevant Kennewick-area monitoring sites, 9/15/2013 (BPKEN, BPHOR 5-minute data; KENMETA 1-minute)

Gusts: Wind Gusts — defined by the NWS as peak wind peaks over 18.4 mph (16 knots) — can also provide supporting evidence of exceptional high wind events. Summary statistics of wind speed data observed at these three stations are shown in Table 6.

Table 6. Regional wind speed summary statistics for 9/15/2013, mph

Site	*Max Gust*	*Max 1-hour*	*Number of hours with wind speeds > 25 mph.*
KENMETA	43.3[1]	20.6	0
BPKEN	94.4	**55.7**	1 (4)
BPHOR	58.5	20.3	0
Hermiston Airport (KHRI)	49.5	32.2	1

[1] One-minute average wind speed used as a surrogate for gust at KENMETA, where gust is not measured.

The 1-hour wind speed exceeded 25 mph at the BPKEN site, near the area of dust entrainment. The maximum 1-hour value was 55.7 mph. There were 4 hours when the wind speed exceeded 25 mph, but since the haboob only spanned 45 minutes, there was technically only one hour during the event. See the Event Day Appendix for details.

After the maximum gust of 43.3 mph in Kennewick at 5:24 (see 1-minute data in September 15 Appendix), the wind changed direction and slowed, causing some dust to settle in the vicinity of the monitor as shown by the 45-minute spike in PM_{10} concentrations. See the hourly values in the September 15 Appendix.

3. *Downwind: to the NW of Kennewick - September 15**:***

As the front moved northeastward into eastern Washington, other communities beyond Kennewick were also impacted. Elevated particulate matter concentrations were observed at several sites downwind of Kennewick for many hours after the PM_{10} spike and provide evidence of the regional impact of the storm. See Figure 24 for the area downwind, to the NW, of Kennewick.

NOAA Event Narrative reported on the event:

> *Strong winds mixed down to the surface along the squall line to created (sic) widespread damaging wind gusts. The squall line could be classified as a Haboob as the strongest winds occurred out ahead of the thunderstorms that kicked up a massive dust cloud. The Haboob hit the Moses Lake area and Upper Columbia Basin the hardest with widespread wind damage reported. The dust cloud resulted in a rapid reduction in visibility to near zero in places. Impacts from the Haboob were felt as far north as Coulee City eastward into Spokane and into Deer Park. Strong damaging*

winds and reduced visibility due to dust were reported across these areas as well.

At about 7:30 pm, Spokane NWS radar showed intense rain and hail at the storm front and elevated hourly $PM_{2.5}$ concentrations were reported downwind of Kennewick at the Ritzville and Pullman sites. (See Section 2.1, page 5 for Ritzville and Pullman sites) $PM_{2.5}$ concentrations peaked in the 7 pm (19:00) hour at 24.3 µg/m^3 and 24.2 µg/m^3, respectively. In the 8:00 pm (20:00) hour, $PM_{2.5}$ peaks were recorded at the Rosalia (31.8 µg/m^3) and Spokane-Monroe (55.4 µg/m^3) monitors.[82]

The Spokane, Augusta Avenue monitoring station measured a dramatic change in wind direction, from ENE to WNW, between 7 and 8 pm, when the haboob came through. Ultimately, Spokane-Augusta Avenue logged an exceedance of the 24-hour PM_{10} standard of 304 µg/m^3.

Cliff Mass Weather Blog reports after the storm, in his Tuesday the 17th, edition, "Haboob Hits Eastern Washington",[83] reports:

- In Adams County, the utility company reported power poles were down and 40 power poles snapped off.
- At Lind, a trained spotter reported visibility was zero. Mesonet reported that at Lind,[84] winds were 55 mph at 7:45 pm.
- NWS- Spokane notes wind damage, power poles down and power outages in the area.
- Power Company reports several thousand homes lost power in eastern Washington.
- Broadcast media reports several tents were flipped and damaged at the Spokane Fairgrounds.

This day differs from nonevent days in the following ways:

- Winds at these speeds are infrequent, occurring only 1-2% of the time[85]
- Concentrations over 150 µg/m^3 are rare and usually in conjunction with high winds, see Figure 20 above.

[82] Data can be accessed on the above named $PM_{2.5}$ sites can be found on Ecology's monitoring website at <https://fortress.wa.gov/ecy/enviwa/Default.htm>
[83] <http://cliffmass.blogspot.com/2013/09/haboob-hits-eastern-washington.html>
[84] Lind is 50 miles NNE, Spokane is about 130 miles NNE from Kennewick. More information about these monitor is in Section 2.1 (page 3).
[85] Per NOAA Climatology Report, <http://www.wrcc.dri.edu/narratives/WASHINGTON.htm>, accessed in July 2015.

- One-minute, instantaneous values of this magnitude (>19,000 µg/m^3 (17:30 pm) don't occur that frequently

The data show that the PM_{10} exceedance on September 15 was due to a haboob created by high winds generated by thunderstorm; clearly a natural event with winds strong enough to overwhelm controls.

5.3 October 28, 2013

The information on elements common to all three events is covered in previous sections. High winds created by thunderstorms overcame controls, entrained particulate matter and caused exceedances for all three events. Conditions contributing to the vulnerability of the soils in the region, before the events, are outlined in detail in the Climate, Soils and Common Factors sections

Conceptual Model/Overview:
On October 28 —very early in the morning —strong winds began as a result of a thunderstorm in western Montana approximately 250 miles northeast of Kennewick. Once in Washington, these winds transported particulate matter down the Columbia Plateau across approximately 50 miles of mostly agricultural lands to the Kennewick monitor. Sustained winds over 14 hours overwhelmed controls and caused an exceedance of the PM_{10} 24-hour NAAQS.

See October 28 Appendix for advisories and reports from the NWS and other entities.

The event-day section for October 28 is separated into two parts.[86]

1. Upwind of Kennewick (from the NE) from Montana for 10/28
2. At or Near Kennewick

Some areas around the region measured winds in the 40 mph range. Figure 23 shows gusts (left) and hourly wind speeds (right) at NWS and RAWS sites across the region during the hour ending at 1:00 PST[87] on 10/28/13. The reported wind speeds are 2-minute averages at NWS sites and instantaneous values at RAWS sites, collected once per hour. Kennewick recorded 40 mph gusts and 26 mph hourly wind speeds; Sand Point, Idaho — north of Coeur D'Alene — recorded 30 mph hourly wind speeds and 40 mph gusts.

[86] There is no information downwind of Kennewick for this event, as the event came from the northeast.
[87] MesoWest time in Coordinated Universal Time (UTC), which is 8 hours later than Pacific Standard Time

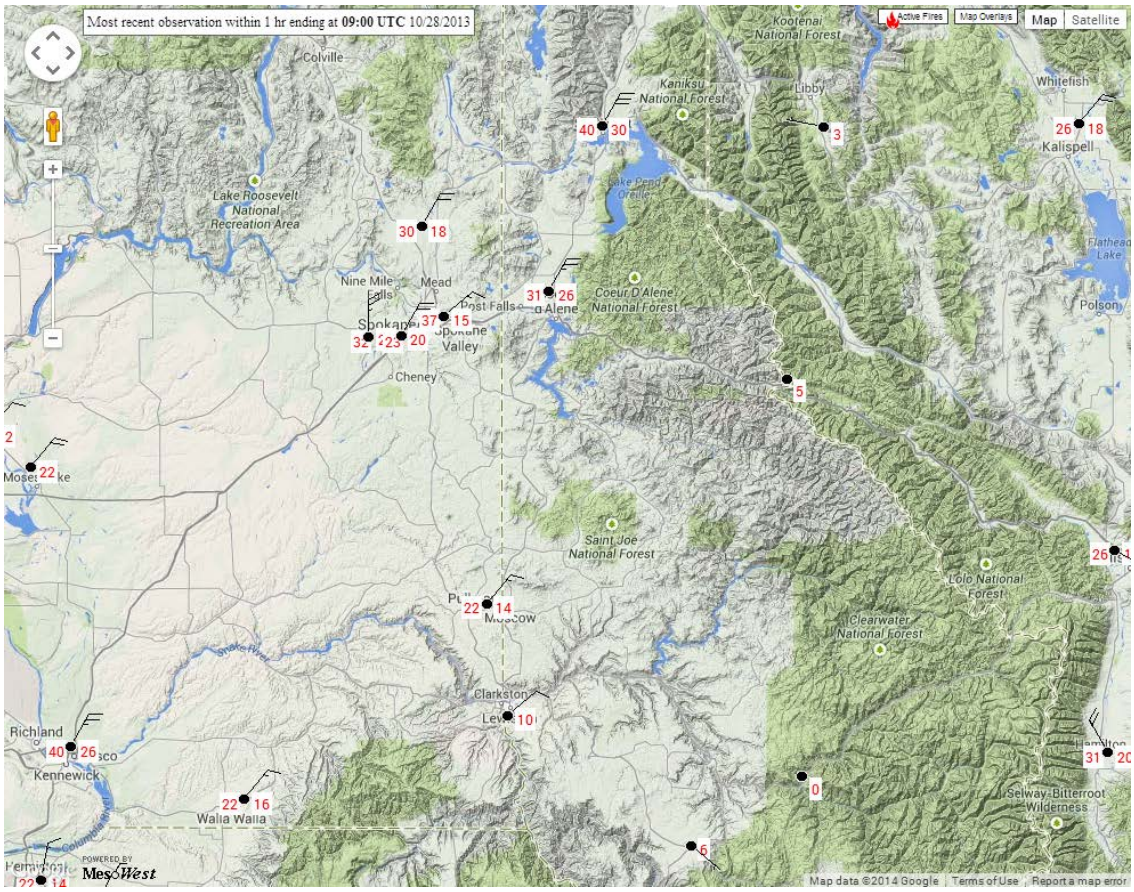


Figure 23. Regional wind speeds, 01:00 PST, 10/28/13 (MesoWest)

EPA considers high winds an exceptional cause of elevated PM_{10} concentrations if the average wind speed for at least one hour exceeds the high wind threshold, which is 25 mph.[88] However, dust can become entrained at lower wind speeds in the Columbia Plateau. Even short gusts, if at high enough speeds, can entrain soil and once entrained, sustained winds at lower speeds can keep soil suspended. The evidence for this is documented in Ecology's NEAP. See the Wind Threshold section on page 92 or Appendix G. 2003 NEAP Update.

Path and Timeline:

1. Upwind of Kennewick (from the NE) from Montana for 10/28

The October 28 event began with strong winds that started on the 27th from western Montana (up to 250 miles to the NE of Kennewick). These thunderstorms created

[88] EPA, *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* ,(Interim High Winds Guidance), May 2013, page 69.

sustained winds that transported particulate matter from the NE across the eastern part of the Columbia Basin and across approximately 50 miles of agricultural lands.

Winds from the NE are unusual. Soils surfaces may form ridges, stabilize and orient in the most frequent wind direction. When winds blow from the opposite direction, as they did on October 28, the soil surface crust is more easily disturbed.

Figure 24 shows the Columbia Basin to the northeast of Kennewick and the land the storm crossed on its way to Kennewick. Natural and agricultural lands comprise the Columbia Plateau.

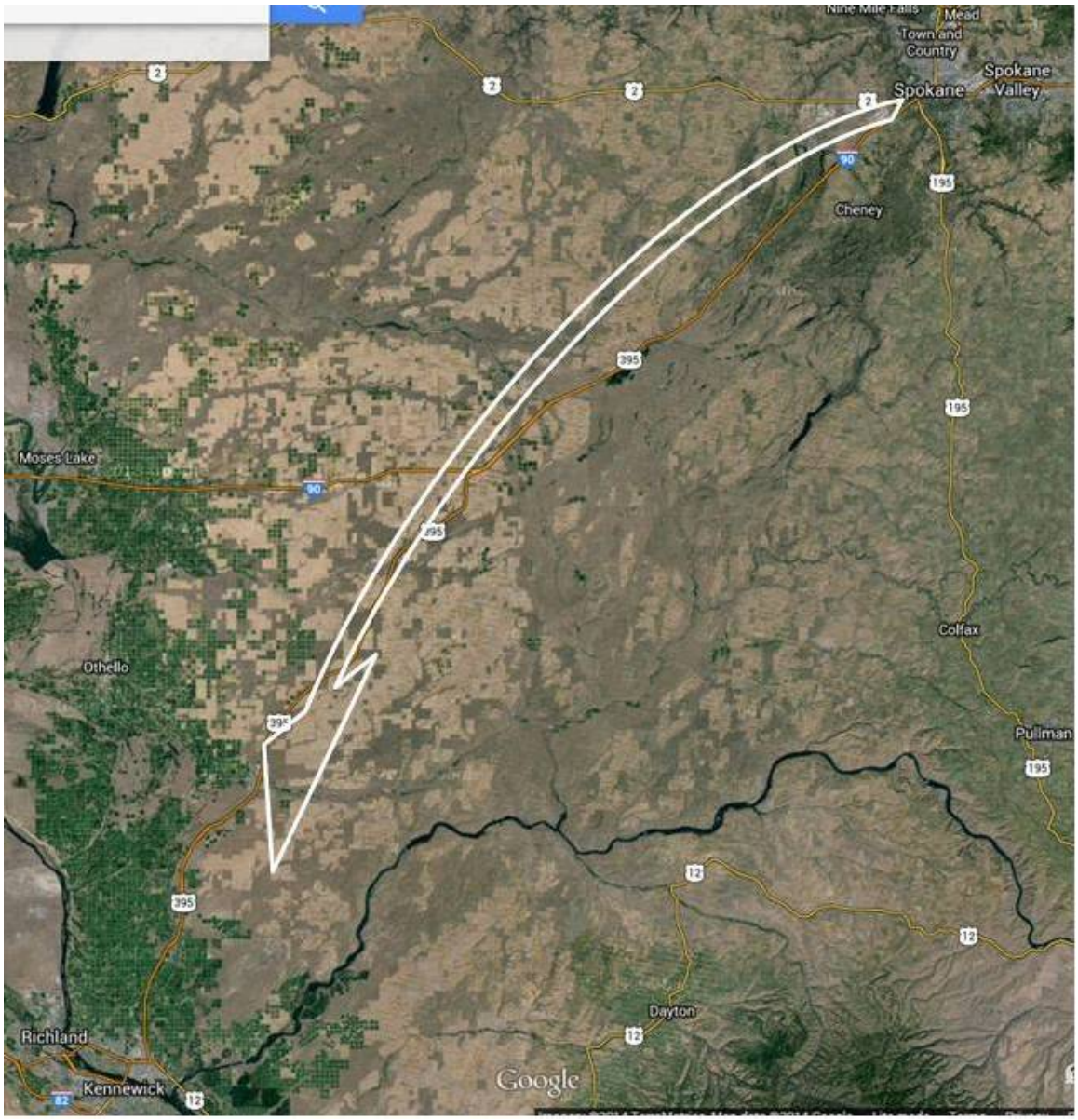


Figure 24. Columbia Basin NE of Kennewick, Direction of 10/28 Storm

The following reports included high wind warnings:

- NWS Pendleton at 2:40 am PDT reported, "Windy conditions across the north and western portion of the forecast area. This is expected to continue through the day then begin tapering off in the late afternoon and evening hours. The wind advisory will continue…"
- The Tri-City Herald reported the NWS issued a wind advisory that started on 5 PM PDT on the 27th. They predicted sustained wind speeds over 20 mph At 2:40 am PDT, in the Area Forecast Discussion, NWS Pendleton reported that windy conditions for the area would continue through to the late afternoon.
- At 5:31 PDT, NWS-Pendleton expected sustained North to Northeast winds of 25 to 35 mph with gusts around 45 mph. The Blowing Dust threat was moderate for Yakima, Kennewick and Hermiston, Oregon.
- At 5:55 am PST the NWS-Pendleton office issued Wind Advisory for Yakima Valley and Columbia Basin through October 29.

The Appendix for October 28 contains warnings and reports for this event.

Upwind Monitors: Upwind monitors at Spokane (Augusta Avenue), Lind (LIDW), Juniper Dunes Wilderness (JUFW1) and Escure (ESCW1) [89] show the storm's progression and impact. The LIDW and JUFW1 sites are the best available meteorological monitoring stations to represent the dust entrainment area for the 10/28/2013 event. LIDW is 50 miles NNE, JUFW1 is 20 miles NNE and Spokane is about 130 miles NNE of Kennewick. ESCW1 is located approximately 50 miles SW of Spokane and 80 miles NE of Kennewick in a largely agricultural area. This site is in the path of the storm. More information about these monitors is in Section 2.1 (page 5).

The sites record winds speeds as follows:

- The JUFW1 site reports instantaneous wind speed and wind direction once per hour as well as hourly maximum wind gust.
- The LIDW site reports maximum wind gust, mean wind speed and mean wind direction at 15-minute intervals.
- The ESCW1 site reports 10-minute average wind speed once an hour.

[89] The Spokane-August Avenue data is available at Ecology's website; LIDW, JUFW1and ESCW1 data are available through MesoWest.

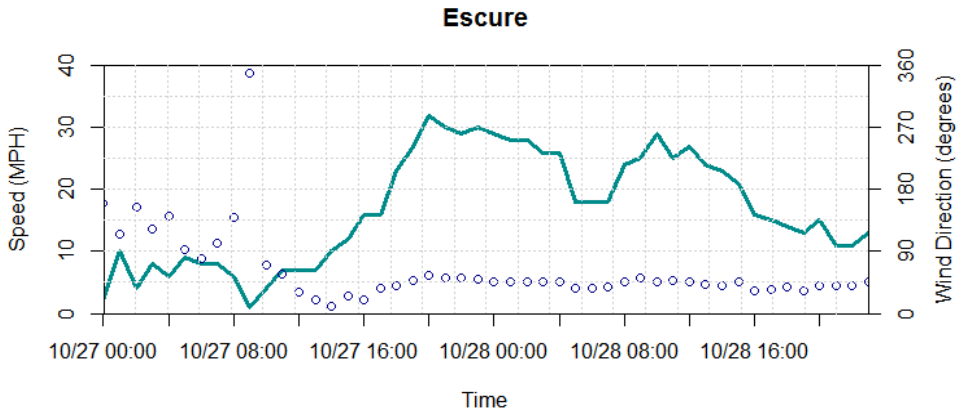


Figure 25. Time-series graphs of wind speed, wind direction and PM_{10} concentrations at relevant sites, 10/28 shows hourly average wind speed and direction, hourly average PM_{10} concentrations, and hourly maximum wind gust at Spokane (August Avenue), Lind and Juniper Wilderness (JUFW1).

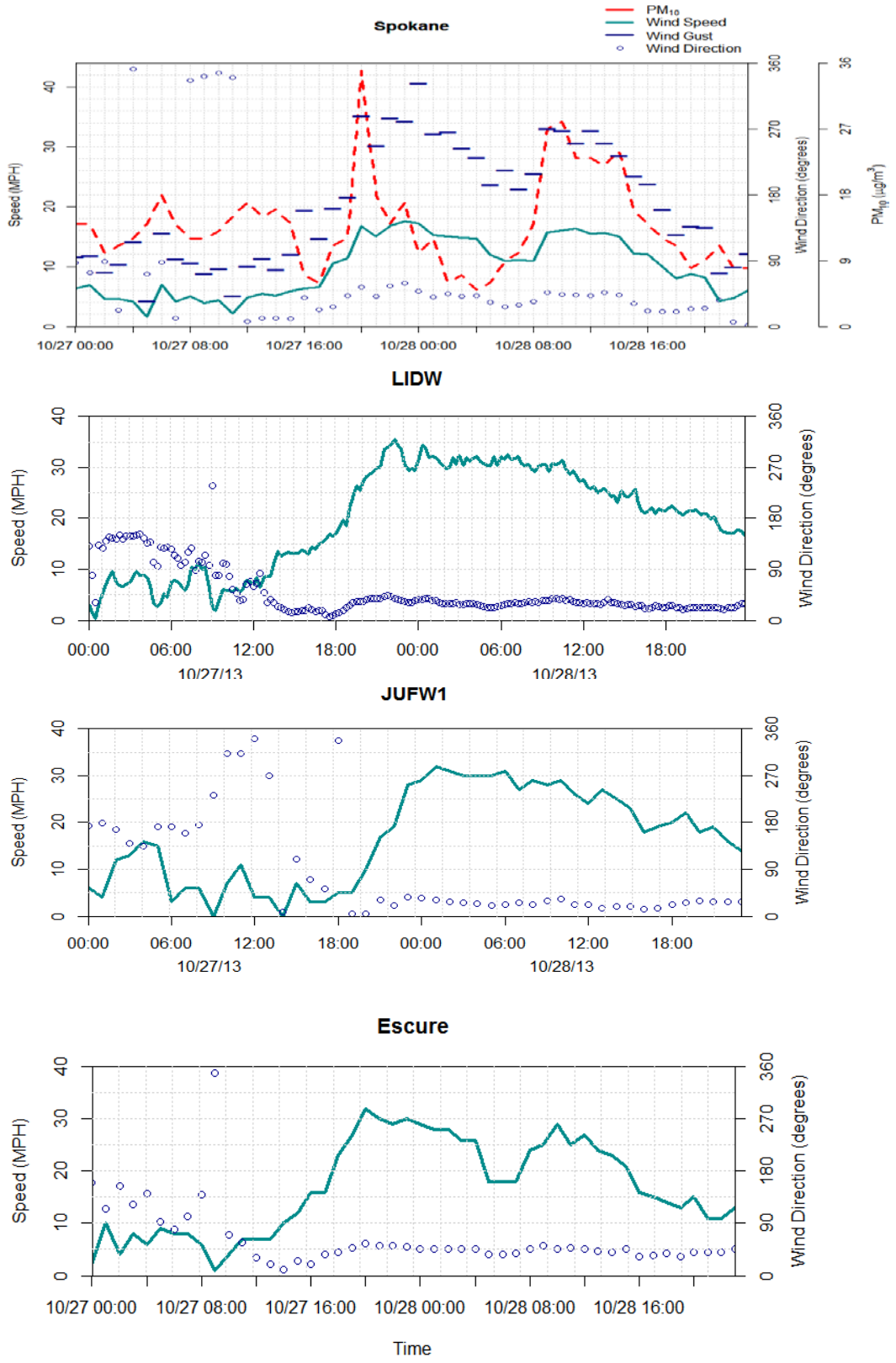


Figure 25. Time-series graphs of wind speed, wind direction and PM_{10} concentrations at relevant sites, 10/28

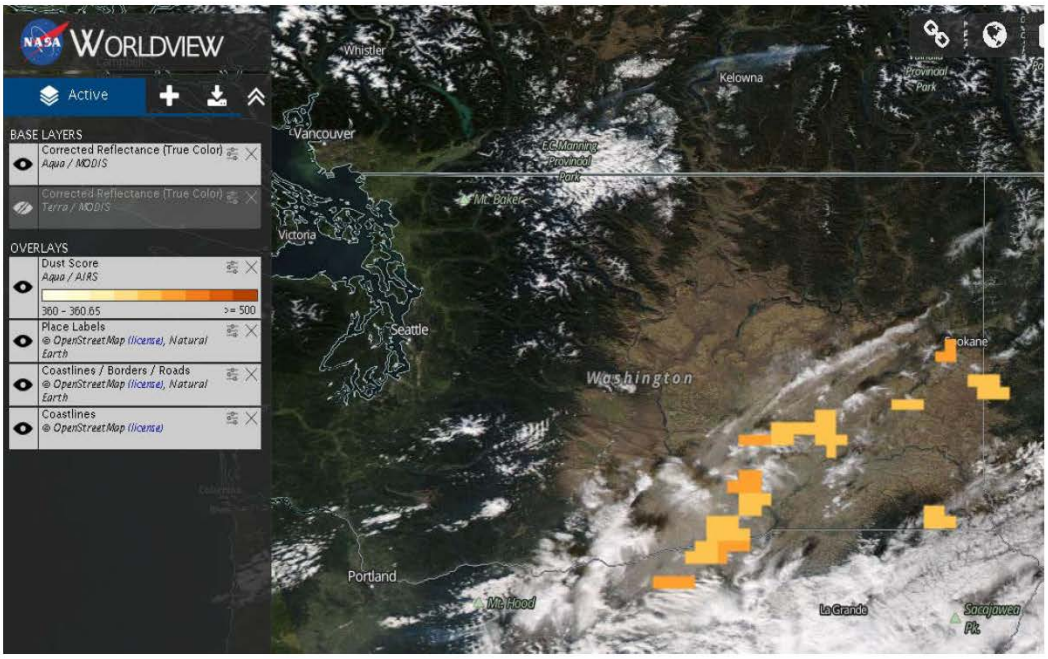
At the Spokane Augusta Avenue monitor, PM_{10} spiked just after 4:00 pm on the 27th and again on the 28th just about 8:00 am. As the storm got closer to Kennewick, the Lind (LIDW), Juniper Wilderness (JUFW1) and Escure (ESCW1) sites registered sustained, elevated wind speeds. Table 7 shows wind speeds and gusts at these monitors from 10/27 through 10/28. Note that LIDW had 18 hours during this event with wind speeds over 25 mph. Kennewick Metaline had gusts over 25 mph, but no one-hour periods that exceeded that level. While hourly winds did not exceed 20 mph at Spokane, wind gusts did consistently exceed 20 miles per hour frequently and over a sustained period.

Table 7. Regional wind speed summary statistics, 10/27/2013 - 10/28/2013

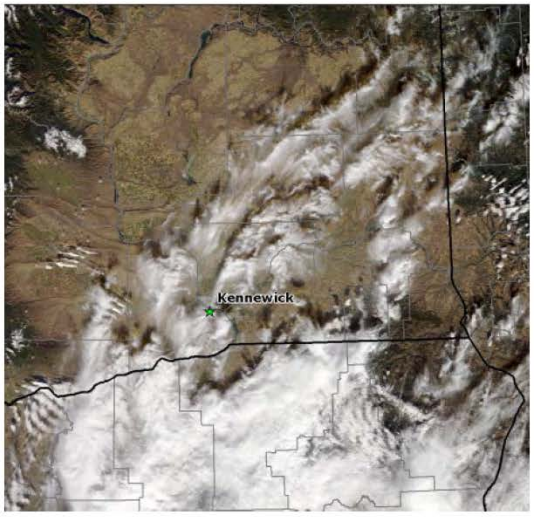
Site	Max Gust	Max 1-hour	Number of 1-hour periods >25 mph during event day
LIDW	52.6	34.5	18 (4 on 10/27; 14 on 10/28)
JUFW1	47	32	14 (1 on 10/27 and 13 on 10/28)
ESCW1	52	32	12 (5 on 10/27; 7 on 10/28)
Spokane (Augusta Ave)	40.6	17.6	0
Spokane Airport (KGEG)	39.1	29.9	2 (1 on 10/27; 1 on 10/28
KENMETA	28.6[90]	20.5	0

Satellite Images: Figure 26 shows MODIS Satellite views from two different satellites (named Terra and Aqua) at 11 am and 2 pm are shown. NASA satellite images show dust in the 2:00 pm image; NASA's dusts score rates dust levels high along the trajectory of the storm and is shown as orange and yellow squares along the storm's path.

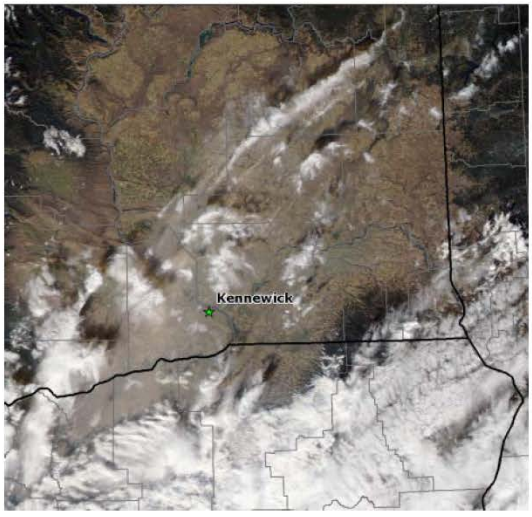
[90] 1-minute average speed used as a surrogate for gust at KENMETA site where gust is not measured



10/28/2013 Dust Score from Aqua/AIRS at ~2 p.m.



10/28/2013 Terra/MODIS imagery at ~11 a.m.



10/28/2013 Aqua/MODIS imagery at ~2 p.m.

Figure 26. October 28 NASA MODIS Satellite Images, ~11 am and ~2 pm, Dust Score - ~2 pm

Back Trajectories - 10/28: The next figures show back trajectories on October 28 at 50, 100 and 500 km. Ecology used HYSPLIT and NAM as described previous section. The three figures show that at each height, the storm initiates in Montana, from north and east of Kennewick.

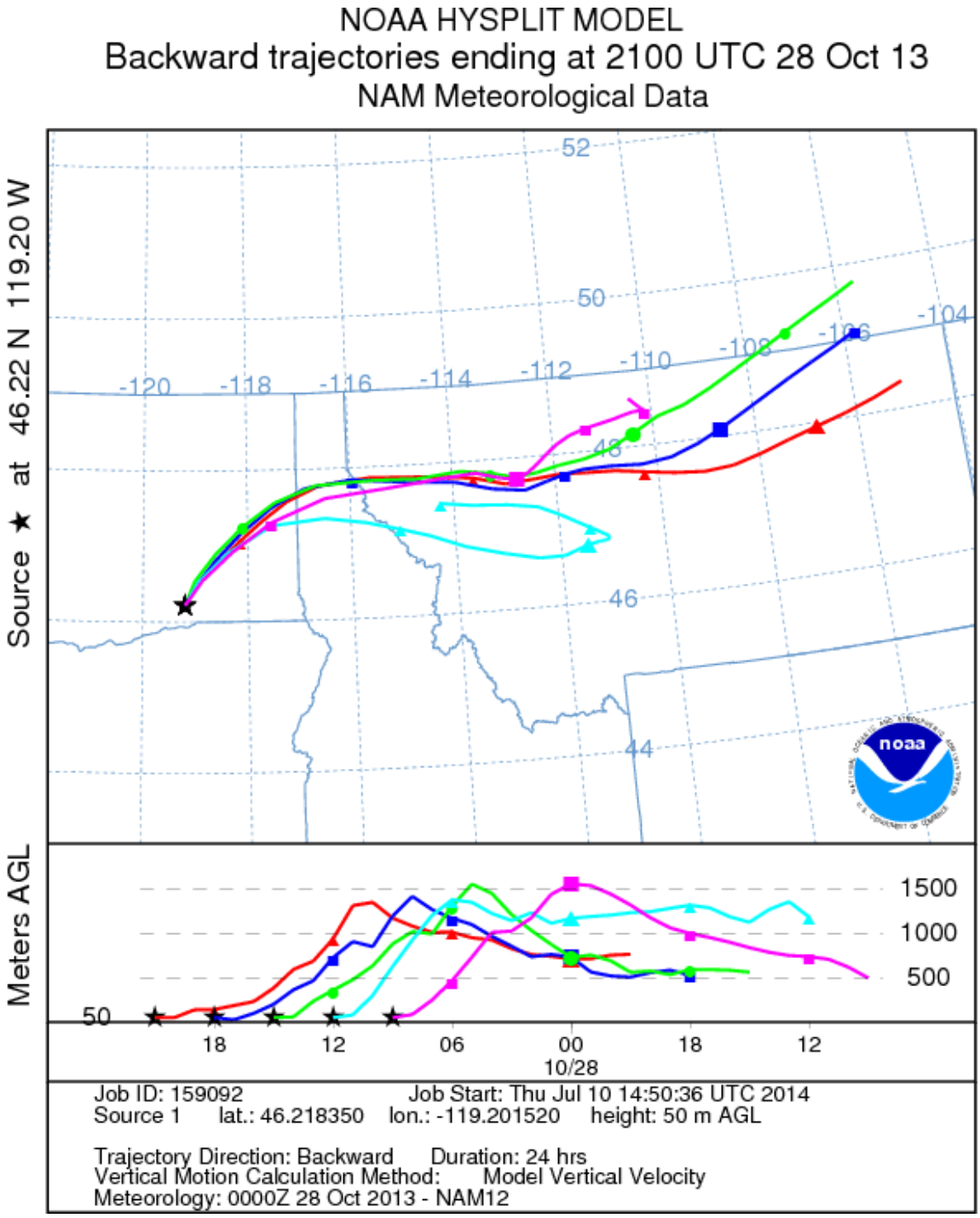


Figure 27. Back trajectory 10/28/13, 50 m

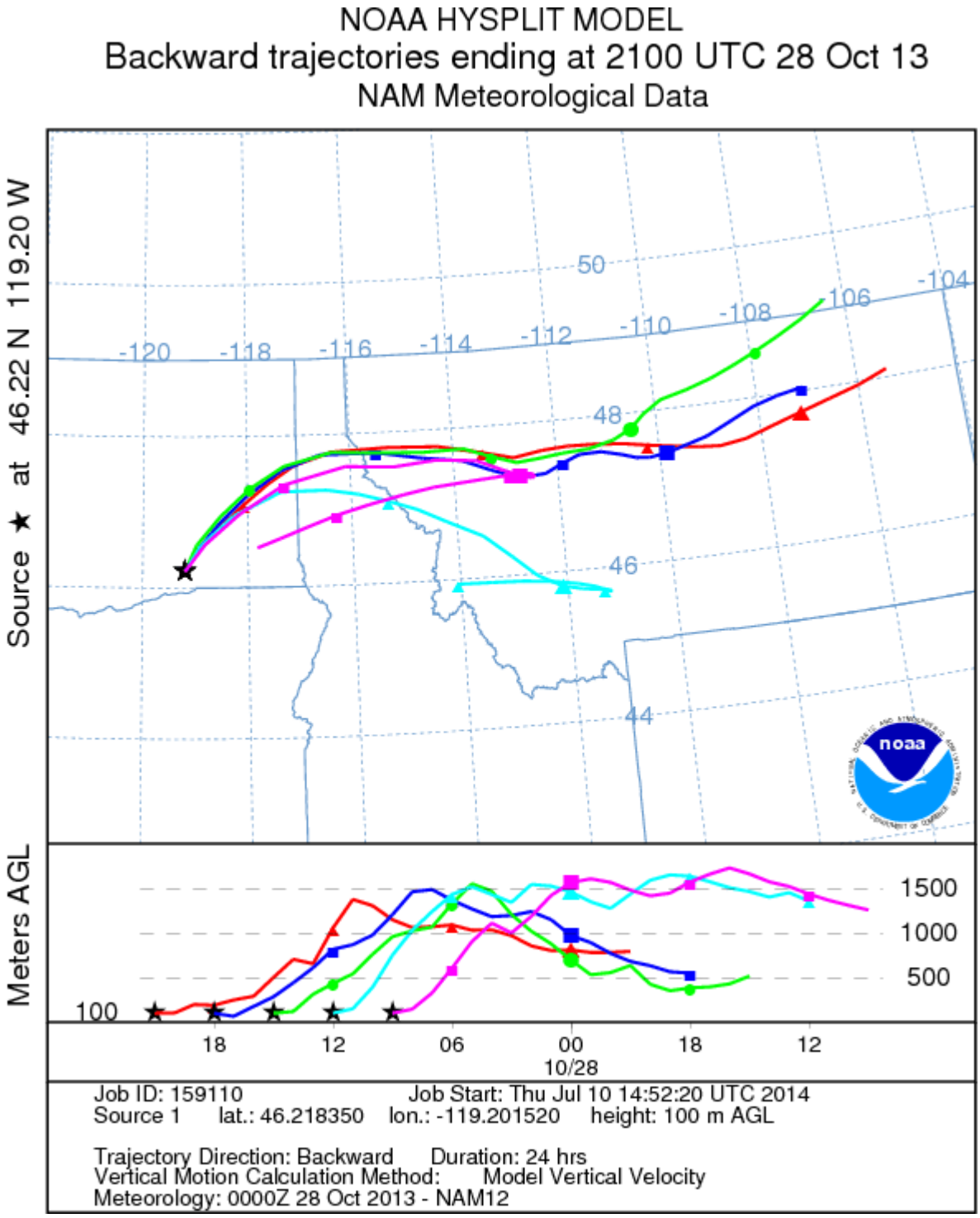


Figure 28. Back trajectory 10/28/13, 100 m

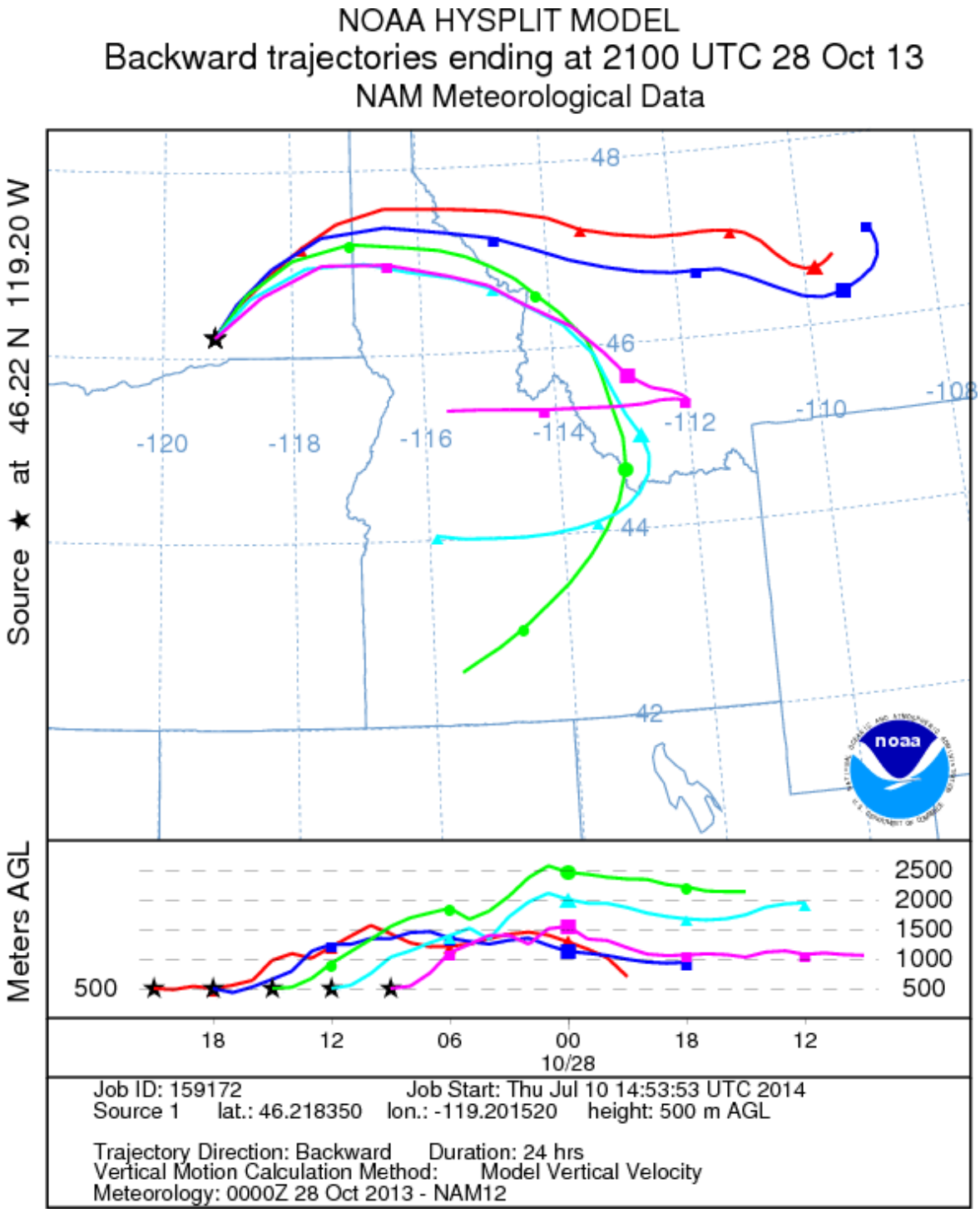


Figure 29. Back trajectory 10/28/13, 500 m

The close-up of the back trajectory in Figure 30 near Kennewick below confirms winds came out of the northeast.

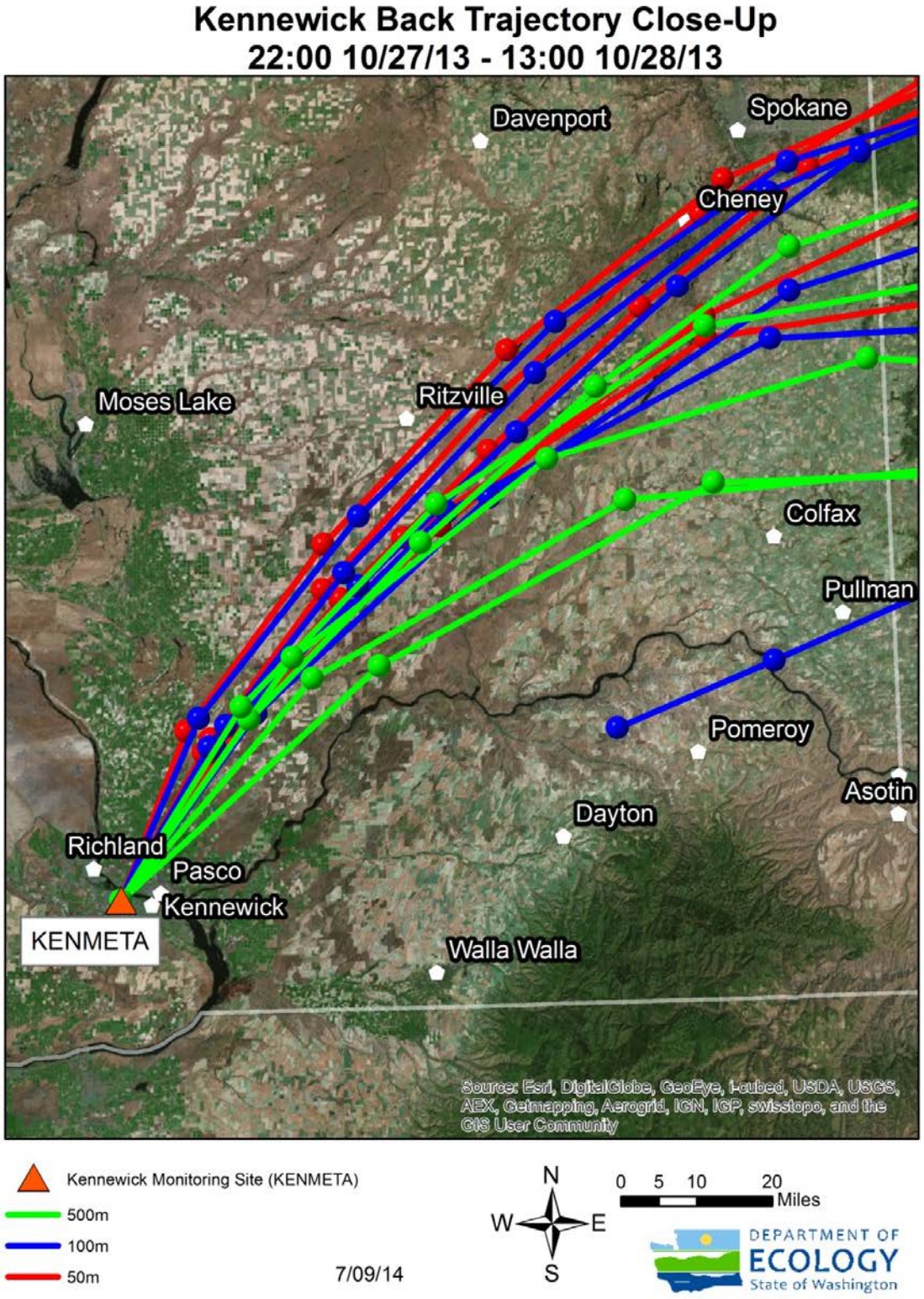


Figure 30. Back trajectory 10/28/13, Kennewick close-up

These trajectories support the case that the storm came from the northeast from Montana.

3. <u>At or Near Kennewick - 10/28</u>

Extensive period of high pressure at upper levels over Washington resulted in a dry spell for much of the month. This system also brought colder than normal temperatures at the surface and persistent fog. The Hanford Climatology report for October, 2013 reported that temperatures were slightly cooler than normal. Peak gusts for the month at Hanford were 49 mph and occurred on the day of the storm.

Precipitation was 78% of normal. There had been no precipitation since October 9, for three weeks, and then only 0.2 of an inch, leaving the area dry and vulnerable at the time of the event. Daily precipitation for October is shown in Figure below.

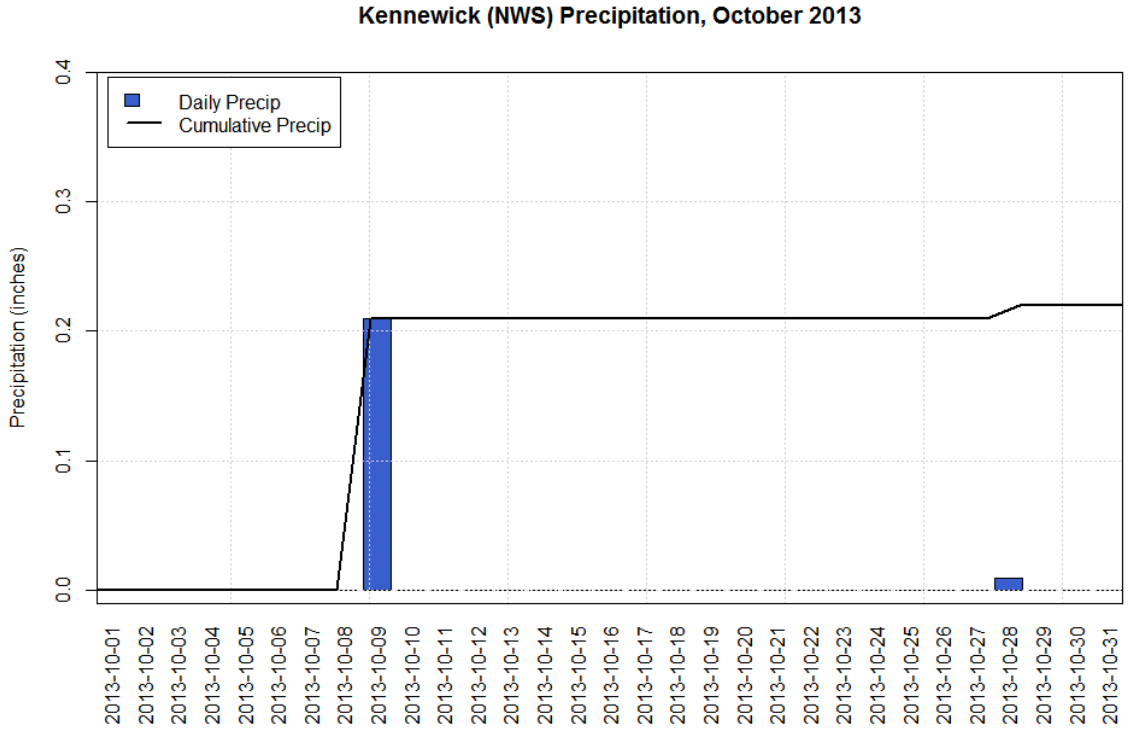


Figure 31. Daily Precipitation for October 2013

<u>Warnings and Advisories:</u> Warnings and advisories are in the October 28 Appendix. The Tri-City Herald reported the NWS issued a wind advisory that started on 5 pm on the Sunday the 27th; they extended the wind advisory through Monday, the 28th until 5 pm. They predicted sustained winds over 20 mph.

Hanford issued an advisory at 10:43 am on October 27 for winds over 35 mph on their site to last through much of Monday. Hanford predicted northeast winds sustained from 30 to 30 mph, with possible gusts up to 40 mph.

The Event: The October 28 event began with thunderstorms creating strong winds from the NE that started on the 27th from western Montana (up to 250 miles to the NE of Kennewick). Winds from the NE are unusual.

These thunderstorms created sustained winds that transported particulate matter from the NE across the eastern part of the Columbia Basin and across approximately 50 miles of mixed natural and urban, but predominantly agricultural lands.

Exceedance: PM_{10} first rose above 150 µg/m^3 at Kennewick slightly before the highest wind gusts at 10:48 pm (22:00 PST)) on October 27. The hourly PM_{10} concentration rose to 600 µg/m^3 at 6:30 am on October 28 and stayed elevated and above 150 µg/m^3 for about 18 hrs. Values reached their 1-minute peak of 704 µg/m^3 at 11:07 am. Levels did not drop below 150 µg/m^3 until about 2:30 pm (14:30 PST).

Figure 32 shows the PM_{10} and 1-minute wind speeds for the two days before and after the 28th.

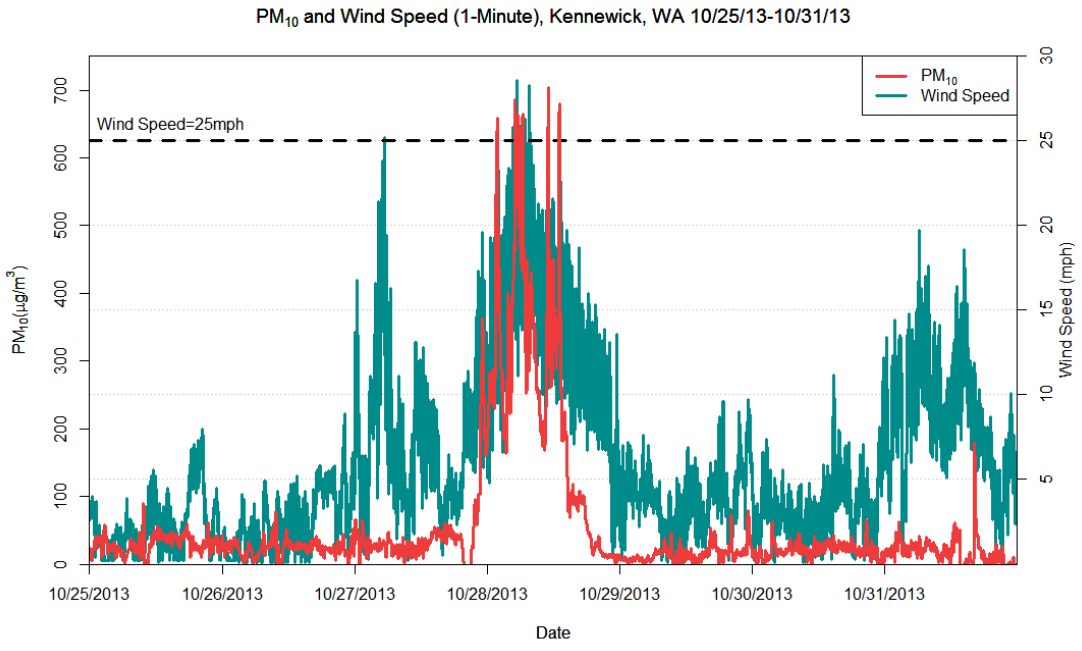


Figure 32. Time-series graph of 1-minute average wind speeds and PM_{10} concentrations, 10/25/13-10/31/13

Winds: Figure 33 shows how the wind changed direction from NNW to NNE before midnight on October 27. Wind Gusts – defined by the NWS as peak wind peaks over

18.4 mph (16 knots) — can also provide evidence of exceptional high wind events. Wind speeds measured at Kennewick station (KENMETA) began to gust consistently above 18 mph at about 12:30 am PST on October 28. While there were few 1-minute peaks over 25 mph, winds stayed elevated above typical levels for 14 hours. These winds reached a peak of 28.6 mph at 5:23 am; gusts above 18 mph occurred until about 2:45 pm.

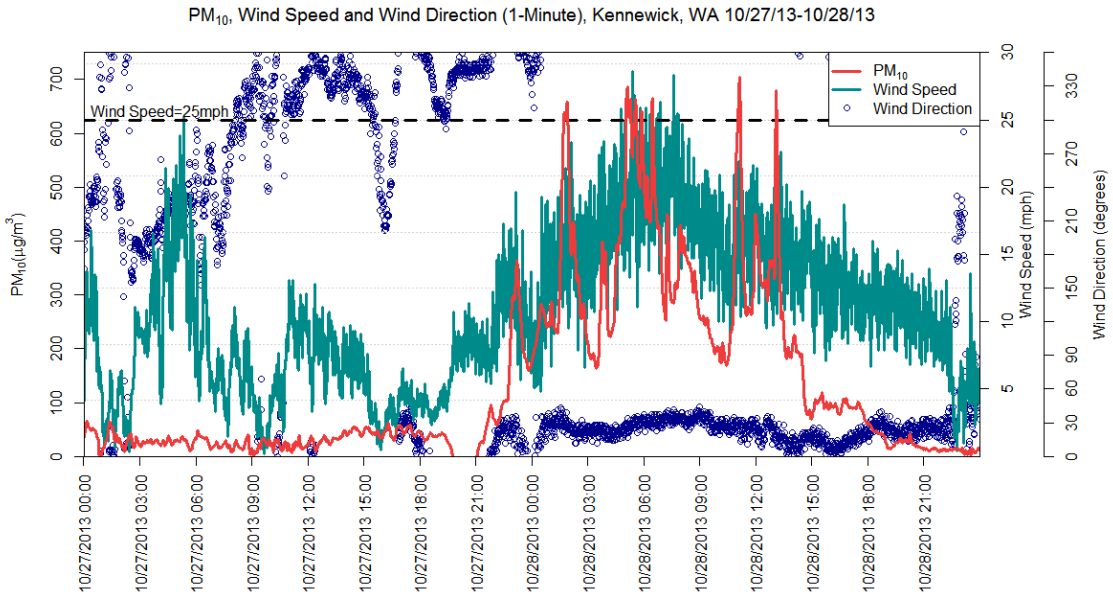


Figure 33. Time-series graph of 15-minute average wind speed, wind direction and PM_{10} concentrations at Kennewick monitoring site, 10/27/2013-10/28/2013

The pollution rose in Figure 34 shows that when the monitored values were above 150 µg/m^3, the winds were from the north and northeast, demonstrating a clear causal relationship. All winds on this day were from the north/ northeast, which is where the storm originated.

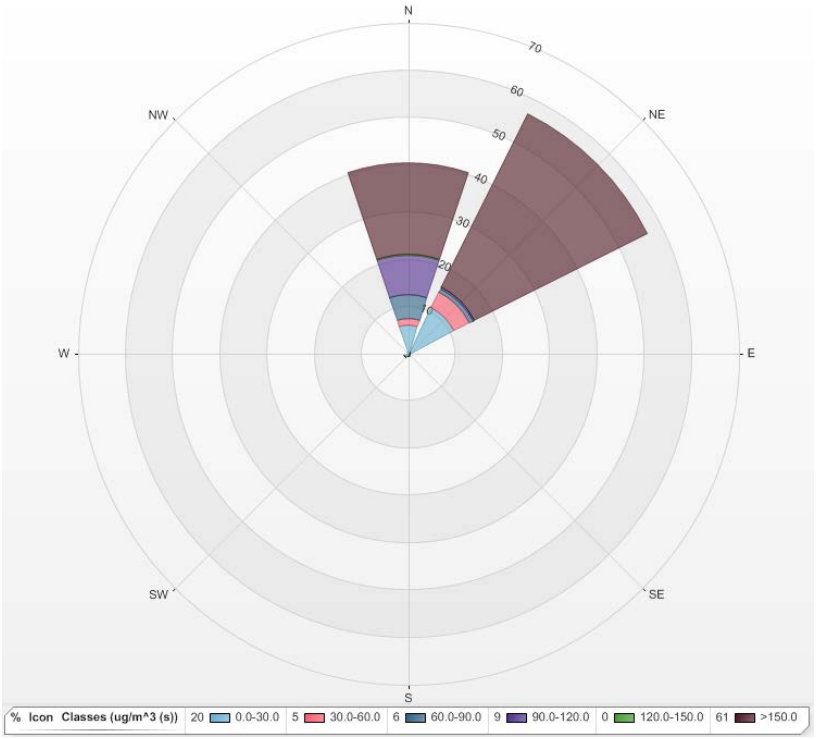


Figure 34. Pollution rose for Kennewick PM_{10} (1-minute average), 10/28/13.

Pasco airport (KPSC) recorded maximum winds of 31 mph from the north and the maximum gust of 43 mph at 1:53 PST (9:53 UTC[91]). The storm continued downwind of Kennewick southwesterly to Oregon and impacted communities in Oregon. No detail on downwind Oregon values are provided here.

Reports on the Storm:

- NOAA's Storm Event Database reported this event produced strong, damaging winds and numerous power outages for the Columbia Basin and Spokane. See the Event Narrative section in the October 28 Appendix.

- The Spokane Spokesman Review reported that NWS predicted gusty winds that should persist throughout the 28th. Gusts of 39 mph were recorded in Othello, 46 mph in Spokane and 47 mph in Wenatchee.

- Cliff Mass' blog says a big ridge of strong pressure brought very strong winds; saw maximum wind gusts of 110 mph at Rattlesnake Mountain.

[91] Coordinated Universal Time (UTC) is eight hours ahead of Pacific Standard Time.

- WSU's AgWeatherNet reported November 13th that the pleasant October weather was 'Blown Away' on the 28th.

What makes this day different than days when the standard was not exceeded is:

- Winds from the N to NE – Winds generally comes from the S and SW; it's unusual to have winds coming from the N to NE. (see wind roses above and in High Winds and Wind Patterns, Section 5.1.1)

- Sustained high wind speeds lasting over 14 hours

The meteorological record supports that the sustained winds caused the PM_{10} values to exceed the standard on October 28.

5.4 November 2, 2013

The information on elements common to all three events is covered in previous sections high winds created by thunderstorms overcame controls, entrained particulate matter and caused exceedances for all three events. Conditions contributing to the vulnerability of the soils in the region before the events are outlined in detail in the Climate, Soils and Common Factors sections.

Conceptual Model/Overview:

The November 2 event started in central to northeastern Oregon. Strong sustained winds from the southwest began in central Oregon (approx. 180 miles away). These winds carried particulate matter from Oregon— and also possibly from nearby hills and agricultural lands about ten miles southwest of Kennewick— to the monitor. Wind speeds stayed elevated for approximately 6 hours at Kennewick. The high speed winds overwhelmed controls and caused an exceedance at the Kennewick Metaline monitor.

Winds first rose above 25 mph at 10:20 am PST in Kennewick and stayed elevated for approximately 6 hours. PM_{10} first exceeded 150 µg/m^3 at 10:23 am and peaked at 5,445 µg/m^3 at 12:29 pm. Wind speed peaked at 47 mph at 12:31. Concentrations fell below 150 µg/m^3 at 4:43 pm.

Excerpts of some warnings and advisories are below; others are in the November 2 Appendix.

This event-day section for November 2 is separated into three parts:

1) Upwind from Oregon,
2) At or Near Kennewick and
3) Downwind beyond Kennewick

The wind data from upwind meteorological sites support the conceptual model sequence.

Figure 35 shows gusts (left) and hourly wind speeds (right) at NWS and RAWS sites across the region during the hour ending at 1:00 pm (13:00)[92] on 11/2/2013. The reported wind speeds are 2-minute averages at NWS sites and instantaneous values at RAWS sites, collected once per hour.

[92] MesoWest values are in Coordinated Universal Time (UTC), which is 8 hours later than Pacific Standard Time

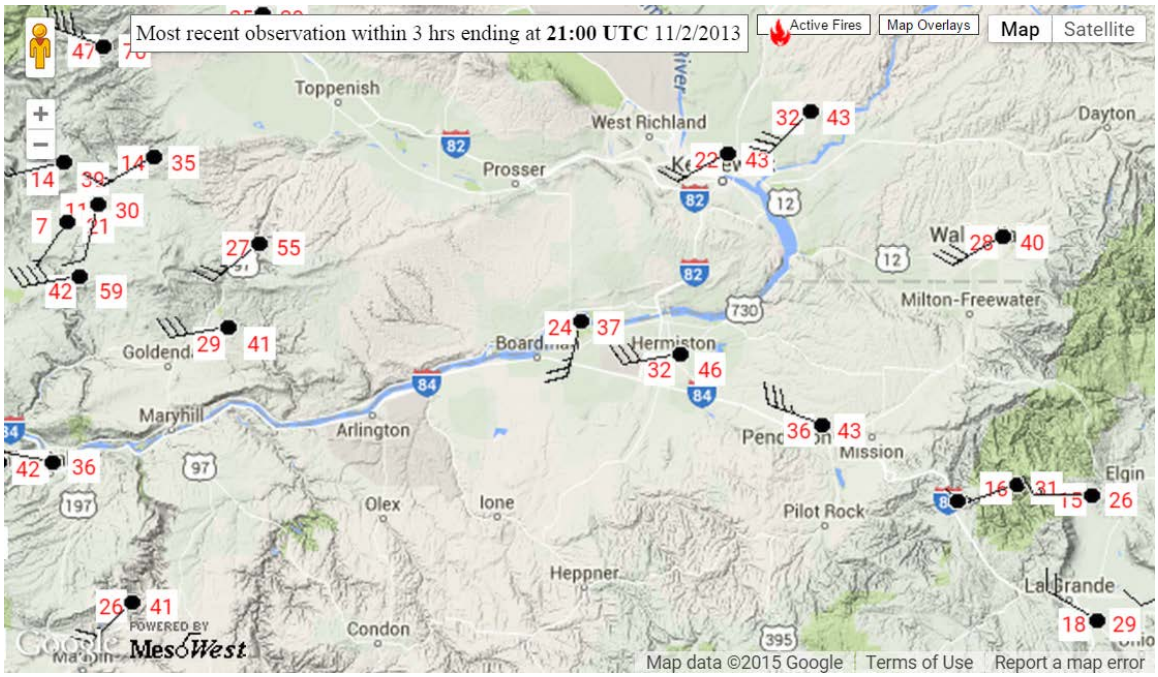


Figure 35. Wind Speeds Near Kennewick, 1:00 pm (13:00), 11/2/2013, (MesoWest)

Wind gusts were over 40 mph at Pendleton and Kennewick.

Path and Timeline

1. <u>Upwind from Oregon</u>

Figure 36 below highlights the area the storm traveled across and the dominance of agricultural lands in the source areas. The November 2 event started in the morning when strong winds and thunderstorms developed over central and northeastern Oregon, (approximately 30 and 180 miles southwest of Kennewick).

Figure 36 Photo of area southwest of Kennewick

Although there is no continuous PM_{10} data available from central or northeastern Oregon, several sites use nephelometers[93] to report $PM_{2.5}$ concentrations. Although dust usually contains a larger percentage of coarse particulate matter ($PM_{2.5}$ - PM_{10}), fine particulate matter ($PM_{2.5}$) readings can still be a useful surrogate. This is because generally as PM_{10} increases, so does $PM_{2.5}$. Using $PM_{2.5}$ readings, the impact and direction of the storm can be inferred.

However, for the November 2 event, there was not an increase in $PM_{2.5}$ noted where PM_{10} was elevated in Washington. While wind speeds were elevated over central and northeastern Oregon earlier in the day, there were no corresponding elevated $PM_{2.5}$ levels at the available monitors approximately 100 – 180 miles south of the Columbia River Gorge (CRG).[94]

[93] A nephelometer is a monitor that measures light scatter – an indirect measure of particulate matter.
[94] This makes it less likely that the source of the dust was south of the CRG. Ecology considered a fire scar in Sunnyside as a potential source of the dust, but since dust from this source would had to have passed right over Pendleton, and there wasn't a noticeable increase of $PM_{2.5}$ there, it is unlikely that the dust came from this source. See footnote 40.

Figure 37 below shows wind speed, gust and direction as well as hourly average $PM_{2.5}$ concentrations at Pendleton and Bend. Wind speed and direction values in Figure 37 are 2-minute averages collected hourly. Meteorological data were obtained from the National Weather Service at the Pendleton and Redmond airports. Wind gust is the maximum gust reported during each hour when wind speeds exceed 18.4 mph[95]. PM_{10} values are not recorded at these stations, so we used $PM_{2.5}$ values. While the majority of dust is composed of coarser particles– 2.5 to 10 microns, there is some percentage of dust in the fine fraction – 2.5 microns or less.

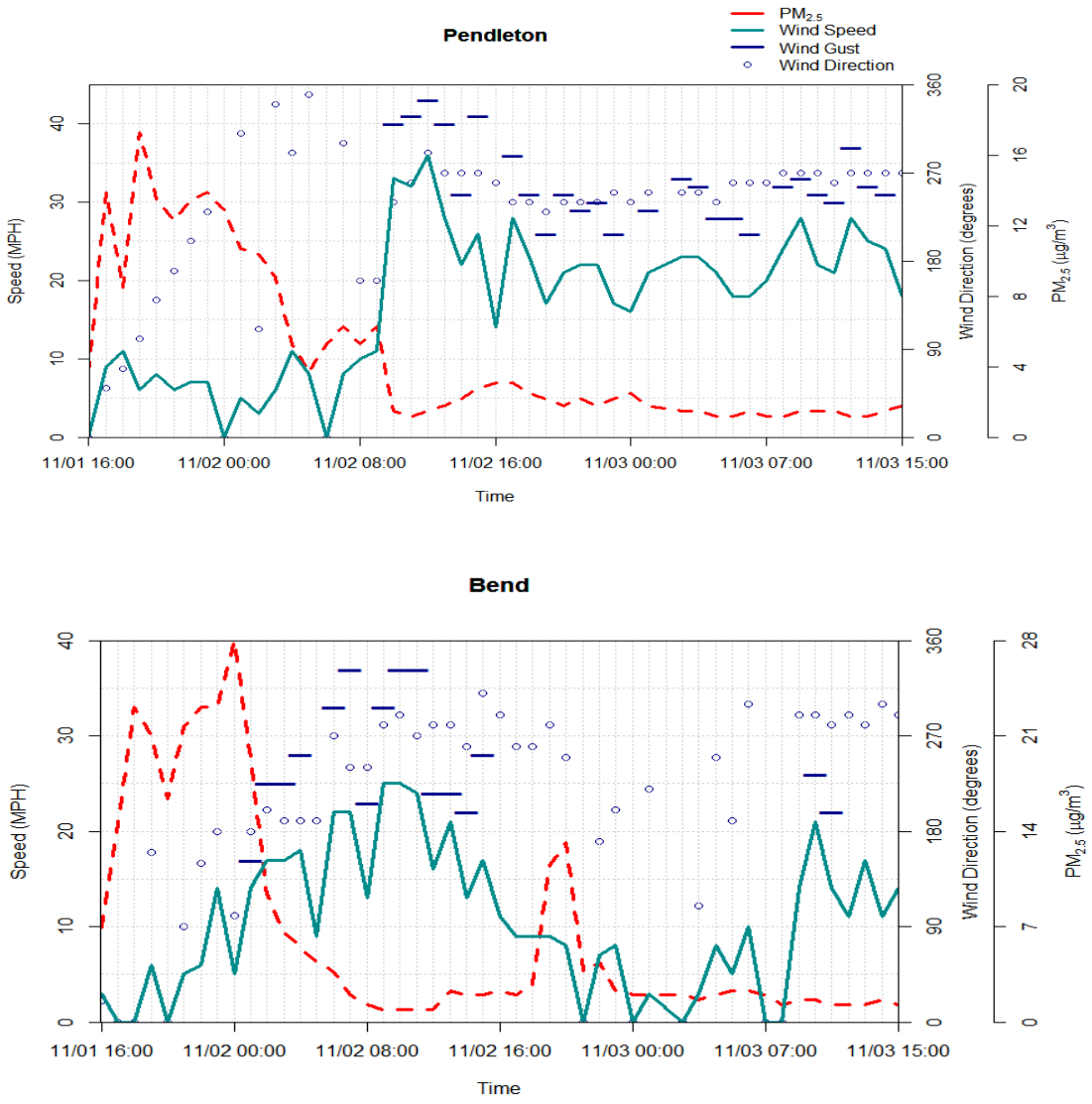
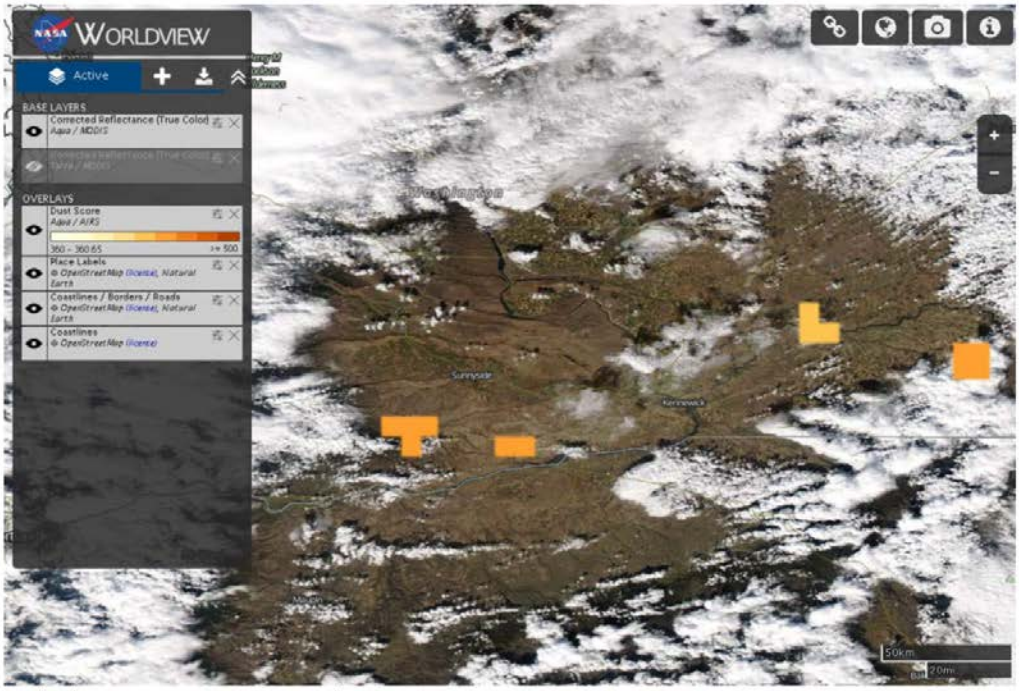


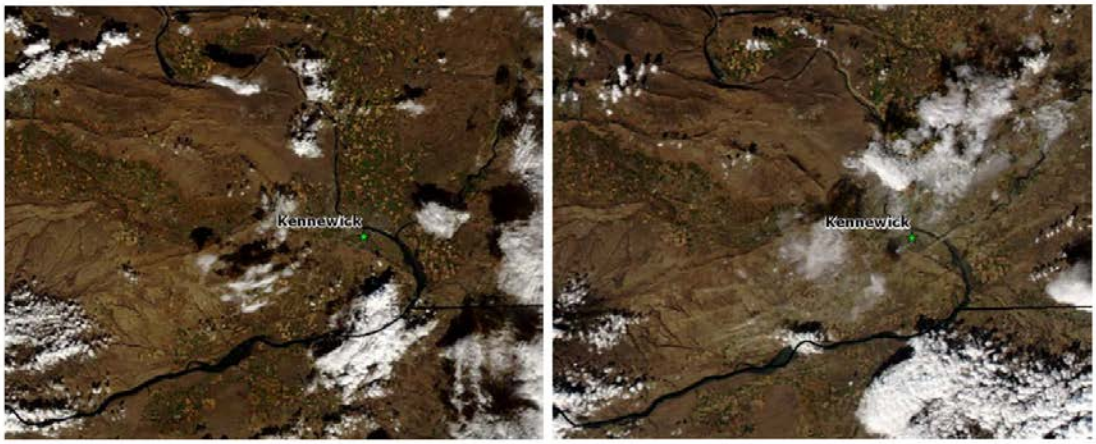
Figure 37. Time-series graph of 1-minute wind speeds and $PM_{2.5}$ concentrations, 11/1-11/3

[95] NWS defines gusts as when the peak wind speeds are above 16 knots (~18.4 mph).

Satellite images – 11/2: Satellite views from two different satellites (named Terra and Aqua) at 11 am and 2 pm are shown in Figure 38. NASA satellite images show dust tracks in the 2:00 pm image; NASA's dusts score rates several areas high at this time, as shown by the orange and dark yellow shading.



11/02/2013 Dust Score from Aqua/AIRS at ~2 p.m.



11/02/2013 Terra/MODIS imagery at ~11 a.m. 11/02/2013 Aqua/MODIS imagery at ~2 p.m.

Figure 38. November 2 Satellite Images NASA MODIS, ~11 am and ~2 pm, Dust Score 2 pm

Back Trajectories – 11/2: The back trajectories at 50, 100 and 500 meters support the winds coming from the southwest of Kennewick.

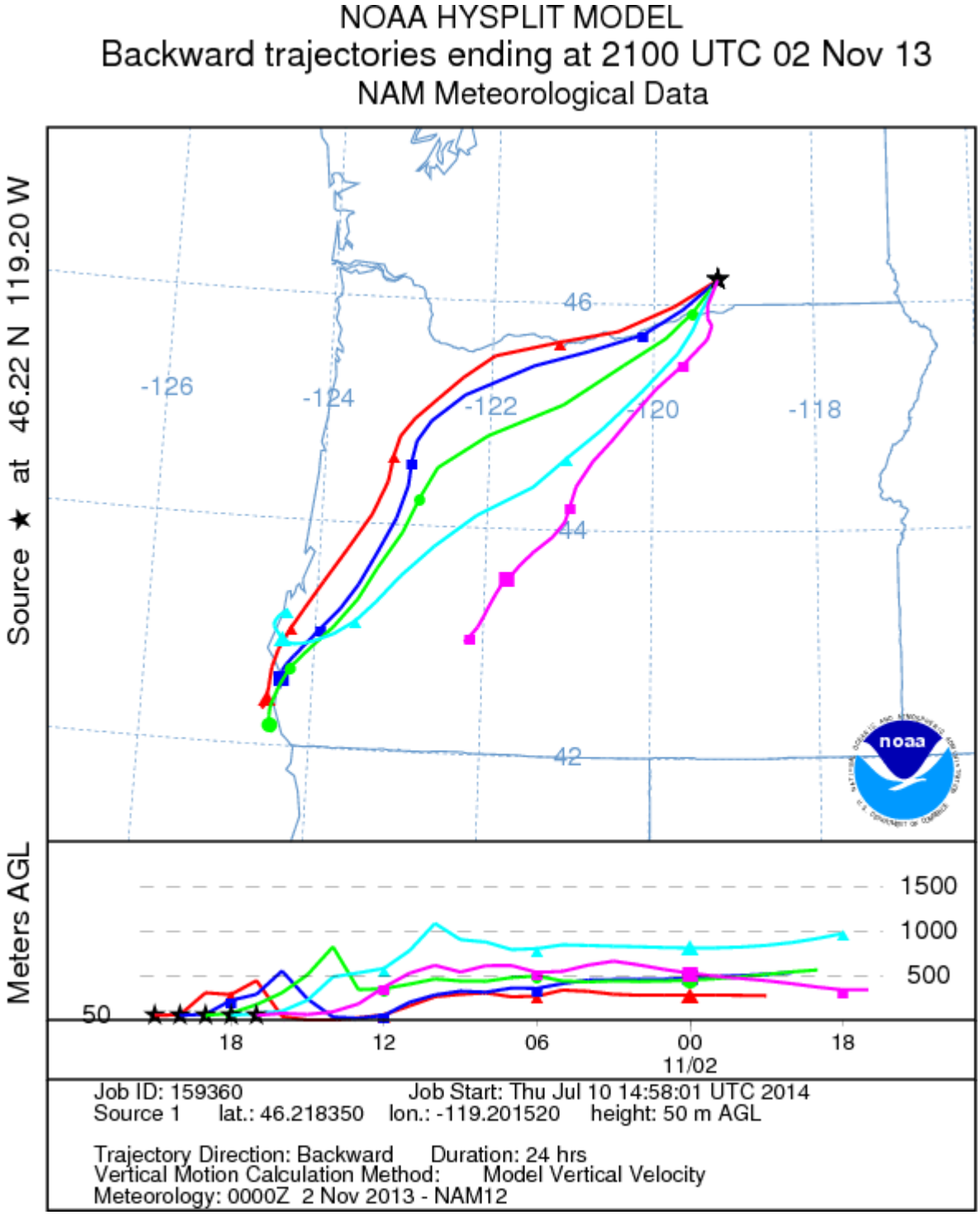


Figure 39. Back trajectory 11/02/13, 50 m

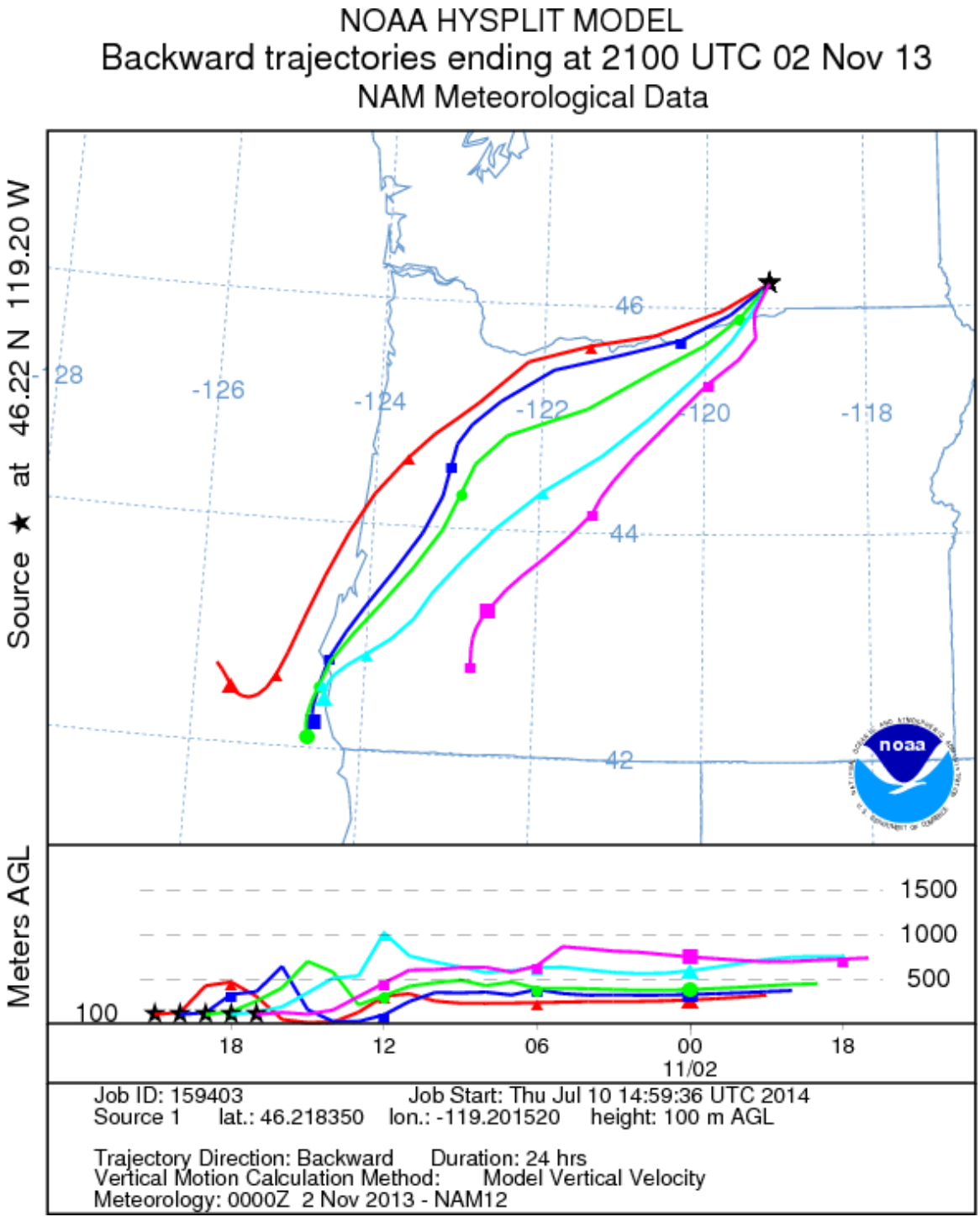


Figure 40. Back trajectory 11/02/13, 100 m

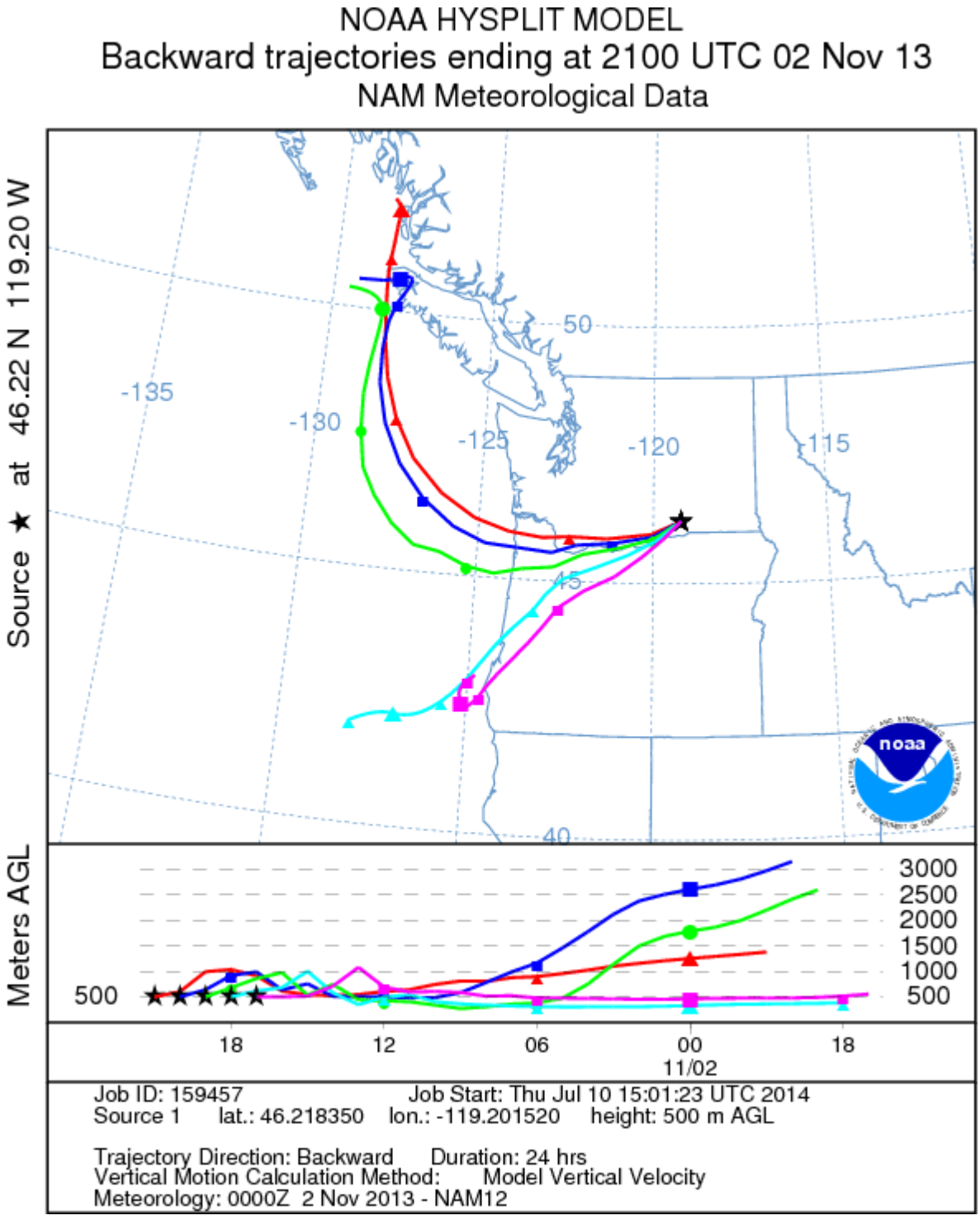


Figure 41. Back trajectory 11/02/13, 500 m

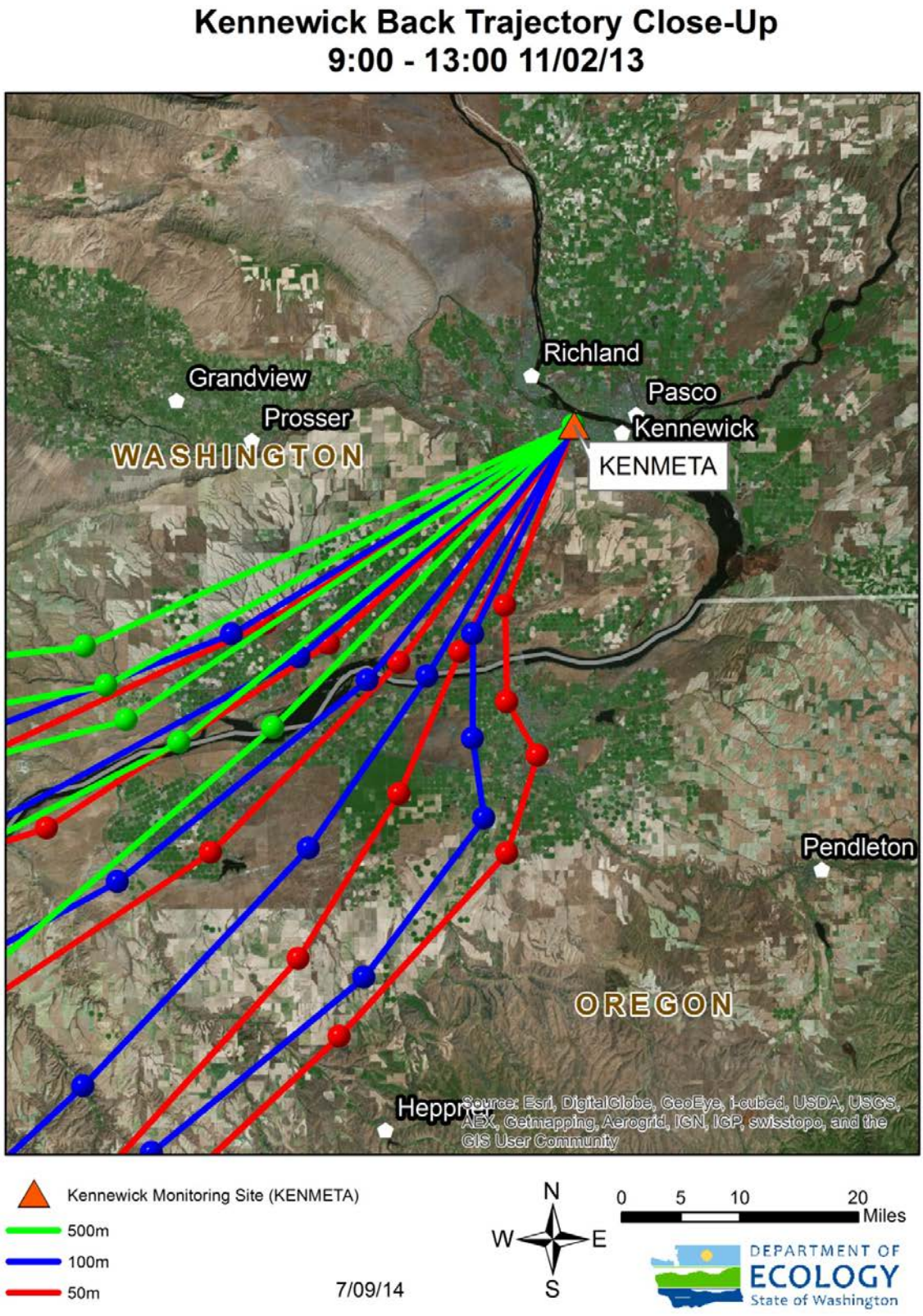


Figure 42. Back trajectory 11/02/13, Kennewick close-up

2. At or Near Kennewick, Saturday, November 2

The Washington State Climatologist report for November notes that the first weekend of the month was eventful. Thereafter, the weather changed to a wetter pattern, but Pasco (one of the Tri-Cities) was still extraordinarily dry. With only 0.40 inches of precipitation, this was Pasco's fifth driest month since records began in 1945[96]. For precipitation near the end of October, see Figure 43. The first two days of November saw only a trace of rain.

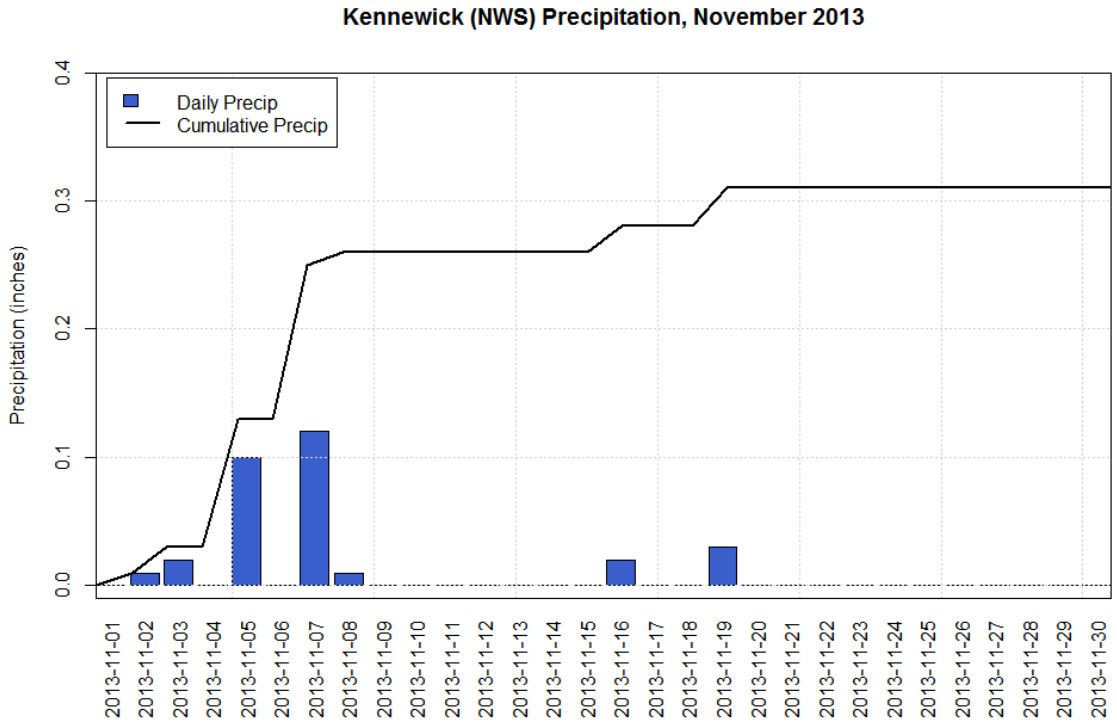


Figure 43. Kennewick Precipitation for November 2013

NWS Pendleton and Hanford issued advisories and reports on the event. Winds were predicted to last all day. These warnings are in the November 2 Appendix.

NWS Pendleton issued a wind advisory at 11:37 am. They predicted winds from the southwest from 30 to 40 mph and gusts up to 50 mph. They issued a Blowing Dust Potential report and Hazardous Weather Outlook valid through the rest of Saturday, 11/2 and into Sunday morning. Blowing Dust Potential was predicted to be very high for

[96] Office of the Washington State Climatologist, *November Event Summary,* Volume VII, Issue 12, December 3, 2013.

Benton and nearby counties through 6:00 am November 3. Later in the day, at 1:38 pm, they continued to predict strong winds — 20 to 30 mph— with gusts up to 50 mph that would continue in to the evening.

Hanford issued an Adverse Weather Advisory for the Hanford site for 11:00 to 10:00 pm (2200) PDT Saturday. This advisory reported a cold front was expected for late Saturday morning, winds from 20 to 30 mph with gusts of 40 to 50 mph were expected by noon and would continue into the evening. Their Data Table notes blowing dust on November 2 and a cold front moving in at 11:00 am.

The Event: The rise, peak and fall of wind speed and PM_{10} were almost simultaneous for the November 2 event. Wind speeds first rose above 25 mph at 10:20 am PST, peaked at 47.4 mph at 12:31 pm and stayed elevated for approximately 6 hours until 4:42 pm. PM_{10} concentrations rose in tandem with wind speed, first exceeding 150 µg/m^3 at 10:23 am and peaking at 5,445 µg/m^3 at 12:29 pm. Concentrations fell below 150 µg/m3 at 4:43 pm.

Figure 44 shows wind speeds and PM_{10} values from three days before to three days after the event.

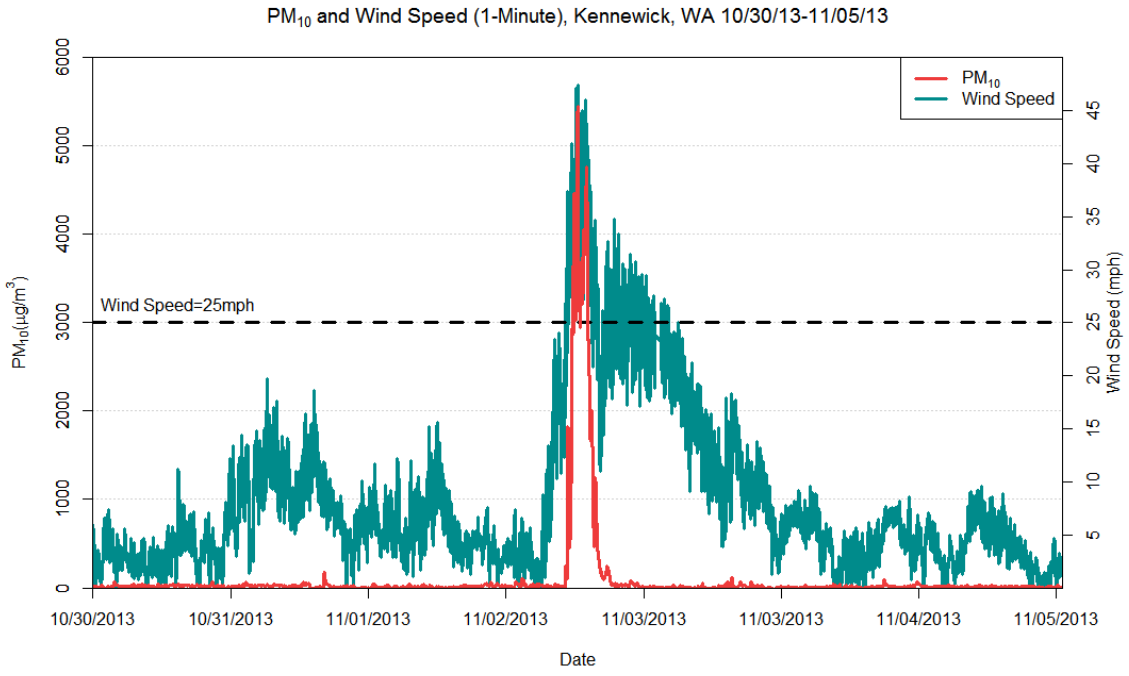


Figure 44. Time-series graph of 1-minute average wind speeds and PM_{10} concentrations, 10/30/13-11/05/13

Sustained Winds: The highlighted values in Table 8 shows the number of times at KENMETA had 2-minute periods over 25 mph that occurred during each hour on November 2. Two-minute peaks over 25 mph occurred consistently over a 14 hour period. The period with the most 2-minute periods over 25 mph was between 10:00 am and 3:00 pm; the wind was over 25 mph for almost the entire period from 10 am through 11 pm.

Table 8. Number of 2-minute periods at KENMETA when wind was over 25 mph, 11/2

Date: Time	#	Date: Time	#
11/2/2013 1:00	0	11/2/2013 13:00	30
11/2/2013 2:00	0	11/2/2013 14:00	29
11/2/2013 3:00	0	11/2/2013 15:00	26
11/2/2013 4:00	0	11/2/2013 16:00	2
11/2/2013 5:00	0	11/2/2013 17:00	14
11/2/2013 6:00	0	11/2/2013 18:00	14
11/2/2013 7:00	0	11/2/2013 19:00	19
11/2/2013 8:00	0	11/2/2013 20:00	11
11/2/2013 9:00	0	11/2/2013 21:00	19
11/2/2013 10:00	15	11/2/2013 22:00	12
11/2/2013 11:00	30	11/2/2013 23:00	13
11/2/2013 12:00	30		

Nearby Monitors: Nearby monitors BPHOR and BKEN also recorded winds from the southwest and elevated wind speeds corresponding to this storm.

BPHOR: Bonneville Power Administration's Horse Heaven Hills Monitor (BPHOR) is located approximately 30 miles SW of KENMETA, within one mile of the north shore of the Columbia River. Due to its lower elevation[97] and proximity to the river, this site represents the wind patterns through the Columbia River Gorge that *preceded the dust event* on 11/2/2013. This site reports instantaneous wind speed and wind direction as well as peak wind gusts every 5 minutes.

BPKEN: BPA's Kennewick monitor is at an elevation of 1990 feet, near the highest point in the segment of the Horse Heaven Hills nearest Kennewick, which reach approximately 2000 feet at their peak. This site reports instantaneous wind speed and wind direction as well as peak wind gust every 5 minutes. BPKEN is the *nearest monitor to one of the suspected dust entrainment areas* for the high wind events on 11/02/2013.

[97] Elevation is approximately 500 feet, relative to the elevation of 265 feet at the nearest point on the Columbia River.

Data for these two monitors can be accessed through Utah's MesoWest website.

The figure below shows Kennewick values compared to these other two monitors.

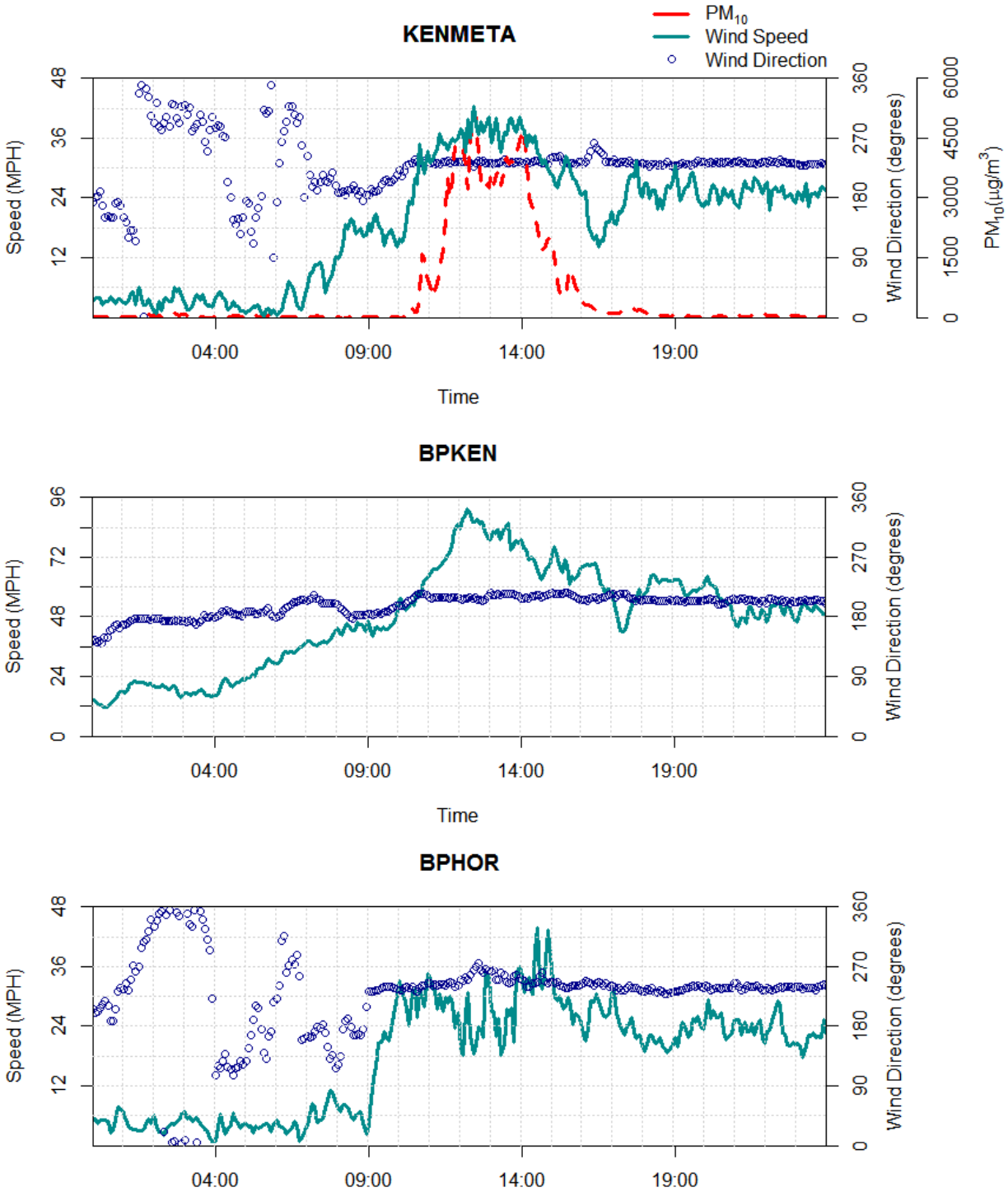


Figure 45. Time-series graphs of wind speed, wind direction and PM_{10} concentrations at relevant Kennewick-area monitoring sites, 11/02/2013

Wind Gusts - Wind Gusts – defined by the NWS as peak wind speeds over 18.4 mph (16 knots) can also provide evidence of exceptional high wind events. Summary statistics of wind speed data observed at these three stations are shown in Table 9.

Table 9. Regional wind speed summary statistics, 11/2/2013

Site	Max Gust	Max 1-hour	Number of times wind speeds > 25 during event
KENMETA	47.4[98]	38.0	0
BPKEN	101.6	86.1	19
BPHOR	59.6	35.5	7

Figure 46 shows that when PM_{10} concentrations were high on November 2, winds were from the southwest. The southwest trend was even more pronounced during the hours of highest PM_{10} levels, demonstrating a clear causal relationship between the storm and the exceedance.

[98] 1-minute average wind speed used as a surrogate for gusts at KENMETA site where gusts are not measured.

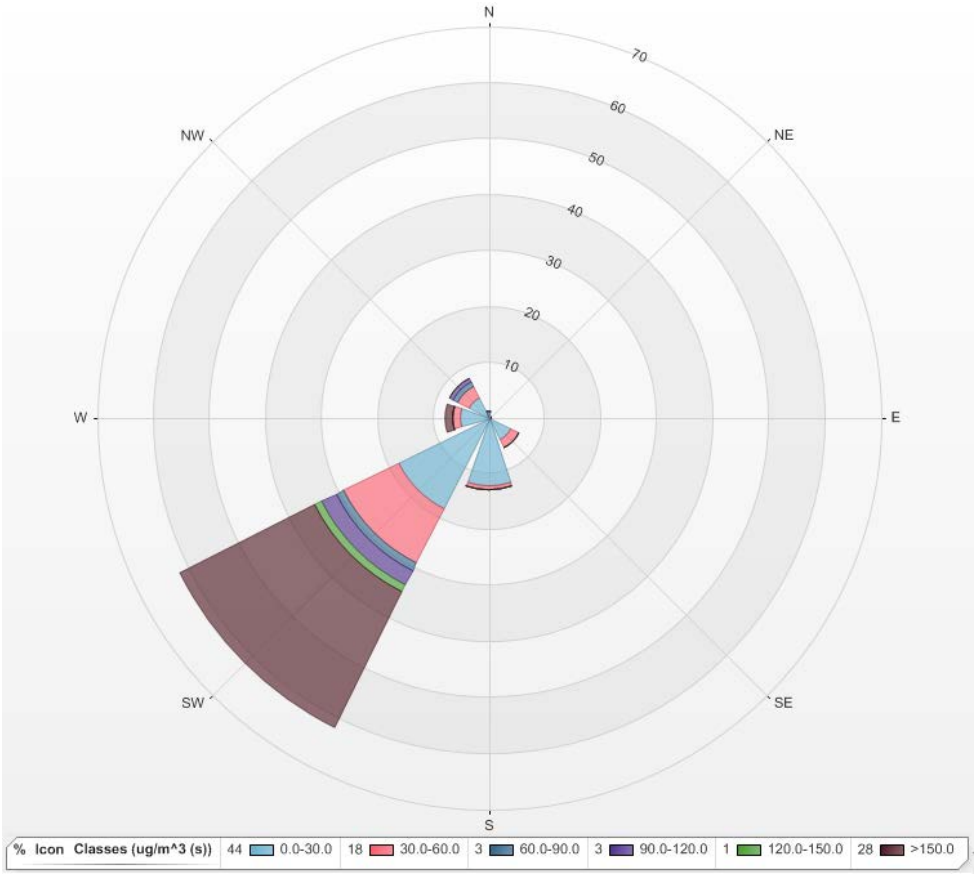


Figure 46. Pollution rose for Kennewick PM_{10} (1-minute averages), 11/2/13.

1. Downwind beyond Kennewick

The storm continued downwind of Kennewick northeasterly across the Columbia Plateau and other communities were impacted. Spokane-Augusta Avenue data support this. [99] Winds began building about 9:00 am, peaked at 21 mph at about 4 pm (16:00) and stayed elevated all evening. PM_{10} readings were also elevated - two hours were over 150 µg/m3 – but the 24 hour standard was not exceeded.

Tri-City Herald reports,

- High Winds cause damage throughout Mid-Columbia, November 2 Strong winds are wreaking havoc on the Mid-Columbia, tipping over at least one semi-truck, uprooting trees….
- Wind Whips Mid-Columbia on Sunday, November 3. School damaged, many trees down as blustery conditions strike region.

[99] Data can be accessed on the above named $PM_{2.5}$ sites can be found on Ecology's monitoring website at https://fortress.wa.gov/ecy/enviwa/Default.htm

The meteorological record and back trajectory support the timeline outlined. The Tri-City Herald reports are in the November 2 Appendix.

This day differs from nonevent days in the following ways:

- Winds at these speeds are infrequent, only 1-2% of the time[100]
- Concentrations over 150 µg/m^3 are rare and usually in conjunction with high winds

The record shows that high winds and high concentrations occurred at the same time, providing evidence that that the winds caused the exceedance. The meteorological records support the conceptual model of the storm.

[100] Per NOAA Climatology Report, http://www.wrcc.dri.edu/narratives/WASHINGTON.htm.

6 Exceptional Event Rule Criteria

The Exceptional Event Rule, found at 40 CFR 50.1 (j), lists the criteria that must be met, on a weight of evidence basis, to qualify high concentrations of air pollution for exclusion from compliance determinations.

Under 40 CFR 50.14(c)(3)(iv), the air agency must submit a demonstration that meets the criteria of the rule to justify exclusion of data. The criteria are:

- The event affects air quality (AAQ);
- The event is not reasonably controllable or preventable (nRCP); and
- The event is caused by human activity that is unlikely to recur (HAURL) at a particular location or [is] a natural event.[101]
- There is a clear causal relationship between the measurement under consideration and the event that is claimed to have affected the air quality in the area (CCR);
- The event is associated with a measured concentration in excess of normal historical fluctuations, including background (HF); and
- There would have been no exceedance or violation but for the event (NEBF)

The information below satisfies these requirements.

6.1 Affects Air Quality

The EER requires agencies to document that the identified source of an exceptional event truly affected air quality at the location of the monitor in question. EPA's interim high wind guidance indicates that if historical fluctuations (HF) and a clear causal relationship (CCR) have been adequately demonstrated, then the affects air quality (AAQ) element will have been met.[102]

See Clear Causal Relationship section (page 118) and Historical Fluctuations (page 119).
All three events affected air quality. Values exceeded the 24-hour PM10 NAAQS as shown below.

Dates (2013)	*Values, µg/m^3*
September 15	227

[101] The EER further defines a natural event as an event in which human activity plays little or no direct causal role.
[102] EPA, *Interim High Winds Guidance*, May 2013, page 22.

October 28	224
November 2	620

6.2 Not Reasonably Controllable or Preventable

This section will demonstrate that these high wind events were

1. Natural events that *were not reasonably controllable or preventable* (nRCP) and
2. Anthropogenic sources for the source areas were *controlled with reasonable and appropriate measures*.

The three wind events were not preventable or controllable. The high winds were created by thunderstorms and were natural events. The wheat and cover crop kill due to the late spring frosts in April/May and early freezes in October also were beyond our control and support the overall demonstration. For each event, nRCP is satisfied as part of the evidence to be evaluated on a weight-of-evidence basis. These sections will identify:

- Default and area-specific wind threshold - Section 6.2.1, page 92
- Calculated sustained wind speed and assess general wind direction - Section 4.2.2, page 93
- Potential Sources - Section 4, page 19
- Controls Analysis - Section 4.2.4, page 93

Sources in Oregon were not preventable or controllable by Ecology. By virtue of the fact that Ecology has no authority over Oregon sources, nRCP for Oregon is satisfied.[103] That said, agricultural conservation programs that minimize erosion are federal programs, so Oregon has the same access to controls for their agricultural lands described in the Controls Analyses section.

6.2.1 Wind Threshold

EPA Guidance: EPA recommends that states develop area-specific wind thresholds that reflect that area's specific characteristics. However, EPA also recognizes 25 mph as the speed at which most controls could be expected to be overwhelmed. Sustained wind speeds above this or an area specific threshold are capable of overwhelming reasonable controls on anthropogenic sources or causing emissions from natural undisturbed areas in

[103] EPA, *Interim Exceptional Events Rule Frequently Asked Questions,* May 2013, page 26

arid, semi-arid, or seasonally dry regions.[104] All three events had periods at upwind stations when 1-hour wind speeds were over 25 mph.[105] Therefore, the three events meet the threshold criteria.

6.2.2 Wind Speeds and Direction

See each Event Day section and the corresponding Appendices for wind speeds and direction information. All three days had periods with hourly wind speeds over 25 mph at either upwind sites or at KENMETA. The meteorological record supports that high wind events caused the exceedances and were not controllable or preventable. Table 10 shows the summary data at KENMETA for the three events.

Table 10. Kennewick, Metaline Wind Data Summary for Event Days

	September 15, 2013	*October 28, 2013*	*November 2, 2013*
Max sustained wind (1-hour average)	20.6	20.5	38.0
Max gust (1-minute average)	43.3	28.6	47.4

6.2.1 Controls Analysis:

EER Requirements: States must demonstrate that sources were 'reasonably well controlled at the time the event occurred'.[106] EPA can consider appropriate RACM measures, where available, as a reference point when evaluating reasonableness of controls.[107]

This section addresses EER requirements for showing the agricultural lands were reasonably controlled at the time of the event.

This section describes:

- Which controls where in place at the time of the events,

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[104] EPA, *Interim 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*, May 2013, page 69. In the EPA's weight-of-evidence analysis of high wind dust events, the EPA will generally assume that sustained wind speeds above the applicable high wind threshold (area specific or 25 mph default) are capable of overwhelming reasonable controls on anthropogenic sources or causing emissions from natural undisturbed areas in arid, semi-arid, or seasonally dry regions, such as in Clark County, NV.

[105] Ibid., page 18, Section 3.1.4: "…the EPA generally 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."

[106] 72 FR 13576

[107] EPA, *Interim 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*, May, 2013.

- How dust is minimized from agricultural activities,
- What agencies are responsible for controls for agriculture, and
- How agriculture incentive programs work.

Ecology views the level of control in place before the fall of 2013 as sufficient to fulfill reasonable control requirements under the ERR. Unfortunately, the high winds and unusual weather were exceptional events and overwhelmed these controls.

Level and Reasonableness of Controls: The level of control needed for sources varies depending on the area's attainment status. BACM is only required for nonattainment areas (NAA)[108]. Generally, the EPA does not expect areas classified as attainment, unclassifiable, or maintenance for a NAAQS to have the same level of controls as areas that are nonattainment for the same NAAQS. There are no PM_{10} nonattainment areas in eastern Washington today. Wallula (near Kennewick) and Spokane were once out of compliance with the 1987 PM_{10} standard. Both areas were back in compliance by the early 1990s and are now maintenance areas entering their second decade of compliance.

In addition, EPA does not consider it reasonable to expect downwind states to require controls in upwind states.[109]

Controls Analysis*:* Controls in place in the Horse Heaven Hills and the Columbia Plateau in the fall of 2013 were:

- USDA-NRCS Conservation Measures for Agriculture
- Washington's Natural Events Action Plan – for high risk Columbia Plateau counties
- Washington State Fugitive Emission rules
- Wallula Maintenance Plan Control Strategies
- Benton Clean Air Agency Urban Fugitive Dust Policy

Oregon Controls: While Ecology believes much of the particulate matter could have been entrained on the Washington side of the Columbia River, we could not rule out the possibility that some of the particulate matter came from Oregon. Oregon growers are eligible for the same federal conservation programs under USDA-NRCS as Washington growers. The Exceptional Event Guidance states that one state cannot be responsible for controls in another state.

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[108] Ibid, Section 3.1.2.2 Consideration of attainment status in judging reasonableness, page 14.
[109] EPA, *Interim Exceptional Events Rule Frequently Asked Questions*, <http://www.epa.gov/ttn/analysis/docs/EER_QA_Doc_5-10-13_r3.pdf>, page 26.

USDA-NRCS Conservation Measures for Agriculture: Control measures implemented for agriculture are provided in this section since dust from agricultural areas contributed to the Fall 2013 exceedances. Some agriculture areas are at risk for soil erosion at times from wind and are potentially a source of fugitive dust.

> *The appropriate way to control agricultural sources is through U.S. Department of Agriculture- Natural Resource Conservation Service (USDA-NRCS or NRCS) conservation measures and programs*.

USDA-NRCS Conservation Programs: USDA-NRCS – previously known as the Soil Conservation Service — with the support of their conservation partners — has a 75 year history of managing soil erosion. NRCS is the recognized expert in the field. They are integrated into the farming community and have far greater knowledge than any other agency. USDA Agricultural Research Service (ARS) and Land Grant Universities have proven that keeping crop residues on the soil surface by reducing or eliminating tillage is effective in controlling erosion. Therefore, NRCS has emphasized the use of reduced tillage and maintaining surface crop residues — post-harvest and during fallow — for controlling wind and water erosion in the Pacific Northwest[110].

Food Security Act: Title XII of the Food Security Act, enacted on December 23, 1985, introduced two conservation provisions to address environmental concerns associated with soil erosion and wetland conversion. Highly Erodible Land (HEL) Conservation, or the "Sodbuster" provision, implemented a federal law requiring that all producers of agriculture commodities must protect all cropland classified as highly erodible from excessive erosion. To comply with the Food Security Act Program Highly Erodible Land Compliance (HELC) provisions, producers must certify that they will not plant or produce an agricultural commodity on HEL without following an NRCS approved conservation plan. Farmers must follow an acceptable conservation system that details minimum levels of surface residue during the critical erosion period, typically fall through spring. Every producer must be compliant with this Food Security Act Program to receive future FSA and NRCS funds. Both the Farm Service Agency and NRCS have oversight of this program. NRCS provides the technical spot checks and FSA issues the penalties. These requirements have been in every Farm Bill since this Act was passed. Every program at FSA and NRCS since 1986 requires HEL compliance.

[110] RI Papendick and W.C. Moldenhauer, *Crop Residue Management to Reduce Erosion and Improve Soil Quality, Northwest*, ARS Conservation Research report Number 40, May 1995.

2014 Farm Bill: The Agricultural Act Of 2014 (2014 Farm Bill) reinstated the Food Security Act Program, with highly erodible land conservation tied to federal crop insurance programs. All producers wanting federal subsidy insurance protection must certify that they are following an NRCS approved conservation plan that details minimum levels of surface residue during the critical erosion period. HEL producers in violation will be ineligible for most USDA programs, including premium subsidies for federal crop insurance, beginning with the 2016 crop year. This will require those not previously using other USDA programs but using USDA Risk Management Association's (RMA) federal crop insurance to comply with HEL provisions.

While participation in NRCS Conservation Title Programs is voluntary, hundreds of agricultural producers implement conservation practices that keep the soil protected and dust out of the air. Each grower works with their county conservation district and chooses measures that meet their goals and are appropriate for their particular land characteristics.

USDA also offers three major financial assistance programs — called Conservation Title Programs — to help farmers adopt conservation practices to reduce soil erosion, improve soil health and reduce the risk for air quality concerns. While some growers implement conservation practices without receiving cost share or other financial assistance to conduct the practice, most use USDA Programs' financial assistance to implement no-till or mulch/reduced tillage management conservation practices.

NRCS conservation measures are funded through federal Farm Bills. Recognizing the problems associated with soil erosion on agricultural cropland, rangeland, forest land and other environmentally sensitive cropland areas, funding for conservation provisions have been included in Farm Bills since 1985.

The 2002 - 2014 Farm Bill legislations reauthorized three Conservation Title programs designed to treat natural resources concerns. Treating soil erosion is the top resource concern for these programs:

- Farm Service Agency's Conservation Reserve Program (CRP)
- NRCS Environmental Quality Incentives Program (EQIP)
- NRCS Conservation Security/Stewardship Program (CSP)

These Conservation Title Programs include conservation practice standards and are recognized as Best Management Practices (BMPs).

These practices stem from recommendations from the USDA's National Agronomy Manual to reduce wind erosion based on the following principles[111]. They include:

- Establishing and maintaining adequate vegetation or other land cover, including crop residue
- Reducing unsheltered distance along the wind erosion direction
- Producing and maintaining stable clods or aggregates on the land surface
- Roughening the land with ridge and/or random roughness

These Conservation Measures have been identified as Reasonably Available Control Measures (RACM) and Best Available Control Measures (BACM) for agricultural sources.

Other Entities Recognize NRCS practices: NRCS is the recognized expert on treating agriculture resource concerns. EPA, Western Regional Air Partnership (WRAP), Ecology and many others nationwide have recognized USDA-NRCS conservation measures as reasonable controls and are appropriate and reasonable controls for agriculture:

- EPA, USDA and NRCS worked collaboratively on identifying the NRCS Conservation Practice Standards that impact air quality and issued the Agricultural Air Quality Conservation Measures –Reference Guide.[112] This technical tool includes measures that provide RACM and BACM controls, where agriculture has already determined to be a contributor to air quality issues. [113]
- EPA's High Wind Exceptional Event Guidance[114] acknowledges that NRCS programs provide best management practices to be considered as valid control measures
- In preamble of 2006 Particulate Matter NAAQS and 2008 ozone NAAQS, EPA recommends that USDA-approved conservation systems and activities may be implemented to achieve RACM and BACM.
- Oregon's Natural Hazards Mitigation Plan, Emergency Management Plan, Dust Storm Chapter[115] references USDA conservation measures.

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[111] USDA-NRCS, *National Agronomy Manual*, October 2002, p. 502-14.

[112] USDA, NRCS, EPA, *Agricultural Air Quality Conservation Measures, Reference Guide for Cropping Systems and General Land Management*, October 2012. <http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1049502.pdf>, accessed July 1, 2015.

[113] In 2014, Washington NRCS adopted this Reference Guide as Air Quality Technical Note 1 and included Table 1, designating NRCS Conservation Practice Standards to treat PM 10 (See Appendix F).

[114] Environmental Protection Agency, *Attachment 2, Interim 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*, June 2012, page 125.

State and regional groups that acknowledge and reference NRCS practices:

- Washington State Department of Ecology, Columbia Plateau NEAP.
- Western Regional Air Partners - Fugitive Dust Handbook[116]

Ecology maintains ties to the NRCS South Central workgroup. Most recently, Ecology representatives attended the spring local workgroup meetings for the last three years to encourage the workgroup to keep soil erosion prevention practices a high priority. Local workgroups send their recommendations to NRCS every year and funding may be based according to these priorities.

Conservation Reserve Program: The most pertinent Conservation Title Program for the Columbia Plateau is the Conservation Reserve Program (CRP). The Conservation Reserve Program (CRP) is a FSA[117] program to remove Highly Erodible Land (HEL) or land inside the Conservation Priority Areas (Air Quality Zone)[118] from agricultural production and plant it into permanent vegetation, providing soil cover. (See Soils, Section 4 for more on HEL). The Air Quality Zone includes parts of Benton, Franklin, Adams, Grant, Douglas Lincoln and Walla Walla counties and small parts of Yakima and Klickitat counties. See the map of this area in the Agricultural Appendix, Appendix F.

The NRCS encourages farmers to enter into contracts with the FSA to place erodible cropland and other land in the Air Quality Zone into long-term conservation reserve. Contracts are generally for 10 to 15 years. Growers who qualify to remove HEL from crop production and establish either a grass or tree cover on the land to control wind and/or water erosion are compensated for the length of the contract.

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[115] State of Oregon's *Natural Hazards Mitigation Plan, Emergency Management Plan*, Dust Storm Chapter, February 2012.
[116] *WRAP Fugitive Dust Handbook*, Prepared for Western Governors' Association, Countess Environmental (WGA Contract No. 30204-111), September 7, 2006. Available at <http://www.wrapair.org/forums/dejf/fdh/index.html> especially section 2.0 Agricultural Tilling and 10.0 Agricultural Harvesting.
[116] RI Papendick and W.C. Moldenhauer, *Crop Residue Management to Reduce Erosion and Improve Soil Quality, Northwest*, ARS Conservation Research report Number 40, May 1995, page 35.
[117] The Farm Service Agency (FSA) ensures the well-being of American agriculture, the environment, and the American public through the administration of farm commodity programs; farm ownership, operating, and emergency loans; conservation and environmental programs; emergency and disaster assistance; and domestic and international food assistance. FSA programs are delivered through an extensive network of field offices in 2,248 USDA County Service Centers and 51 State Offices. <http://www.usda.gov/documents/about-usda-quick-reference-guide.pdf>.
[118] FSA, *Washington State Conservation Priority Areas, Air Quality Zone*, 5/88/11, 2-CRP (Rev. 5) WA Amend. 1, page 1.

NRCS Environmental Quality Incentive Program: (EQIP): EQIP is a voluntary program that provides financial and technical assistance to eligible agricultural producers and forest landowners to help them address soil, water, air and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. Producers receive assistance after practices and activities identified in EQIP plan are implemented and verified. EQIP contracts are typically for three years.

EQIP programs incentivize residue and tillage management practices because they are consistent with soil erosion prevention principles by increasing crop residue and/or surface roughness.

Conservation Tillage: To qualify as full conservation tillage, growers must leave at least 30% residue – and often growers leave more. No-till — where growers plant crops directly through vegetative cover or crop residue of the previous year's crop— aims for 100% soil cover year round. The grower may have nearly 100% cover on the field, but using any form of tillage disqualifies the land for true no-till.

Reduced tillage leaves between at least 15 and 30% residue cover on the soil. This may involve the use of a chisel plow, field cultivators, or other implements. While many practices can leave much more cover – 50% or higher. Reduced -till limits the soil-disturbing activities where the surface is tilled before planting; managing plant residue year-round.

In contrast, *conventional tillage* leaves less than 15% soil surface covered by previous year's crop residue following harvesting.

NRCS *Conservation Stewardship Program:*[119] The Conservation Stewardship Program (CSP) provides financial assistance to participants for conservation performance — the better the performance, the higher the payment. In CSP, producers install conservation enhancements to make positive changes in soil, water, and air quality; water quantity; plant and animal resources; and energy conservation. Fuel use reduction for field operations (ENR01), is one of the CSP enhancements that provides a direct benefit to air quality. Growers reduce their energy usage by reducing the number of tillage passes. Reduced tillage will leave more crop residue on the soil surface and reduce the risk of soil erosion

Washington's NEAP and Updates: In the late 1980's and early 1990's, a number of PM_{10} exceedances were recorded around the state and in Kennewick and Wallula[120]. These

[119] http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/, accessed July 1, 2015.
[120] Wallula is about 20 miles southeast of Kennewick.

exceedances were often accompanied by high winds and caused by windblown dust from upwind agricultural fields. In 1996, EPA issued a Natural Events Policy (NEP). This Policy outlined the requirements states had to follow to show that air quality standards were exceeded due to natural events. Washington developed a Windblown Dust Natural Events Action Plan (NEAP) for the Columbia Plateau which outlined the conditions and process that Ecology would use to qualify events. EPA approved Ecology's Columbia Plateau NEAP as meeting the minimum requirements of the NEP in May 1998, with some recommendations that were incorporated in the 2003 NEAP update.

Washington's original NEAP was completed in 1998, updated in 2003, reported on in 2007 and is still in effect. The 2003 NEAP can be accessed through Ecology's website, Publications page, Publication 03-02-014[121], and includes the original plan and the first two updates. The Columbia Plateau Windblown Dust NEAP (March, 2003) and the 2006 Status Report (March, 2007) are provided as Appendices.

The NEAP:

- Highlights the extensive research done on the soils and farming methods and documents the conditions when controls can be overwhelmed.
- Defined agricultural BACM as USDA Conservation Title Programs supplemented by implementation of incentive-based wind erosion conservation practices.
- Determined that Columbia Plateau counties were using Best Available Control Measures (BACM)

When developing the NEAP, Ecology relied upon the Natural Resources Conservation Service (NRCS) Field Office Technical Guide for adoption of conservation practices and the Columbia Plateau PM_{10} Project (CP3) for conservation practice use and research. Taken together, these resources provide a fundamental source for well proven conservation practices and region-specific, best management practices for reducing wind erosion.

The 2006 Update reported on 2004, the last year for which compiled data is available. The evaluation included data on CRP, minimum tillage, and residue remaining on fields. The 2004 data showed almost 80 percent of Columbia Plateau counties' total farmable acres are in a USDA conservation program, use one of the minimum till practices, or contain 15-30% residue. [122]

[121] <https://fortress.wa.gov/ecy/publications/summarypages/0302014.html>
[122] See page 101 for description of conservation practices. Total farmable acres is likely most similar to Total Cropland Acres, according to Steve Anderson from the National Agricultural Statstics Service, email 11/23/2015.

The Columbia Plateau PM_{10} *Project:* In September 1993, Washington State University initiated the Columbia Plateau PM_{10} Project (CP^3) project with USDA's Agriculture Research Service (ARS). Ecology, EPA, University of Idaho and Oregon State University also contributed to this comprehensive study of windblown dust on the Columbia Plateau. Through this ongoing effort, the CP^3 conducted comprehensive evaluations of windblown dust and developed many appropriate control measures for reducing wind erosion from agricultural fields.

WSU's website states the purpose of the project as follows:

> "The goal of the CP3 is to develop farming practices that allow growers to control wind erosion and dust emissions without suffering economic hardship, and to assist them with adopting these practices on their farms. The key for controlling wind erosion and dust pollution in downwind areas is to maintain year round vegetative cover and surface roughness. *Since its inception, the CP3 has focused on prediction and measurement of dust sources, development of viable farming practices to reduce wind erosion, and promotion of best management practices."*

"*Farming with the Wind: Best Management Practices for Controlling Wind Erosion and Air Quality on Columbia Plateau Croplands (1998)* and *Farming with the Wind II* (2004)" were two popular publications developed out of the CP3 project. WSU's website has more info on CP3 research.[123]

Historical participation:
Washington's NEAP and updates included participation values for Conservation Measures applied. County-by-county data for both *conservation* and *conventional tillage* from across the nation was available from the Conservation Technology Information Center's (CTIC) Core 4 program until 2004.[124]

In the 2003 NEAP update, Ecology found that *68%* of the high priority counties — those with the lowest rainfall on the Columbia Plateau[125] — used one or more conservation practices. Ecology added Benton and Walla Walla counties for the 2006 status report. In this last status report, based on 2004 data, Ecology found that *79%* of priority counties'

[123] Research project listing at: http://www.pnw-winderosion.wsu.edu/researchmethods.html.
[124] Core 4 was an information sharing and management system sponsored by private and public sector organizations. This project provided the most comprehensive information on minimum tillage practices available and included residue-on-the- field estimations that represent a collection of conservation practices.
[125] High priority counties are Adams, Douglas, Franklin, Grant, and Lincoln.

total farmable acres were in a USDA conservation program, using one of the minimum till practices (No-Till, Ridge Till or Reduced/Mulch-Till) or contained 15-30% residue.

Ecology determined that the level of participation of these programs on the Columbia Plateau in our initial NEAP in 1999 and further updates in 2003 and 2006 fulfilled BACM for the area. This exceeds the current control level necessary for areas not designated NAA.

Conservation Measures Participation: This section presents information on participation in conservation practices that were in place to minimize soil erosion and control dust on the Columbia Plateau at the time of the Fall 2013 events.

While information on CRP participation is still available, the county-by-county reporting through Core 4 on conservation tillage practices no longer is. 2004 is the last year for which there is compiled data. There is no local source of this same information. Instead, the FSA, Washington NRCS and Benton-Franklin Conservation District provided the following information on conservation measures participation:

- Pacific Northwest Basin Participation, 2003-2006 for the watershed
- CRP implemented acres, 1986-2013
- WA NRCS State Resource Assessment Report by County, EQIP implemented acres by County No-till, Reduced-till, 2009-2013
- CSP implemented acres by County
- Recent Benton/Franklin Conservation District funded programs

Pacific Northwest Basin Participation: USDA's Conservation Effects Assessment Project (CEAP) developed a way to quantify the effects of conservation practices using statistics from NRCS and physical process simulation models to estimate measures in place from 2003 to 2006 on a watershed scale. Their June 2014 Summary of Findings report[126] on the effects of conservation practices in the Pacific Northwest Basin[127] — which includes more than just Washington — includes a review of practices that affect

[126] NRCS-CEAP, *Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Pacific Northwest Basin*, July 1, 2014. <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/az/home/?cid=stelprdb1256696>, accessed on July 1, 2015.

[127] This Pacific Northwest Basin study area includes all of Washington, most of Oregon and Idaho, part of western Montana, and small parts of California, Nevada, Utah, and Wyoming. The Pacific Northwest Basin is larger than all other water resource regions of the United States except for the Missouri River Basin and is about the same size as the South Atlantic Gulf Basin.

soil erosion and thus air quality. Some facts on grower use of conservation practices in the Basin are noteworthy.[128]

- Reduced tillage is common in the region: 80 percent of the cropped acres meet criteria for either no-till (21 percent) or reduced-till (mulch till) (59%). All but 10 percent of the acres had evidence of some kind of reduced tillage on at least one crop.
- Land in long-term conserving cover, as represented by enrollment in the CRP General Signup, consists of 2.3 million acres in the region, of which 73 percent is highly erodible land.
- Average wind erosion for cropped acres has been reduced by 62%, compared to the no-controls scenario, due to the implementation of conservation practices: residue management, conservation crop rotation, conservation cover and cover crop.[129]
- The percentage of cultivated cropland with some combination of structural practices (e.g., wind breaks) for reducing soil erosion and reduced tillage practices is *consistent with that in most other regions across the nation.*[130]

Conservation Reserve Program Implemented Acres: Values available for FSA's Conservation Reserve Program show participation levels — acres enrolled in CRP contracts — throughout the plateau and in Benton County has remained steady over the last few decades. Figure 47 shows the number of acres in CRP for eastern Washington counties.[131] There is some variability related to federal fund availability.

[128] NRCS-CEAP, *Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Pacific Northwest Basin*, Chapter 2, page 24, July 1, 2014.
[129] Ibid, Page 51, Table 14. Average annual wind erosion (tons/acre) for cultivated cropland in the Pacific Northwest Basin.
[130] NRCS-CEAP, *Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Pacific Northwest Basin - Summary of Findings*, June 2014, page 9, accessed October 18, 2015, <http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1256683.pdf>
[131] USDA FSA, Reports and Statistics, http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=rns, accessed July 1, 2015.

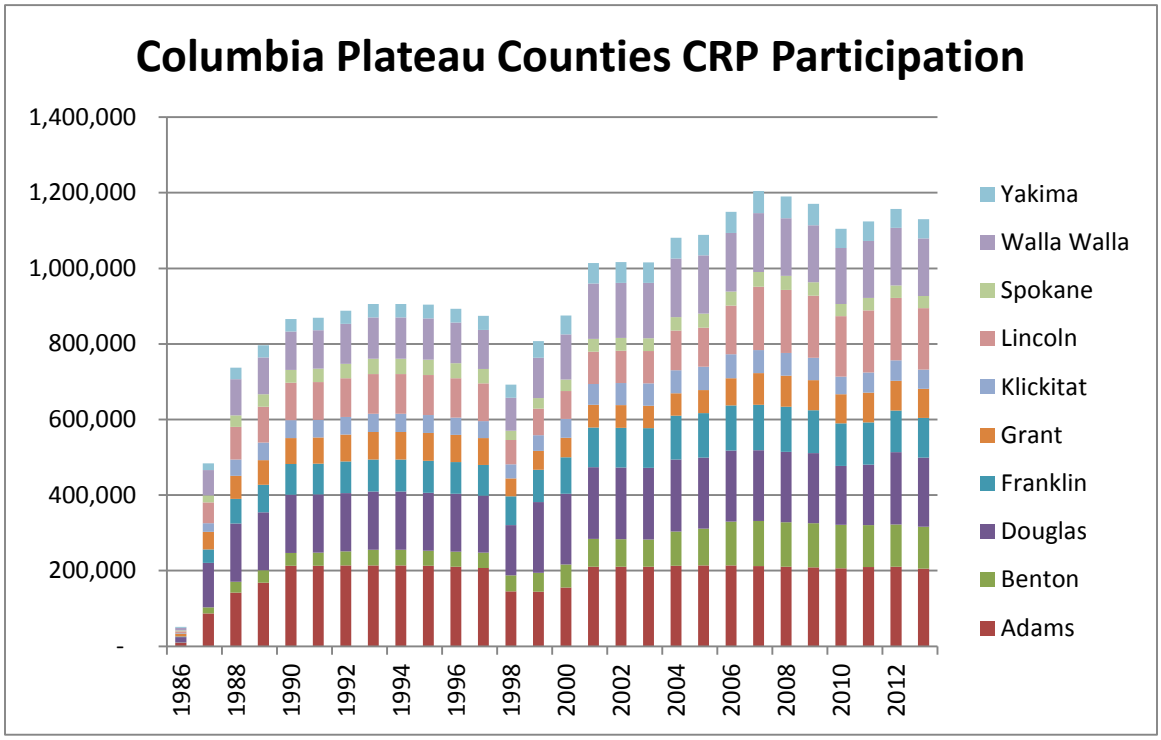

Figure 47. Conservation Reserve Program participation in Columbia Plateau counties, Fiscal 1986-2013, acres

Conservation Tillage Practices Participation: Columbia Plateau growers actively participate in USDA agricultural conservation programs. Local work groups set priorities and recommend NRCS allocate funds in their areas matching their request. Soil erosion was identified as a priority resource concern by most of the NRCS local work groups in the last three years.

In place of the Core 4 data on supplemental incentive-based wind erosion conservation practices, Bonda Habets, NRCS' Washington State Conservationist provided the following information on current and future participation in practices and programs for Columbia Plateau counties. NRCS codes for the practice are in parenthesis.

EQIP Acres by County, 2009-2013: NRCS Environmental Quality Incentive Program (EQIP) program has contracts that are implemented in Columbia Plateau counties. The last few years the acres contracted were halved due to NRCS's budget being reduced due to the national debt. Local work groups (see Appendix F for map) decided to reduce how many acres each producer could qualify for these two categories —no-till and reduced till —so the budget could be stretched to assist more producers. Even these small acreages are effective in establishing no till and reduced till practices as the producer will generally be contracted for 200 acres of no-till or reduced-till residue management and

this is enough to provide an incentive to continue the practice beyond the three year contract period and to extend the equipment use to the rest of their acres. Therefore, this snapshot of EQIP contracts only captures a portion of the adoption of no-till and reduced-till residue management practices on Columbia Plateau agricultural lands.

Washington NRCS provided financial assistance on almost 200,000 acres for No-till Residue Tillage and Management (329) and 250,000 acres of Mulch/Reduced-till Residue and Tillage (345) conservation practices from 2009 through 2013. Figure 48 shows the breakdown by Columbia Plateau counties.[132]

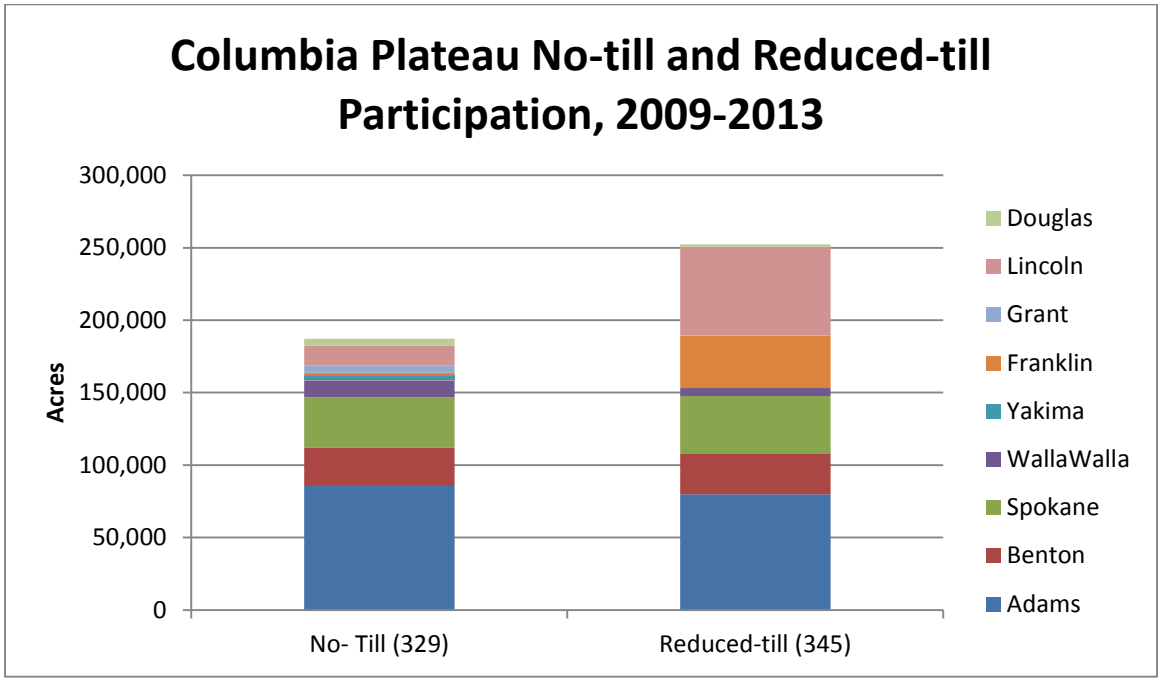

Figure 48. EQIP Completed Contracts, Columbia Plateau Counties, 2009-2013

Conservation Stewardship Program Implementation by County: NRCS Conservation Stewardship Program enhancement for treating soil erosion on the Columbia Plateau is the Energy 01 (ENR01) 2010 to 2014. The producer agrees to reduce fuel use by twenty percent for their field operations so less tillage amounts to less soil disturbance and more surface residue remaining on 19,000 acres under this program. Values are below in Table 11.

[132] Bonda Habets, State Conservationist, Spokane Washington NRCS office, in attachment, *"Air Quality ControlsanalysisJan16"*, email message "Air Quality "Control" draft, January 23, 2015.

Table 11. Conservation Stewardship Participation by county, 2010-2014

County	*Acres*
Benton	860
Franklin	2,213
Grant	2,722
Lincoln	116
Spokane	458
Walla Walla	12,677

Other organizations that promote conservation practices that prevent soil erosion:

- Pacific Northwest Direct Seed Association[133]
- WA Conservation Partners to Soil Health Committee[134]
- WA Tilth Association[135]

Recent Benton Conservation District funded programs: In 2013, Benton Conservation District funded 160 acres of Field Borders and cost-shared on 1,700 linear feet of windbreaks. Also, the Big Bale Strawmulcher was used on 435 acres. Once the practice is installed, the CD inspects the areas prior to payment. Many producers plant cover crops and install wind breaks without any cost sharing or technical assistance.

Implementation Verification/Auditing – Consequences of noncompliance: Many NRCS and FSA programs have an audit component which checks that the practices have been implemented or maintained properly. A violation of these provisions can put producer eligibility at risk for most NRCS and FSA programs.

Since 1996, FSA and NRCS have required producers be in compliance with their conservation plans to be eligible for their programs. USDA (Risk Management Agency (RMA), Farm Service Agency (FSA), Natural Resource Conservation Service (NRCS) ensure growers with HEL have a conservation plan.

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[133] http://www.directseed.org/about/, accessed July 1, 2015.

[134] NRCS Soil Health Team and national incentives have encouraged growth of a WA Conservation Partners to Soil Health Committee. This committee promotes management activities and practices that keep residue on the soil surface. In addition to no till and reduced tillage, planting cover crops after harvest to cover the soil surface with vegetation is also encouraged. These practices reduce wind erosion in the fall and spring since there is additional residue protecting the soil surface from harvest to frost and prior to spring planting.

[135] http://washingtontilth.org/, accessed July 1, 2015.

If there is annual tillage or crop planted on the farm, a conservation compliance plan will be developed that specifies the minimum residue cover required to protect the soils. NRCS conducts random compliance reviews on HEL lands annually to verify that the producer has the specified amount of surface residue protecting the field from wind erosion. Producers that have soils defined as Highly Erodible Land (HEL) must agree to certain provisions. They must agree not to plant or produce an agricultural commodity without following an NRCS approved conservation plan or system. The producer must maintain a conservation system of practices that keeps erosion rates at a substantial reduction of soil loss. There are consequences for not complying with these provisions; Non-compliance may affect some USDA program benefits.[136]

Annually, 5% of EQIP or CSP Programs are spot checked to see that they have been processed correctly from internal paperwork review to the producer implementation of the conservation practice. This means each year 150 to 175 farm tracts are randomly selected to be spot checked to see that they have the required minimum of crop residue on the soil surface for soil erosion protection. Washington's rate of violation is typically one percent per year.[137]

NRCS planners are required to have the appropriate authorization (i.e., Job Approval Authority) to issue the design of a conservation practice to a producer. If producers are found in violation, they have to pay money back with interest.

CRP Spot Checks: A certain percentage of CRP contracts are included in the "nationally selected" spot checks by FSA. Producers chosen in the national selection process are subject to review for all FSA program participation, including CRP. The state also has its own formula for the number of on-the-ground spot checks that must be completed by each Farm Service Agency every year. The number of checks is based on the number of contracts in CRP and particular operations are chosen at random based on the CRP spot check policy.[138]

Typically, about 4.5% of CRP contracts statewide are spot checked under the combined national and state selections.[139] FSA contracts with NRCS to make sure the stands meet

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[136] For more information, see the USDA press release, "*USDA Reminds Farmers of 2014 Farm Bill Conservation Compliance Changes*" in the Agriculture Appendix.
[137] Habets, Bonda, NRCS, "Controls Analysis", email message, January 30, 2015, in attached document, ControlsAnalysisJan312015.doc.
[138] Rod Hamilton, Farm Service Agency, Spokane, "CRP Compliance Checks, email message, October 12, 2014.
[139] Rod Hamilton, Farm Service Agency, Spokane, "Re; Auditing Consequences", email message, December 11, 2014.

standards (i.e., have the minimum plant growth and number of plant species as directed by the practice standards) before paying on the contract.

The local FSA uses the Washington CRP Spot Check Worksheet to review grower operations with contracts for compliance with the Washington State FSA Committee (STC) policy. Spot checks, that are conducted based on the national spot check selection process, are documented in the National Compliance Review Database.

Questions in the Spot Check Worksheet include:

- Was an unauthorized crop planted on CRP land?
- Has there been activity, such as mowing, spraying or burning during primary nesting and brood rearing season, if applicable?
- Has CRP land been used for haystacks, parking or converted to non-ag use?
- Has there been any unauthorized harvesting of CRP cover, including haying or grazing?
- Has there been any unauthorized treating of weeds, plants, insects or other pests?
- A failure to maintain an acceptable stand of approved cover?

County FSA offices must spot check and review those producers identified on the national producer selection list. However, they may spot check any producer not on the list, if they have reason to question the producer's compliance with any program provisions.[140] Noncompliance can affect the producer's FSA program benefits for the current year.

NRCS offices spot check a nationally selected group of producers each year for compliance with HELC requirements. Growers who plant crops on HEL or other environmentally sensitive land in violation of these requirements may have to refund benefits and/or be assessed a penalty. In these cases, growers may lose or received reduced benefits for the year or years when planting occurred. FSA and NRCS each determine grower compliance for their own programs.

Should the FSA or NRCS find a violation, without a 'good faith effort' determination, the grower will lose the crop insurance subsidy for the year.

Ecology Determination: Ecology finds the level of control in Columbia Plateau counties using USDA-NRCS conservation measures consistent with the Washington's Natural Event Action Plan and constitutes reasonable controls. Based on this evaluation,

[140] FSA Handbook, Acreage and Compliance Determinations, 2-CP (Rev. 15) Amend. 66, <http://www.fsa.usda.gov/Internet/FSA_File/2-cp_r15_a88.pdf>, accessed July 1, 2015, Page 3-3.

Washington State views the level of control in place before the fall of 2013 as sufficient to fulfill reasonable control requirements under the ERR. Unfortunately, despite these controls, the high winds and unusual weather were exceptional events and overwhelmed these controls.

Continuing Programs/New Initiatives: Recent legislation continues programs and new initiatives will bring even more emphasis to preventing soil erosion on the Plateau.

Farm Bill 2014: The Farm Bill that passed in 2014 maintained many of the same programs.[141] CRP, EQIP and CSP Programs were well funded even though there was a slight decrease from previous levels.

The *2014 Farm Bill* requires growers have conservation plans to be eligible for crop insurance subsidies. This Bill also recouples conservation compliance to eligibility for federal crop insurance premium subsidies. Producers that till or grow crops on HEL every year must have a conservation plan to get insurance subsidies starting June 1, 2015. In December 2014, these requirements were extended to landowners that previously haven't participated with FSA and NRCS (i.e., Risk Management Agency participants). These producers were notified that they are now required to file a report with FSA and certify that they are in compliance by June 1, 2015 to be eligible for any crop insurance subsidies.

Air Quality Initiative: The new Air Quality Initiative (AQI) is NRCS National Initiative funded under the EQIP program rolled out in 2014. This program provides technical and financial assistance to qualifying operations in select counties to implement Reduced Till (Mulch Till), No Till, Direct Seed practices and more. This Initiative makes additional funds available to counties having a history of national nonattainment designations for PM_{10}. Growers in four Columbia Plateau counties were eligible to apply for this new program. Most of the 1.4 million dollars granted went to Benton County growers in the Horse Heaven Hills. Seven contracts were signed committing 9,605 acres to high residue tillage practices for approximately three years.[142]

For 2015, NRCS-Washington put in another proposal for Air Quality Initiative funds to include even more counties in the Columbia Basin. Since State and Regional support was encouraged, Ecology submitted a letter of support. For fiscal 2015, this year the program will not only provide funding for practices to reduce for PM_{10}, but also could be

[141] Agricultural Act of 2014 (P.L. 113-79), February 7, 2014, <http://www.ag.senate.gov/download/?id=5363B4FE-29C5-43E9-8F16-9CD6FF0416DA>, accessed July 1, 2015.
[142] Ray Gekosky, NRCS – Spokane "Air Quality Acres", email message, 10/8/2014.

used to fund practices that reduce ozone precursors and greenhouse gas resources concerns in targeted areas. Ecology is working with NRCS and their other partners to identify where the focus areas should be.

2015 NRCS Voluntary Conservation Plan Initiative and *2016 Conservation Streamline Delivery Initiative (CDSI)* encourages producers to have their farms assessed. The resource concerns for their areas are inventoried and assessed against a conservation threshold, and a conservation plan developed. This plan includes alternatives to treat these concerns

2012 NRCS State Resource Assessment identified soil erosion as one the top ten resource concerns (out of 33). Most local work groups designated wind erosion as the top priority in the Columbia Plateau. In 2016, air quality will be added to the next three year NRCS State Resource Assessment top resource concerns and be an additional alternative for local work groups to select for funding.

2016 WA NRCS Air Quality Assessment Tool. WA NRCS plans to adopt an Air Quality Assessment Tool for fiscal year 2015 and provide Ecology and others a review and comment period. Implementation is planned for Fiscal Year 2016.

Continued Research by WSU's Bill Schillinger and ARS' Brenton Sharratt. WSU released results of a new study "Best Management Practices for Summer Fallow in the World's Driest Rainfed Wheat Region", published September 14, 2014 in Soil Science Society of America journal. [143] Brenton Sharratt continues his research on cropping systems and erodibility of soils.

Controls for Other Fugitive Dusts Sources:
Other sources that likely contributed to the events were small compared to agriculture areas in the HHH and Columbia Plateau. Washington has fugitive dust regulations for construction sites and other sources.

Washington State Fugitive Dust rules:
Unpaved roads, construction sites, and tilled land are areas that originate fugitive dust. Fugitive dust is a type of fugitive emission. Washington's air rules, at Washington Administrative Code (WAC) 173-400-030 and -040, define fugitive emissions and fugitive dust and require that sources take reasonable precautions to prevent dust.

Rules governing fugitive emissions that were approved and on file with EPA (SIP-approved rules) in Washington's State Implementation Plan at the time of the

[143] Schillinger, W.F., and D.L. Young. 2014. *Best management practices for summer fallow in the world's driest rainfed wheat region*. Soil Science Society of America Journal, 78:1707-1715.

exceedances are noted below.[144] Ecology adopted updated rules on 12/29/12, submitted them to EPA in December 2013. EPA approved them in November 2, 2014. There were no substantive changes to these sections - only minor text changes made for clarity.

173-400-030 Definitions: Definitions in the SIP as of the fall of 2013 are below.

> (30) "Fugitive dust" means a particulate emission made airborne by forces of wind, man's activity, or both. Unpaved roads, construction sites, and tilled land are examples of areas that originate fugitive dust. Fugitive dust is a type of fugitive emission.
>
> (31) "Fugitive emissions" means emissions which do not pass and which could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening.

173-400-040 General Standards for Maximum Emissions: The rules that cover fugitive emissions are noted below.

> (3) Fugitive emissions. The owner or operator of any emissions unit engaging in materials handling, construction, demolition or any other operation which is a source of fugitive emission:
> a) If located in an attainment area and not impacting any nonattainment area, shall take reasonable precautions to prevent the release of air contaminants from the operation.
> (b) If the emissions unit has been identified as a significant contributor to the nonattainment status of a designated nonattainment area, shall be required to use reasonable and available control methods, which shall include any necessary changes in technology, process, or other control strategies to control emissions of the contaminants for which nonattainment has been designated

[144] Fugitive Dust rules in SIP: State effective: 9/20/93; Last approved by the EPA effective: 6/2/95.<http://yosemite.epa.gov/r10/airpage.nsf/SIPs/SIPs/ECOLOGY/SIPEcologyHome>

(8) Fugitive dust sources.

(a) The owner or operator of a source of fugitive dust shall take reasonable precautions to prevent fugitive dust from becoming airborne and shall maintain and operate the source to minimize emissions.

(b) The owner(s) or operator(s) of any existing source(s) of fugitive dust that has been identified as a significant contributor to a PM-10 nonattainment area shall be required to use reasonably available control technology to control emissions. Significance will be determined by the criteria found in WAC 173-400-113(3).

State effective: 9/20/93; Last approved by the EPA effective: 6/2/95

The appropriate way to address agricultural dust control is through the conservation programs managed by the Natural Resource Conservation Services program. Sources of fugitive dust are expected to take reasonable precautions. Growers take reasonable precautions in the form of these Best Management Practices.

Right to Farm: While agricultural operations are not exempt from Washington's Fugitive Dust laws, the Right to Farm Act[145] provides exemption from enforcement if three essential elements are met: (1) the agricultural activity must be consistent with good agricultural practices; (2) the agricultural activity must pre-date the surrounding nonagricultural activities; and (3) the agricultural activity cannot have a substantial adverse effect on the public's health and safety.

[145] Revised Code of Washington (RCW) 7.48.305 Agricultural activities and forest practices — Presumed reasonable and not a nuisance — Exception — Damages – "Right to Farm Act".

Wallula PM_{10} *Maintenance Plan:*

Wallula (near Kennewick) was once out of compliance with the 1987 PM_{10} standard. Wallula and is now a maintenance area nearing its second decade of compliance. The most recent plan was approved by EPA in 2005. [146]

Control and contingency measures for the Wallula PM_{10} maintenance plan in Washington's State Implementation plan (SIP) are outlined below. The EPA describes the Wallula area compliance history in their website summary[147]. The plan relies on a control strategy that focuses on the control of fugitive dust from agricultural sources and a composting operation to assure attainment of the PM-10 National Ambient Air Quality Standards (NAAQS).

Control Strategies: The maintenance plan control measures included controls for a few relevant sources for fugitive dust and Ecology's 2003 NEAP update. The relevant facilities and control strategies are in Table 12 below[148].

[146] Washington State Department of Ecology, *A Plan for Maintaining Particulate Matter (PM_{10}) Ambient Air Quality Standards in the Wallula PM_{10} Maintenance Area*, March 2005, Publication No. 05-02-008, https://fortress.wa.gov/ecy/publications/publications/0502008.pdf, accessed July 1, 2015.
[147] EPA, Wallula, Washington PM_{10} Attainment Plan Summary, http://yosemite.epa.gov/r10/airpage.nsf/a853080dfbf1a78588256b6e0003579e/0d37370cca919ce38825700c0079d9da!OpenDocument, accessed July 1, 2015, effective date June 1, 2005.
[148] Ecology, *A Plan for Maintaining Particulate Matter (PM_{10}) Ambient Air Quality Standards in the Wallula PM_{10} Maintenance Plan Area*, (Wallula PM_{10} Maintenance Plan), Publication No. 05-02-008, March 2005, Table 3-3, page 3-6.

Table 12. Wallula Maintenance Plan Control Strategies

Facility	*Control Strategies to prevent Fugitive Dust*
Boise Cascade Wallula Mill - pulp and paper mill and composing operations	Paved haul road for heavy duty trucks delivering wood chips Lowest Available Emission Rate (LAER) on the No. 3 Recovery Furnace
Boise White Paper: composting operation	Fugitive Dust Control Plan
Tyson Foods: beef processing	BACT on PM_{10} emission controls
Simplot Feeders Limited Partnership beef cattle feedlot[149]	Ecology Fugitive Dust Control Guidelines for Beef Cattle Feedlots and Best Management Practices, dated December 13, 1995. Fugitive Dust Control Plan for Simplot Feeders Limited Partnership, dated December 1, 2003.

Ecology's 2003 Columbia Plateau Windblown Dust Natural Events Action Plan is also part of the Wallula control measures. The measures are grower participation in USDA-NRCS conservation measures as described above. These measures are implemented on an ongoing basis, seasonally as appropriate.

Contingency Measures: The Wallula maintenance plan contingency measures focus on the mitigation of windblown dust because windblown dust is associated with exceedances of the standard and was identified as the most likely cause of future exceedances. The plan does not include a PM_{10} trigger level for implementing the contingency measures. Rather, the measures are to be implemented on a regular basis regardless of the PM_{10} levels measured.

The contingency measures, as summarized by EPA, are listed below. Table 13 lists the contingency measures and how the measures were fulfilled. This information is in the 2003 NEAP, 2006 NEAP Status Report or the Wallula Maintenance plan. The NEAP and NEAP Status Report are included as Appendices.

[149] Simplot Feeders is a Confined Animal Feeding Operation (CAFO) located in Walla Walla County, approximately 3.5 miles north of Wallula, Washington and has been in operation since 1970. The Fugitive Dust Control plan for Simplot Feeders Limited Partnership and the Ecology Fugitive Dust Guidelines for Beef Cattle Feedlots and BMPs were the control strategies in place documented in the Wallula Maintenance plan. The 2003 agreement in the SIP required that Simplot maintain a log and send reports to Ecology for one year. The facility is composed of open air fenced pens. Methods of suppressing dust include: Pen floor maintenance, a sprinkler system and maintaining water trucks. http://yosemite.epa.gov/r10/airpage.nsf/283d45bd5bb068e68825650f0064cdc2/0d37370cca919ce38825700c0079d9da/$FILE/Simplot%20Feeders%20Fugitive%20Dust%20Control%20Plan.pdf.

Table 13. Wallula Maintenance Plan Contingency Measures

EPA summary	*How fulfilled*	*Actions/practices*
Improvements to process for identifying source contributors during high wind events	Enhancements to PM_{10} monitoring	Relocated monitor to Burbank, installed TEOM to obtain hourly PM_{10} concentrations
	Fundamental change to PM_{10} monitoring	Installed TEOM, providing for more frequent PM_{10} readings
PM_{10} reduction projects included in 2003 NEAP	NRCS conservation measures	(various)
	Columbia Plateau PM_{10} Project	Direct Seeding Demonstration Project and a Whitman Conservation District and the Pacific Northwest Direct Seeding Association (2001)
	Special projects	Conventional cropping system practices: straw mulching and the use of low disturbance tillage implements. Ecology with the Benton Conservation District (2002)
PM_{10} reduction projects, 2006 NEAP Status Report, continued	See projects under, "*Enhancing Wind Erosion Conservation Measures in Priority Counties*	Partnered with conservation districts on outreach for wind erosion buffer strips, Partnered in purchase of equipment (WeedSeeker®, Undercutter) Participation in local work groups
Demonstrations of BACM for natural events with EPA review	Ecology submitted natural event demonstrations under the Natural Events Policy[150] to EPA	

Benton Clean Air Agency Enforcement: Benton Clean Air Agency has jurisdiction in Benton County over most sources of dust.

Urban Fugitive Dust Policy:[151] Benton Clean Air Agency (BCAA) has an active dust enforcement program. The agency has one full-time person dedicated to dust control. BCAA provides dust control enforcement for Benton County and the cities in Benton County (Kennewick, Richland, Prosser, Benton City, and West Richland). Local

[150] EPA's Natural Events Policy preceded the Exceptional Event Rule.

[151] <http://www.go2kennewick.com/go2kennewick/default.aspx?option=com_docman&task=doc_view&gid=2090&Itemid=600>

planning departments refer construction applicants to BCAA for guidance on dust control and, depending on the scale of the project, BCAA may require the contractor to submit a dust control plan. BCAA responds to complaints about dust moving off property and works with the property owner or contractor to mitigate the dust. BCAA may require a dust control plan if circumstances warrant; that plan may become part of an enforceable Compliance Order. Penalties may be applied as warranted. Generally sites with dust control issues are promptly remediated. Practices in the Urban Fugitive Dust policy are expected to be implemented by contractors. If these practices are not followed and dust is observed leaving the property, BCAA begins warning and enforcement actions. BCAA issued over a hundred dust control warnings and 11 violations in 2014; 79 warnings and 8 violations in 2013.

Vineyard Dust Controls: As the wine grape industry has grown in Benton County, BCAA has increasingly worked to control dust as vineyards are planted. During the initial planting, which may be preceded by clearing or removal of other fruit crops, soil can be exposed and result in blowing dust. New vineyards are generally irrigated by drip systems which cannot be completely installed until after the plants are in. Once the plants are in, a cover is established and supported by the irrigation. As there is incentive to bring the vineyard quickly into production, this time period is generally quite short, however blowing dust can result during planting, until the cover is established. BCAA works with vineyards to come up with interim measures which may include gravel, water, or an annual cover crop, when the situation requires a short term solution.

Demonstrations for high wind dust events need to address whether controls were in place for anthropogenic sources and whether they were reasonable in consideration of recurring windblown historical PM_{10} dust exceedances. Ecology considers NRCS programs, for agricultural activity as the industry standard. Despite the area being reasonably well controlled, high winds overwhelmed controls and caused an exceedance.

> *Therefore, the level of control in Columbia Plateau counties is consistent with Washington's NEAP and NRCS conservation measures. Washington finds that the three events at Kennewick in the fall of 2013 were not controllable or preventable and that anthropogenic sources that contributed to the exceedance were reasonably controlled.*

6.3 Human Activity Unlikely to Recur at a Particular Location

High wind dust events are considered natural events if sources are entirely natural or if *contributing anthropogenic sources are reasonably controlled* and therefore it is not relevant to demonstrate whether the event was caused by human activity and will recur.[152] The EPA also acknowledges that events that recur may qualify for exceptional event treatment as long as anthropogenic sources are reasonably well controlled.

The natural event/human activity unlikely to recur (HAURL) criterion is met by demonstrating that the incident is a natural event that is not reasonably controllable or preventable (nRCP) and that there is a clear causal relationship (CCR) with the identified natural source area.

The EER requires agencies to document that the identified source of an exceptional event is either a *natural event* (NE) or a *human activity unlikely to recur at the same location* (HAURL) and affects the monitors in question again. However, EPA's interim high wind guidance[153] indicates that if an agency has adequately demonstrated that the source is a natural event or, if not natural, *is not reasonably controllable or preventable* and that there is *a clear causal relationship* between the identified source and the affected monitor, then the natural event/human activity unlikely to recur at the same location criterion is also satisfied.

These three high wind events were natural, not reasonably preventable or controllable, that overwhelmed adequately controlled sources. This demonstration also shows the clear causal relationship between the events and the exceedances, in the Event Day sections with a broad summary in Section 6.4, Clear Causal Relationship.

[152] EPA, Interim High Winds Guidance, May 2013, page 8, footnote 16.
[153] EPA, Interim High Winds Guidance, May 2013, page 23.

6.4 Clear Causal Relationship

A clear and causal relationship has been demonstrated for all three events. Most of this information is in each Event Day Section.

A 'clear and causal relationship' and 'but-for' the event demonstration has been made for these exceedances based on:

- High winds caused by thunderstorms entrained soils and created dust clouds are natural events
- PM_{10} concentration patterns correspond directly to the winds entraining dust. As wind speeds increased, PM_{10} monitored values increased, then declined after the storm passed the area, showing a direct causal relationship
- Backward trajectories are consistent with the National Weather Service reports and images and generally correlate well with upwind readings and hourly PM_{10} increases (see specific Event Day sections)
- Frequency distributions of PM_{10} concentrations for three dates show that high winds correspond with exceedances of the 24 hour PM_{10} NAAQS.
- There are no upwind air quality monitors in Oregon to identify what portion of the particulate matter may have come from Oregon for the September 15 and November 2 events. The Kennewick monitor and downwind stations do show impacts. The meteorological record shows that these two storms originated in Oregon. The two storms may also have picked up particulate matter from the Washington side of the river from the Horse Heaven Hills. (see September 15 and November 2 individual event day sections)
- Spokane (upwind) does not show elevated PM_{10} readings for the October 28 event for winds from the NE of Kennewick. So for this event, dust was entrained along the path of the storm across most of the Columbia Plateau.
- Pollution roses show that when the PM_{10} concentrations were over 150 $\mu g/m^3$, the wind direction was from the identified direction of the storm.
- NWS forecast discussions, wind advisories and news reports also describe strong winds and blowing dust in the Columbia Plateau, providing substantial weight-of-evidence for the sequence of events.

Therefore, the current weight of evidence supports that high winds entrained dust and caused all three PM_{10} exceedances. Details can be found in their Event Day sections and corresponding Appendices.

NWS forecast discussions, wind advisories and news reports describe strong winds and blowing dust, providing substantial weight-of-evidence for the sequence of events. The

body of evidence shows that regional dust storms caused the PM_{10} exceedances at Kennewick for all three dates.

6.5 Historical Fluctuations

This section will demonstrate that the monitored values for the three event days are outside the normal historical fluctuations. This information satisfies the HF criterion and serves as an important basis for the CCR, NEBF, and AAQ criteria.

Analysis and observations showed that high winds may create dust storms and elevate PM_{10} concentrations in the Kennewick area but not often. The records shows PM_{10} concentrations at Kennewick rarely measure over the federal PM_{10} standard of 150 $\mu g/m^3$. In Kennewick, from 2007 — when the exceptional event rule was finalized — through 2012, the 24-hour PM_{10} standard was exceeded only three times before the fall of 2013.[154] Table 14 shows the dates and values over 150 $\mu g/m^3$ since 2007.

Table 14. Dates and values of exceedances from 2007 through 2012, Kennewick

Year	*Exceedance Date*	*24-hour Monitor Value, µg/m³*
2007	4/9	192
2009	10/4	290
2011	8/28	158

[154] There was one exceedance of the 24-hour PM_{10} standard January 11, 2014; the value was 216 $\mu g/m^3$. This exceedance will be evaluated for exceptional event treatment at a later date.

Figure 49 below shows that over the ten year period, 2004-2014, exceedances of the PM_{10} standard were rare.

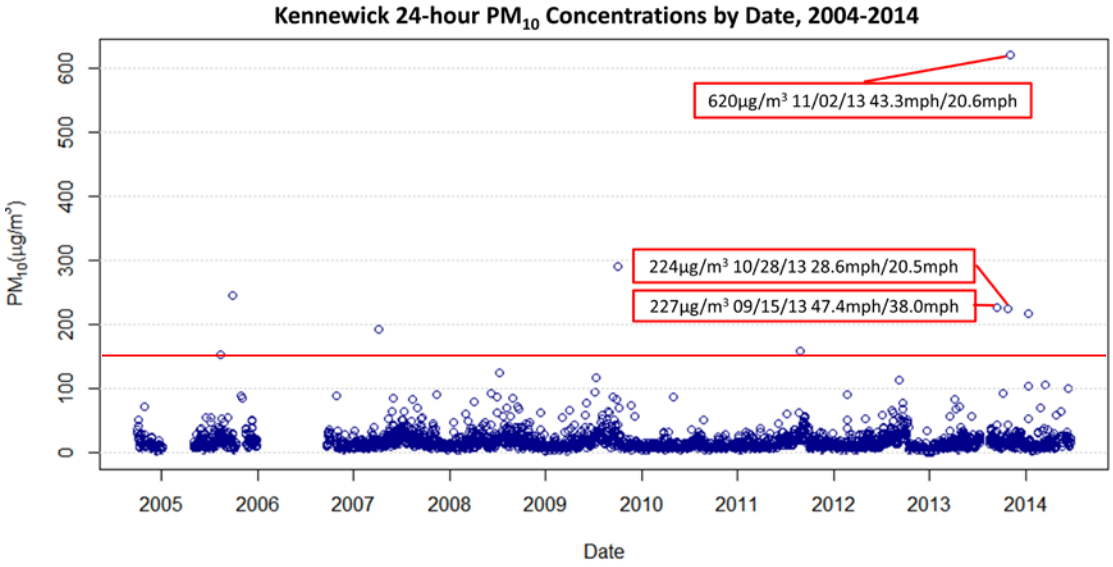

Figure 49. Kennewick 24-hour PM10 concentrations by date, 2004-2014.

Exceedances of the PM_{10} standard at Kennewick are infrequent and values are normally well below the standard. Figure 50. shows a frequency distribution for the 24-hour PM_{10} levels for a ten year period, 2004 to 2014. This illustrates that PM_{10} levels over the standard are rare. Data labels show maximum 1-minute gust/1-hour average wind speed for each of the three 2013 exceptional event days.

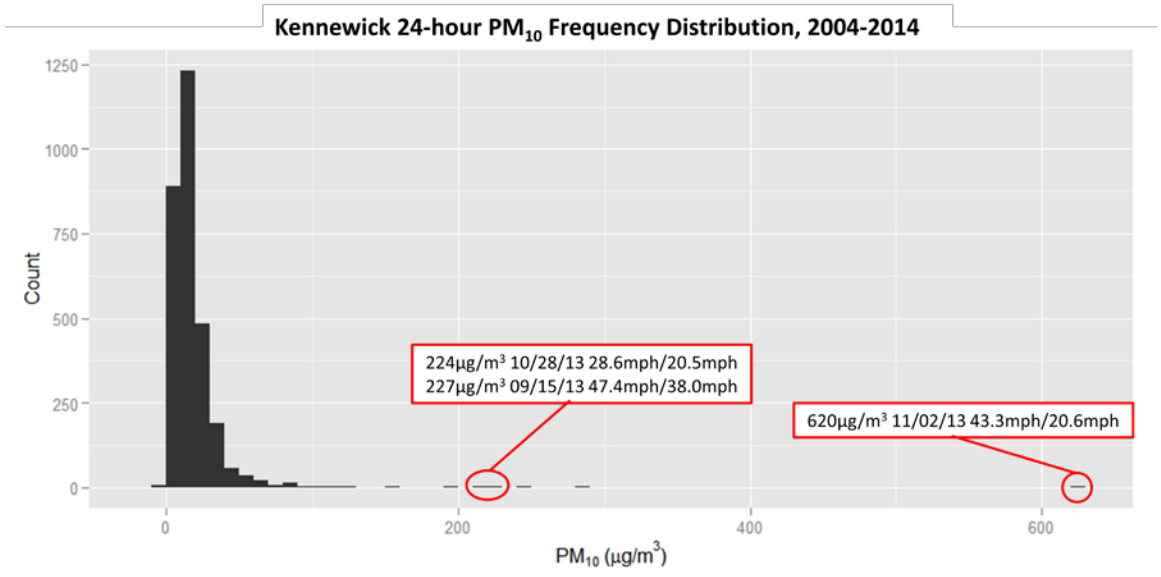

Figure 50. Kennewick Frequency Distribution of 24-hour PM_{10} Concentrations, 10/01/2004-6/23/2014.

Table 15 shows that concentrations over the standard and wind speeds over 25 mph are infrequent. The statistical analysis shows where the three event days fall in relation to all Kennewick PM_{10} data (since 2004) and also days when 1- minute wind speeds are over 25 mph.

Table 15. Kennewick 24-hour PM_{10} value, percent relative

Date	*24-hour PM_{10}, (µg/m3)*	*Percentile Relative to*			
		All Data[1]	*Annual Data, 2013[2]*	*Seasonal Data[2]*	*All High Wind Days (1-min speed>25mph)[3]*
9/15/2013	227	99.88%	99.85%	99.78% (Q3)	97.50%
10/28/2013	224	99.85%	99.53%	97.19% (Q4)	95.83%
11/2/2013	620	99.98%	99.22%	99.78% (Q4)	99.17%
Number of Observations		2,950	322	695 (Q3) 801 (Q4)	60

[1]All data since PM_{10} monitor was established at Kennewick on 10/01/2004.
[2] All data in 2013
[3]All data in the listed quarter since the PM_{10} monitor was established at Kennewick on 10/01/2004.
[3]All days with 1-minute wind speed >25mph since meteorological data collection began on 08/07/2012.

The statistical analysis in Table 16 shows the mean, median and mode of PM_{10} values in 2013 further demonstrate that PM_{10} values at Kennewick generally fall well below the standard.

Table 16. Statistics of 24-hour PM_{10} concentrations recorded in Kennewick, 2004-2014, µg/m^3

Statistic	*Concentration*
Mean	17.8
Median	13.4
Mode	10.0
Standard deviation	19.9
Count	2,950

Before the fall of 2013, daily mean PM_{10} concentrations for last 10 years in Kennewick show only a few exceedances. High winds characteristic of all three wind events are outside the range of normal historical fluctuations.

This evidence shows that PM_{10} exceedances occur infrequently and so are outside range of normal historical fluctuation.

6.6 'But For' Analysis

The EER 40 CFR 50.14(b)(1) directs EPA to exclude data only where an agency demonstrates an *exceptional event* caused a concentration in excess of a NAAQS. It must be shown that the concentrations at the monitor would have been below the standard if the event had not occurred (i.e., *but for* the event).

EPA guidance suggests that if nonevent pollution levels are typically significantly below the NAAQS during the season of the event, then a qualitative no exceedance *but for* (NEBF) may be adequate.[155] A quantitative no exceedance 'but for' analysis is provided below in addition to the qualitative discussion.

Analysis of historical data reveals a close association between PM_{10} concentrations and high winds for Kennewick.

The values in Table 17 show that if it had not been for the three events causing exceedances, there would not have been exceedances of the federal PM_{10} standard of 150 $\mu g/m^3$ at Kennewick.

Table 17. 2013 Kennewick PM_{10} maximum hourly values, with and without high wind exceedances

2013	*TPM10, max*	*2nd*	*3rd*
With high wind events	620	227	224
Without high wind events	93	84	73

This evidence shows that 'but for' the unusually strong winds on the three days in the fall of 2013, exceedances of the PM_{10} NAAQS would not have occurred at Kennewick. The climatology records shows winds 25 mph or higher occur only 1 to 2 % of the time; Winds over 50 mph can occur at least once in two years. Winds from 60 to 70 mph occur once in 50 years.[156] Without these winds, we are confident that PM_{10} values would have been below the standard.

The timing of the events is verified with the high wind observations and other reports in conjunction with the PM_{10} measurements at the Kennewick and surrounding monitors. With the weight of evidence provided, Ecology concludes that the PM_{10} exceedances

[155]EPA, Interim High Winds Guidance, May 2013, subsection 6.3.7.1, page 63
[156] National Oceanic and Atmospheric Administration, *Narrative Summaries, Tables and Maps for Each State with Overview of State Climatologist Programs*, Third Edition, Volume 2: New York-Wyoming , 1985 - Gale Research Company, <http://www.wrcc.dri.edu/narratives/WASHINGTON.htm>.

would not have occurred without the high winds that overwhelmed controls, creating the wind-entrained dust from sources that were reasonably controlled.

6.7 Procedural Requirements

Ecology has prepared this documentation to demonstrate that these exceedances were due to high wind natural events, in accordance with the U.S. EPA Exceptional Event Rule. EPA's Demonstration Completion Checklist, Appendix A, lists Procedural Criteria.

Exceedance: Exceedances of the 24-hour PM10 NAAQS were documented.

Flagging: Ecology flagged the data in EPA's Air Quality System on June 11, 2014 - before the July 1, 2014 deadline to notify EPA that Ecology suspected these exceedances were due to high winds.

Public Comment: This exceptional event demonstration will be available for public comment for 30 days. Any comments received will become part of the final document. These comments will be submitted to EPA as required by the EER.

Demonstration Deadline: Demonstrations are due no later than the end of the quarter in which the exceedances occurred, or one year before regulatory action is needed by EPA. The end of the quarter three years after the exceedances occurred is September 30, 2016 for the September 15, 2013 event and December 31, 2016 for the October and November 2013 events. Ecology plans to submit this demonstration request well before these deadlines.

6.8 Public Notification, Warnings and Educational Materials

In the 2003 NEAP update, Ecology agreed to prepare an annual news release that combines wind erosion and a health message, develop a windblown dust page for the website, and continue to post air quality data.[157] Ecology also committed to posting the NEAP and Natural Event documentation. These documents are available through Ecology's publication site.

- The spring 2013 News Release, entitled "Take Precautions – Dust Season is Here" was issued May 3, 2013. (In Appendix B, Regional Info.)
- The informational webpage on Outdoor Dust is at Ecology's website at: <http://www.ecy.wa.gov/programs/air/other/Windblown_dust_information.htm>
- Real time monitoring data is available on the website at: <https://fortress.wa.gov/ecy/enviwa> and air quality results for filter-based, official data — air quality statistics and specific monitor information — is at EPA's AirData website: <http://www.epa.gov/airquality/airdata/>

Other educational materials and available through the Outdoor Dust webpage[158] online. The Outdoor Dust page on Ecology's website outlines precautions residents may take to protect themselves during times when particulate matter levels are elevated and provides link to the Service website[159] as well as other publications. Copies of the news release and website are in Appendix B, Regional Information.

In 2012, Ecology updated the website and the Windblown Dust brochure,[160] which describes wind events on the Columbia Plateau and suggests actions to minimize exposure if possible, and precautions if exposure cannot be avoided. A link to NOAA's NWS site was added to the webpage as part of this update.

The early notification of wind events typically occurs through two methods:

- NWS reporting system
- Ecology monitoring information on website

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[157] Ecology, NEAP, page 16, 17
[158] Washington State Department of Ecology, Outdoor Dust webpage, <http://www.ecy.wa.gov/programs/air/other/Windblown_dust_information.htm>, accessed July 1, 2015
[159] National Weather Service, <http://www.weather.gov/>
[160] Washington State Department of Ecology, *Windblown Dust*, Publication no.04-02-009, <https://fortress.wa.gov/ecy/publications/publications/0402009.pdf>

The first method is through the National Weather Service reporting system. In addition to website information or regional weather related conditions, this information system is likely to be the first report to reach media when conditions reach "dust storm" levels.

Northwest Weather Service Warnings: NWS wind warnings provide the most accurate information on the likelihood of wind event. NWS is likely to be the first report to reach media when conditions reach 'dust storm' levels. Often radio stations will feature these reports as part of the news, particularly when wind speeds elevate quickly. Public Health Departments, Local Clean Air Agencies, the Hanford site (for its workers and contractors), and Ecology may also issue warnings based on these alerts.

Unfortunately wind events on the CP are not always predictable. Event notification is not always possible because wind events can occur with as little as two or three hours warning. Wind events also occur overnight.

Monitoring Website: The second notification method is through the *Washington State monitoring network system webpage*.[161] The Department of Ecology Air Quality Program website can be accessed by interested members of the public and features monitors with "real -time" data for a number of monitoring sites throughout the state. The "real-time" data is displayed in the Air Quality Index format, which clearly marks color coded ranges for specific monitors.

As part of the original NEAP and NEAP update: Washington State committed to preparing Public Service Announcements (PSAs) with a sound health message and evaluating the most efficient means of media distribution.

Methods to notify the public have changed significantly since 2006 and PSAs and news releases are not always the best way to issue event warnings. Since high wind events can occur with little notice, Ecology is evaluating using social media to notify the public of impending events that are expected to affect air quality and public health. Ecology will continue to issue the annual wind season warning and provide public access to monitoring data through the agency website.

Since high wind events can be short lived and occur with little warning, Ecology relies on National Weather Service high wind and hazardous weather outlook warning systems to alert the public. If time allows, Ecology considers issuing warnings to amplify the message.

[161] https://fortress.wa.gov/ecy/enviwa/

Ecology Air Quality Advisory Process: At Ecology:

- Ecology forecasters monitor weather conditions and other organizations' warnings, such as NWS reports, to evaluate phenomenon that could affect air quality.
- Ecology forecasters evaluate risk of air quality impacts and work with Communications Managers at Headquarters.
- Ecology Headquarters Communication Managers consider issuing news releases or public information statements using social media to alert the public, if time allows before an event occurs.

Benton County Notification Procedure: Benton Clean Air Agency staff also monitors meteorological conditions and work closely with local media to ensure public notification of potential and actual blowing dust. Benton County can be subject to sudden strong winds, and at times these winds pick up particulate matter and cause a dust storm. On a daily or hourly basis as conditions warrant, BCAA keeps abreast of the potential for blowing dust using weather forecasts and other tools provided by the National Weather Service and Washington State University. Agency staff scans the media releases for their notifications when conditions warrant. If media are not seen to be alerting the public, BCAA issues a press release to assure that the public is aware of the potential for blowing dust. As these events can be severe and sudden when they do occur, BCAA works with the local media to assure quick and effective notification of potential, as well as actual, windblown dust events. BCAA has recently agreed to share information from their daily analysis with Ecology, if conditions suggest air quality impacts.

Ecology's Outdoor Dust webpage[162] provides a link to the National Weather Service page, where individuals can enter their location and find advisories and warnings for their area. See the complete actual warnings from NWS in the Event Day Appendixes. Highlights below:

The Northwest Weather Service (NWS) Pendleton office issued warnings before each of the events. Excerpts below:

> September 15, 2:40 am: "Low level northerly flow feeding into the upper level low is generating windy conditions across the northern and western portion of the forecast area. This is expected to continue through the day and then begin tapering off in the later afternoon and evening hours. Wind advisories will continue for zones 27, 28 and 521". (Kennewick: zone 28).

[162] <http://www.ecy.wa.gov/programs/air/other/Windblown_dust_information.htm>

October 28, 10:28 am: "Winds across portions of Franklin, Benton and Yakima Counties in Washington are running 25 to 35 mph sustained with gusts around 45 mph. Expect these winds to continue and will continue the current wind advisories."

November 2, 11:37 am: "Very windy today... A strong cold front will move through the area today. This front will cause southwest winds to increase creating very windy conditions this afternoon and evening. ..A wind advisory remains in effect until 11 pm this evening… Timing: winds are increasing across the region late this morning. Strong winds will persist through the afternoon into the evening. Winds: southwest to west 30 to 40 mph with gusts to 50 mph..."

7 Conclusion

Ecology asserts that these three events qualify for treatment under the Exceptional Event Rule based on the following:

- There is a strong causal connection, supported by the meteorological record, between the high PM_{10} concentrations measured in Kennewick on September 15, October 28 and November 2 and the three exceptional events. The timing of these events corresponds to the high wind observations and the hourly PM_{10} measurements from the Kennewick monitor.
- NWS forecast discussions, wind advisories and news reports describe strong wind and blowing dust and other impacts to property providing a substantial weight of evidence for the cause and sequence of the events.
- The exceedances were caused by widespread events with wind blowing over many sources of the windblown dust that included both natural, undisturbed areas, and anthropogenic, mainly agricultural, sources.
- The three exceptional events (high winds) overwhelmed reasonably controlled anthropogenic (i.e., agricultural) sources.
- Agricultural sources on the Columbia Plateau are controlled through grower participation in USDA approved practices. The Columbia Plateau counties continue to have a high level of participation in these programs. Oregon growers have access to the same programs.
- Ecology concludes that the PM_{10} exceedances would not have occurred without the high winds that entrained surface dust.

Based on the evidence provided in this document, Ecology requests that EPA support the exclusion of the PM_{10} exceedances at Kennewick, Metaline monitoring station for September 15, October 28 and November 2 in 2013 from calculations when determining compliance with the PM_{10} 24-hour NAAQS or other regulatory compliance purposes by placing a concurrence flag on the data in the official record (i.e., AQS).

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9 Appendices

Appendices

- Appendix A. Demonstration Completion Checklist
- Appendix B. Regional Info – Meteorological, Emissions, Warning
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Appendix A. Demonstration Completion Checklist

Completeness Checklist for High Wind Dust Exceptional Events.[163]

Site Name/AQS ID: Kennewick, Metaline, AQD number 53-005-0002, POC 3

Pollutant: Particulate Matter ten microns or less (PM_{10})

Date(s): September 15, October 28 and November 2, 2013

Procedural Criteria		[Y/N]	EPA Use
Did an exceedance of the NAAQS occur?		**Y**	
Were data flagged by July 1st of following year?		**Y**	
Was there a 30-day public comment period? Is documentation for the comment period included?		**Y**	
If public comments were received, are the public comments and responses included.		**Y**	
Was the package submitted within 3 years of the end of the quarter in which the event occurred and 12 months prior to the date that any regulatory decision must be made by EPA?		**Y**	
September 15, 2013			
Evidence	**Information Included**	**Sections, Page(s)**	EPA Use
Conceptual Model	*Hover over and click to follow links to page numbers, Sections*		
-description of weather phenomena resulting in high wind	Y	42	
-description of what sources were likely entrained by the high wind	Y	19, 42, 27	
-explanation of the path by which the dust reached the monitor(s)	Y	43	
-map showing relevant monitors, topography, other relevant geographic features	Y	15	
-description of how the event day differs from non-event days	Y	30, 56	

[163] From EPA *Interim Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds Under the Exceptional Events Rule*, Appendix B1. Checklist for High Wind Exceptional Events Demonstration Submission, May 2013, page 75.

-description of concentration and wind patterns for the exceeding monitor(s) and surrounding area	Y	49	
Wind Statistics			
-max sustained wind (Hourly avg)	20.6 mph at KENMETA	55	
- max sustained wind (1-5 min avg)	36.3 mph	55	
-max gust (1 min avg)	43.3 mph	55	
-wind trajectories included?	Y	47	
-other:	[list other wind analyses]	[page #]	
nRCP		92	
-Area-specific high wind threshold (default = 25mph)	25 mph	6.2.1, 92	
-sources contributing to event identified, including anthropogenic vs. natural?	Y	19	
-controls identified for anthropogenic sources? (note: level of control analysis depends on wind speed)	Y	93	
-are natural sources not reasonably controllable?	Y	93	
-was a High Wind Action Plan included?	N (optional)	NA	
HF			
-were time-series analyses for concentration and wind data included?	Y	51	
-annual comparison to historical data (wind and concentrations)	99.85%	121	
-seasonal comparison to historical data (wind and concentrations)	99.78%(Q3)	121	
CCR (=> AAQ & / Natural Event)			
-were spatial analyses included, establishing a spatial relationship between the event, sources, transport of emissions, and recorded concentrations?	Y	42	
-were temporal analyses included, establishing a temporal relationship between the high wind and elevated PM concentrations at the monitor?	Y	42	

-comparison of event-affected day(s) to specific non-event days?	Y	51	
-was the dust shown to be from the sources discussed in the nRCP section?	Y	118	
-were alternative hypotheses discussed?	Y	19	
-was a causal (not just correlational) relationship established?	Y	118	
NEBF			
-was a but-for analysis included?	Y	122	

October 28, 2013

Evidence	**Information**	**Page(s)**	EPA
Conceptual Model			
-description of weather phenomena resulting in high wind	Y	58	
-description of what sources were likely entrained by the high wind	Y	19, 42, 27	
-explanation of the path by which the dust reached the monitor(s)	Y	5.3, 58	
-map showing relevant monitors, topography, other relevant geographic features	Y	15	
-description of how the event day differs from non-event days	Y	74	
-description of concentration and wind patterns for the exceeding monitor(s) and surrounding area	Y	63	
Wind Statistics			
-max sustained wind (Hourly avg)	20.5 mph	Appendix D	
- max sustained wind (1-5 min avg)	25.5 mph	72	
-max gust (1 min avg)	29 mph	Appendix D	
-wind trajectories included?	Y	65	
-other:	[list other wind analyses]	[page #]	
nRCP			
-Area-specific high wind threshold (default = 25mph)	25 mph	92	
-sources contributing to event identified, including anthropogenic vs. natural?	Y	19	

-controls identified for anthropogenic sources? (note: level of control analysis depends on wind speed)	Y	93	
-are natural sources not reasonably controllable?	Y	93	
-was a High Wind Action Plan included?	N	NA	
HF			
-were time-series analyses for concentration and wind data included?	Y	71	
-annual comparison to historical data (wind and concentrations)	99.53%	121	
-seasonal comparison to historical data (wind and concentrations)	97.19%(Q4)	121	
CCR (=> AAQ & / Natural Event)	[Y/N]		
-were spatial analyses included, establishing a spatial relationship between the event, sources, transport of emissions, and recorded concentrations?	Y	58	
-were temporal analyses included, establishing a temporal relationship between the high wind and elevated PM concentrations at the monitor?	Y	58	
-comparison of event-affected day(s) to specific non-event days?	Y	58, 85	
-was the dust shown to be from the sources discussed in the nRCP section?	Y	118	
-were alternative hypotheses discussed?	Y	19	
-was a causal (not just correlational) relationship established?	Y	118	
NEBF			
-was a but-for analysis included?	Y	122	

November 2, 2013

Evidence	**Information**	**Page(s)**	EPA
Conceptual Model	Y		
-description of weather phenomena resulting in high wind	Y	75	
-description of what sources were likely entrained by the high wind	Y	19, 42, 27	
-explanation of the path by which the dust reached the monitor(s)	Y	75	
-map showing relevant monitors, topography, other relevant geographic features	Y	5	

-description of how the event day differs from non-event days	Y	90	
-description of concentration and wind patterns for the exceeding monitor(s) and surrounding area	Y	85, 87	
Wind Statistics			
-max sustained wind (Hourly avg)	38 mph	88	
- max sustained wind (1-5 min avg)	42.3 mph	88	
-max gust (1 min avg)	38 mph	88	
-wind trajectories included?	Y	80	
-other:	[list other wind analyses]	[page #]	
nRCP	[Y/N]		
-Area-specific high wind threshold (default = 25mph)	[25 mph]	6.2.1, 92	
-sources contributing to event identified, including anthropogenic vs. natural?	Y	19, 102	
-controls identified for anthropogenic sources? (note: level of control analysis depends on wind speed)	Y	94	
-are natural sources not reasonably controllable?	Y	6.2.1, 93	
-was a High Wind Action Plan included?	N (optional)	NA	
HF			
-were time-series analyses for concentration and wind data included?	Y	85	
-annual comparison to historical data (wind and concentrations)	99.22%	121	
-seasonal comparison to historical data (wind and concentrations)	99.78%(Q4)	121	
CCR (=> AAQ & / Natural Event)	[Y/N]		
-were spatial analyses included, establishing a spatial relationship between the event, sources, transport of emissions, and recorded concentrations?	Y	75	
-were temporal analyses included, establishing a temporal relationship between the high wind and elevated PM concentrations at the monitor?	Y	75	

-comparison of event-affected day(s) to specific non-event days?	Y	85	
-was the dust shown to be from the sources discussed in the nRCP section?	Y	118	
-were alternative hypotheses discussed?	Y	19	
-was a causal (not just correlational) relationship established?	Y	118	
NEBF			
-was a but-for analysis included?	Y	122	

Appendix B. Regional Info – Meteorological Info, Emissions, Warnings

Link to Appendix B.

Appendix C. September 15 Info

Link to Appendix C.

Appendix D. October 28 Info

Link to Appendix D.

Appendix E. November 2 Info

Link to Appendix E.

Appendix F. Agricultural Info

Link to Appendix F.

Appendix G. 2003 NEAP Update

Link to Appendix G.

Appendix H. 2006 NEAP Status Report

Link to Appendix H.

Appendix I. Public Process Documents

Outreach and public communication documents for preview period and webinar can be found here. Will be modified to contain final public process documents.

Link to Appendix I.

Appendix J. Comments/Response to Comments

Link to Appendix J.