Pinal County Air Quality Control District

Source Apportionment Study

Prepared by Pinal County Air Quality Staff

Sampling conducted in October and November of 2003

July 29, 2005

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Abstract

Pinal County Air Quality Control District (PCAQCD) began a source apportionment study in 2003 to identify emission sources that contributed to elevated particulate matter concentrations in the local agricultural basin.

Pinal County lies in central Arizona, in the heart of the Sonoran Desert. Historical monitoring indicated elevated levels of particulate matter at sites located in the agricultural basin, which occupies roughly the western third of the county. With grant support from the United States Environmental Protection Agency (EPA) and the Arizona Department of Environmental Quality (ADEQ), the county retained Desert Research Institute to perform the analysis and modeling aspects of the study.

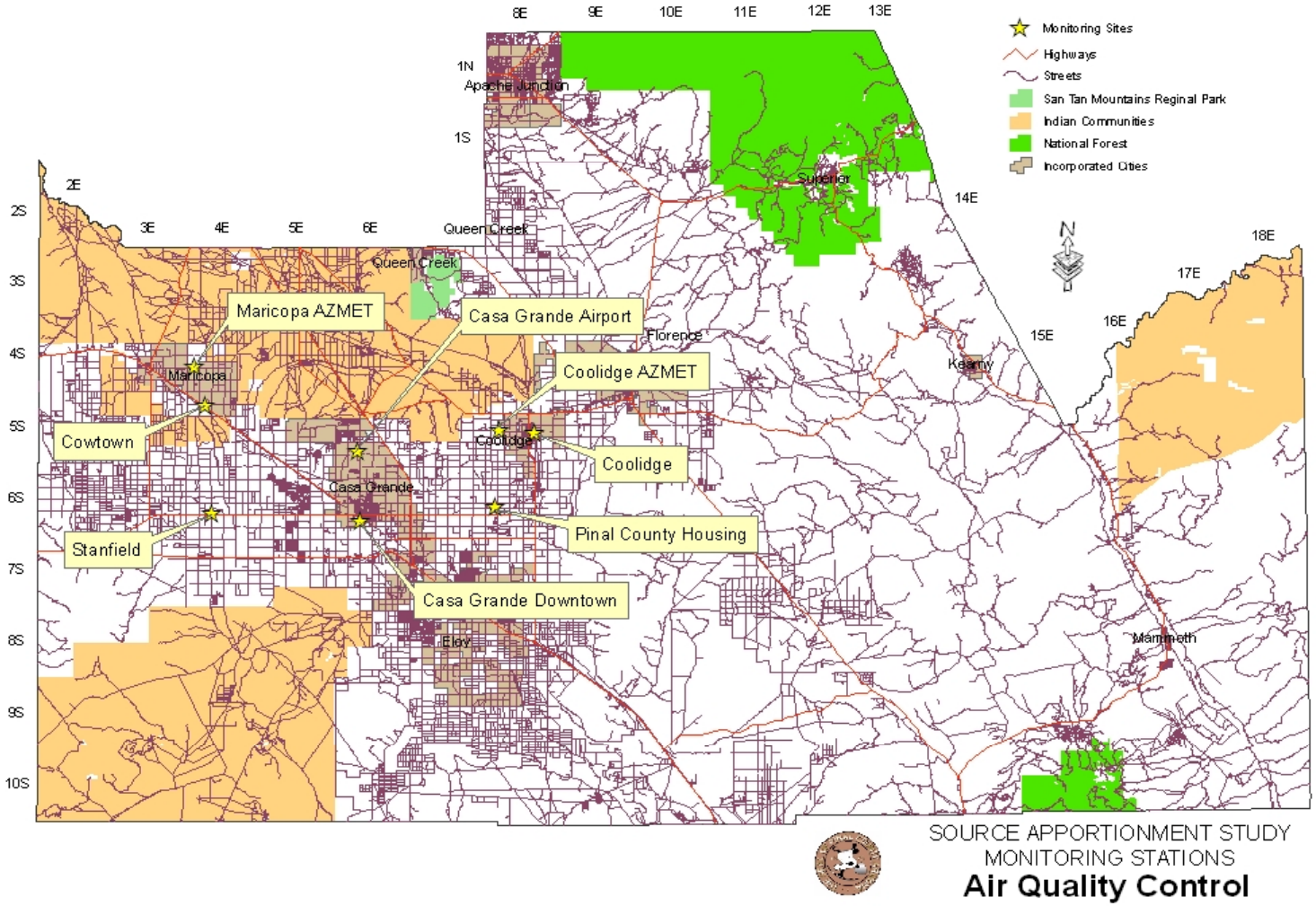
To collect data for the study, PCAQCD co-located filter based Mini-Vol monitors capable of measuring particulate matter smaller than 2.5 microns ($PM_{2.5}$) and particulate matter smaller than 10 microns (PM_{10}) at five existing monitoring sites. All the existing sites had at least one Federal Reference Method (FRM) monitor configured to measure ambient PM_{10} concentrations and one site had an existing FRM monitor configured to measure ambient $PM_{2.5}$ concentrations. The Mini-Vol monitors operated in parallel with existing FRM monitors.

Data collection occurred in October and November of 2003. In addition to servicing the Mini-Vol monitors, the fieldwork included collection of soil and feedlot surface material samples. During the data collection process the FRM monitors indicated 24-hour average PM_{10} concentrations ranging from 25.3 to 577.0 $\mu g/m^3$. PCAQCD transmitted the collected Mini-Vol filters and surface material samples to DRI.

DRI analyzed the material on the filters using chemical mass balance (CMB) techniques. That effort included refinement of a CMB “fingerprint” for Pinal soils and a definition of a “fingerprint” for feedlot emissions. The CMB analysis indicated that under conditions of low concentrations of particulate matter, a relatively diverse category of sources contributed to observed ambient impacts.

DRI’s analysis also indicated that when ambient concentrations rose to elevated levels, at four of the sites soil emissions, followed by feedlot emissions, produced the greatest impacts. At a fifth site, identified as the “Cowtown” site, feedlot emissions produced the dominant impact. When particulate concentrations reached elevated levels, those conclusions regarding source-attribution applied to both PM_{10} and $PM_{2.5}$ emission impacts.

PCAQCD prepared this final report. This report draws conclusions from the DRI analysis and provides additional background information, including corresponding FRM monitoring data and meteorological data.


Monitoring Sites
Highways
Streets
San Tan Mountains Reginal Park
Indian Communities
National Forest
Incorporated Cities
N
8E
9E
10E
11E
12E
13E
14E
15E
16E
17E
18E
1N
1S
2E
2S
3E
3S
4E
4S
5E
5S
6E
6S
7S
8S
9S
10S
Apache Junction
Superior
Queen Creek
Florence
Kearny
Maricopa
Coolidge
Casa Grande
Eloy
Mammoth
Maricopa AZMET
Casa Grande Airport
Coolidge AZMET
Cowtown
Coolidge
Pinal County Housing
Stanfield
Casa Grande Downtown
SOURCE APPORTIONMENT STUDY
MONITORING STATIONS
Air Quality Control

Section 1

Project Description

1.1 Study Objective

This project was designed to identify the dominant sources of particulate matter in the Pinal County agricultural basin, which covers roughly the western third of the County. Dual samplers capable of measuring particulate matter smaller than 2.5 microns ($PM_{2.5}$) and particulate matter smaller than 10 microns (PM_{10}) were utilized to collect ambient air samples from five existing monitoring sites. Samples collected at each site were analyzed by Desert Research Institute (DRI) to determine the chemical aspects of the particulate matter on the filters. This data was then used to perform a source apportionment modeling analysis that resulted in a list of source categories that contribute to particulate matter concentrations in the Pinal County agricultural basin.

1.2 Study Duration

The sampling portion of this study occurred between October 1, 2003 and November 8, 2003. Originally, the study was to involve collecting ten filter sets on a one in three day cycle between October 1, 2003 and October 31, 2003. The study duration was extended to November 8, 2003 so that three additional filter sets could be collected. The ten filter sets with the highest data recovery were then chosen for analysis.

This time frame was chosen since elevated particulate matter concentrations have historically been recorded during the months of October and November.[1] Several local conditions contribute to this every year, with the most notable one being cotton harvest. Local cotton fields are being harvested, fall tillage is taking place, and nine cotton gins spread throughout the agricultural basin are in full operation at this time. The equipment utilized in all of these operations tends to create particulate matter. The cotton harvest also adds a substantial amount of traffic to field apron roads and to the county dirt road system, thus creating additional particulate matter. The amount of construction activity in the area does not seem to vary seasonally, although it is steadily growing, providing another source of particulate matter. Finally, the cooler ambient temperatures during this time period often create inversion conditions trapping emissions close to the earth's surface.

1.3 Study Area

Based on historically elevated PM_{10} levels, the western portion of Pinal County was the area of focus for this study. Open field agriculture dominates this portion of the County, although the area is rapidly developing.

1.4 Site Descriptions

The following five sites were chosen for this study due to their proximity to possible sources of particulate matter. A picture of each site and a tabular summary of the parameters monitored at each site are included in Appendix A.

[1] Pinal County Air Quality PM_{10} monitoring records

1.4.1 Casa Grande – 401 Marshall St. (Lat. N 32°52' Long. W 111°45')

This site is located on the roof of an Arizona Department of Economic Security building in the downtown area of Casa Grande. A core business district surrounds the site followed by residential areas in all directions. It was expected that the many minor industrial sites, Southern Pacific mainline railroad traffic, and paved roadway traffic surrounding the area would impact this site. This site may have been impacted slightly by an agricultural area to the south. The area surrounding this site consists almost entirely of buildings, paved streets, and paved parking lots. Since the area surrounding this site was generally stabilized and the site was centrally located within the study area, this site was used as the control site during data comparison. As the control site it was expected that this site would be the least impacted by the local sources of particulate matter.

Historical FRM data indicates that, apart from unusual wind events, typical maximum 24-hour PM_{10} concentrations at this site only reach about 67% of the 24-hour PM_{10} standard, and annual average concentrations only reach about 60% of the annual PM_{10} standard. Typical maximum 24-hour $PM_{2.5}$ concentrations at this site only reach about 50% of the 24-hour $PM_{2.5}$ standard, and maximum individual annual average concentrations only reach about 60% of the annual $PM_{2.5}$ standard.

1.4.2 Coolidge – 212 E. Broadway (Lat. N 32°58' Long. W 111°30')

This site is located within the Pinal County Public Works Yard on the east side of Coolidge. Coolidge lies about thirty miles southeast of the Phoenix urban area, in a desert basin largely dominated by open field agriculture. Residential homes surround the site to the north, south, and east. West of the site is a railroad track with a business district on the other side. It was expected that the agricultural sources along the eastern edge of Coolidge, Phoenix spur railroad traffic, vehicle traffic, and the minor industrial sources located near the area would impact this site.

Historical FRM data indicates that, apart from unusual wind events, typical maximum 24-hour PM_{10} concentrations at this site approach 100% of the 24-hour PM_{10} standard, and maximum individual annual average concentrations only reach about 67% of the annual PM_{10} standard.

1.4.3 Cowtown – 37580 W. Maricopa/Casa Grande Hwy. (Lat. N 33°63' Long. W 111°58')

This site is located approximately four miles southeast of the City of Maricopa and fiftteen miles south of the Phoenix urban area. The site lies within the irrigated desert plain, with active and retired agricultural operations to the north, northwest and east. Three cattle feedlot companies and a grain-processing complex operate to the south, southwest and southeast. It was expected that the vast agricultural area that surrounds the

site, the nearby feedlots, dirt roads, Southern Pacific mainline railroad traffic, and paved roadway traffic would potentially impact this site.

Historical FRM data indicates 24-hour PM_{10} concentrations at this site often reach 200% or more of the 24-hour PM_{10} standard, and maximum individual annual average concentrations exceed 200% of the annual PM_{10} standard. Observed concentrations recorded by the Tapered Element Oscillating Microbalance (TEOM) PM_{10} monitor over a 3-year period extending through 2004 actually reached twice those values or more. However, installation of a second, parallel TEOM in April of 2005 indicated that, at least under elevated PM_{10} conditions, ambient concentrations reached only roughly 60% of those indicated by the original TEOM. Accordingly, for purposes of this discussion, PM_{10} concentrations are characterized as <u>only</u> 200%, rather than 400%, of the prevailing standards.

1.4.4 Pinal County Housing – 970 E. Eleven Mile Corner Rd. (Lat. N 32°53' Long. W 111°30')

This site is located within the Pinal County Housing Complex and is approximately eleven miles east of Casa Grande in the heart of the agricultural basin of Pinal County. The site is located within a fenced area that houses the sewer lift station for the subdivision. The enclosure is immediately surrounded by native desert growth with active and retired agricultural areas in all directions. The County Housing subdivision lies just to the southeast of the enclosure. A dairy, two cotton gins, and the Pinal County Fairgrounds are approximately one mile south of the site. It was expected that the nearby dairy, nearby cotton gins, surrounding agricultural sources and surrounding County dirt roads would potentially impact this site.

Historical FRM data at this and a predecessor site indicates that, even apart from unusual wind events, maximum 24-hour PM_{10} concentrations at this site exceed 200% of the 24-hour PM_{10} standard, and maximum individual annual average concentrations reach about 125% of the annual PM_{10} standard.

1.4.5 Stanfield – 36697 W. Papago Dr. (Lat. N 32°53' Long. W 110°57')

This site is located behind the Stanfield County Complex. Stanfield lies about fifteen miles west of Casa Grande, and about thirty miles south of the Phoenix urban area. Residential homes surround the site on all sides, but the surrounding landscape is dominated by open-field agriculture. Sizeable feedlot and dairy operations lie about three miles to the north, east and west. It was expected that the vast agricultural area that surrounds the site, several nearby feedlots, County dirt roads, and paved roadway traffic would potentially impact this site.

Historical FRM data indicates that, even apart from unusual wind events, maximum 24-hour PM_{10} concentrations at this site exceed 200% of the 24-hour PM_{10} standard, and maximum individual annual average concentrations reach about 120% of the annual PM_{10} standard.

1.5 Monitors Installed or Utilized

Pinal County Air Quality Control District (PCAQCD) installed and operated twenty (20) Airmetrics low volume particulate matter (Mini-Vol) samplers for this study. Four (4) Mini-Vol samplers were installed at each site listed below. Two (2) Mini-Vol samplers were equipped with PM_{10} heads and two (2) Mini-Vol samplers equipped with $PM_{2.5}$ heads. Teflon filters were utilized in two of the Mini-Vols, one having a PM_{10} head and one having a $PM_{2.5}$ head. Pallflex quartz filters were utilized in the remaining two Mini-Vols, one having a PM_{10} head and one having a $PM_{2.5}$ head. The Mini-Vols operated on a one in three day schedule. Additionally, each site had existing monitors that were utilized as part of the study. These monitors are listed in following subsections. The concentration data collected during the study for Mini-Vols and the monitors listed below is included in Appendix B for reference.

1.5.1 Casa Grande

In addition to the Min-Vol samplers, an existing high volume (Hi-Vol) PM_{10} sampler utilized quartz filters and operated on a one in six day schedule. An existing Andersen $PM_{2.5}$ sampler utilized Teflon filters and operated on a one in six day schedule.

Meteorological conditions were recorded for the Casa Grande area during the study using an existing ten-meter system located at the Casa Grande airport site. This site is located approximate five miles north of the Casa Grande Downtown site where the ambient particulate matter samples were collected.

1.5.2 Coolidge

In addition to the Min-Vol samplers, an existing Hi-Vol PM_{10} sampler utilized quartz filters and operated on a one in six day schedule.

A three-meter meteorological system operated by the University of Arizona Cooperative Extension Arizona Meteorological Network (AZMET) program was used to gather meteorological data for this site. This meteorological system is located 0.5 miles southwest of the intersection of Curry Road and Bechtel Road and is approximately five miles west of the Coolidge site. Wind speed and wind direction data collected at this site were utilized.

1.5.3 Cowtown

In addition to the Min-Vol samplers, an existing TEOM PM_{10} sampler operated continuously during the study.

An existing three-meter meteorological system operated during this study. The system recorded temperature, relative humidity, wind speed, wind direction, and wind direction

standard deviation. The meteorological system at the Cowtwown site experienced hardware and software failures during the study.

A three-meter meteorological system operated by the University of Arizona Cooperative Extension AZMET program was used to supplement the meteorological data for this site. This meteorological system is located at University of Arizona Agricultural Research Station near the City of Maricopa and is approximately five miles north of the Cowtown site. The topography between the two sites consists of flat irrigated farmland. Since the AZMET site had a more complete data set available and the data was representative of the area, the wind speed and wind direction data collected at the University of Arizona Agricultural Research Station site was utilized in place of the Cowtown meteorological data set.

1.5.4 Pinal County Housing

In addition to the Min-Vol samplers, an existing Hi-Vol PM_{10} sampler utilized quartz filters and was operated on a one in six day schedule. An existing TEOM PM_{10} sampler was operated continuously during the study.

An existing three-meter meteorological system operated continuously during the study. The system recorded temperature, relative humidity, wind speed, wind direction, and wind direction standard deviation.

1.5.5 Stanfield

In addition to the Min-Vol samplers, an existing Hi-Vol PM_{10} sampler utilized quartz filters and operated on a one in six day schedule.

Neither PCAQCD nor the University of Arizona Cooperative Extension AZMET program has a meteorological system located in the vicinity of the Stanfield site. The closest meteorological stations are located at the Cowtown site, the Casa Grande airport site, and the University of Arizona Maricopa Agricultural Research Station. The Cowtown system is approximately nine miles north of the Stanfield site, the Casa Grande airport system is approximately thirteen miles northeast of the Stanfield site, and the University of Arizona Maricopa Agricultural Research Station AZMET system is approximately fourteen miles north of the Stanfield site. None of these meteorological stations can be considered representative of the Stanfield area. Thus, this site did not have site-specific meteorological data available.

1.6 Soil Sampling

Soil sampling was conducted at one of the monitoring sites in order to create a more accurate source profile for the source apportionment. The Cowtown site was chosen for soil sampling due to its historically elevated PM_{10} concentrations and its proximity to three major sources of particulate matter, feedlots, open field agriculture, and dirt roads.

PCAQCD collected a grab sample from each of these sources of particulate matter. The feedlot soil samples involved collecting one pound of fine material from the surface of five randomly selected feed pens. These samples were then combined into one composite sample. The agricultural field soil samples involved collecting one pound of fine material from the surface of five randomly selected locations within the agricultural field immediately surrounding the Cowtown monitoring site. These samples were then combined into one composite sample. The dirt road soil samples involved collecting one pound of fine material from the road surface of five randomly selected locations along Hartman Road between Farrell Road and Casa Grande Maricopa Highway. These samples were then combined into one composite sample.

DRI resuspended each composite soil sample individually and took two sets of air samples from each resuspension. These filters were then analyzed using the same methods as the ambient filters obtained from the Pinal County monitoring sites. Using the results from these filters DRI constructed a chemical fingerprint for feedlot soil emissions, agricultural soil emissions and dirt road soil emissions. The feedlot soil emission chemical analysis was significantly different than the other two analyses in that it contained a substantial amount of total carbon. Thus, a feedlot soil category was formed in the source apportionment analysis. DRI could not significantly differentiate between the agricultural field and the dirt road analyses. Thus, a separate category was not formed in the source apportionment for these two samples. A more detailed discussion of the feedlot chemical fingerprint analysis can be found in Section 2.2 and Appendix C Addendum.

1.7 Road Counts

PCAQCD installed a road counter on five different roads during the course of this study. The counter was placed on each road for seven days and a total traffic volume was recorded.

The five roads counted were all near the Cowtown site and are as follows:

- Hartman Road – the dirt section between Farrell Road and Casa Grande Maricopa Highway. This count took place between September 26th and October 3rd.
- Farrell Road – the dirt section between Hartman Road and White and Parker Road. This count took place between October 3rd and October 10th.
- Casa Grande Maricopa Highway – the paved section between Hartman Road and White and Parker Road. This count took place between October 28th and November 4th.
- White and Parker Road – the dirt section between Farrell Road and Casa Grande Maricopa Highway. The count took place between October 14th and October 21st.
- Cowtown Road – the dirt road section between Hartman Road and White and Parker Road. This count took place between November 7th and November 14th.

The road count information is included in Appendix E for reference.

1.8 Note Taking

The technicians in charge of maintaining the monitors were supplied with aerial photographs of each site. Dust producing activities or events observed during site visits were noted by placing a number on the aerial photograph. The number corresponded to a written description of the dust producing activity or event.

1.9 Filter Analyses

DRI analyzed the Teflon filters by X-ray fluorescence spectrometry (XRF) for 40 elemental species and weighed the filters for mass calculations. The number of Teflon filters analyzed were as follows; ambient PM_{10} = 50, ambient $PM_{2.5}$ = 50, source PM_{10} = 3, source $PM_{2.5}$ = 3, blanks = 10.

DRI analyzed the pallflex quartz fiber filters for the cations Na^+ and K^+ by Atomic Absorption (AA) Spectroscopy, ammonium (NH_4^+) by Automated Colorimetry (AC), the anions SO_4^{2-}, NO_3^-, Cl^- by Ion Chromatography (IC), and the eight carbon species as well as carbonate ($CO_3^=$) by Thermal/Optical Reflectance (TOR) carbon analysis. The number of pallflex quartz filters analyzed were as follows; ambient PM_{10} = 50, ambient $PM_{2.5}$ = 50, source PM_{10} = 3, source $PM_{2.5}$ = 3, blanks = 10.

DRI also performed a source apportionment analysis on the filters that were speciated using the Chemical Mass Balance (CMB) Version 8 model. This analysis involved using source profiles previously developed by DRI and source profiles developed by DRI using the Cowtown soil samples to produce a list of likely sources at each site. The source profiles utilized in this CMB modeling are described in Appendix C - Table 3 and Appendix C Addendum - Chemical Fingerprint Analysis.

PCAQCD performed mass calculations on the Hi-Vol quartz filters. PCAQCD performed the data management necessary on the continuous TEOM readings and the meteorological measurements. The Arizona Department of Environmental Quality (ADEQ) performed mass calculations on the Andersen $PM_{2.5}$ filters.

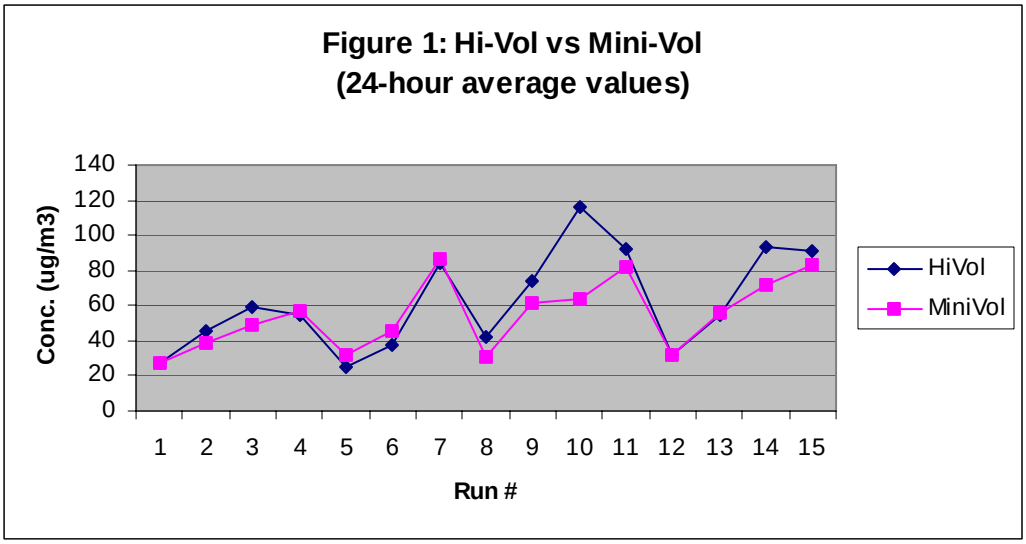
Section 2

Results and Analysis

2.1 Method Comparison

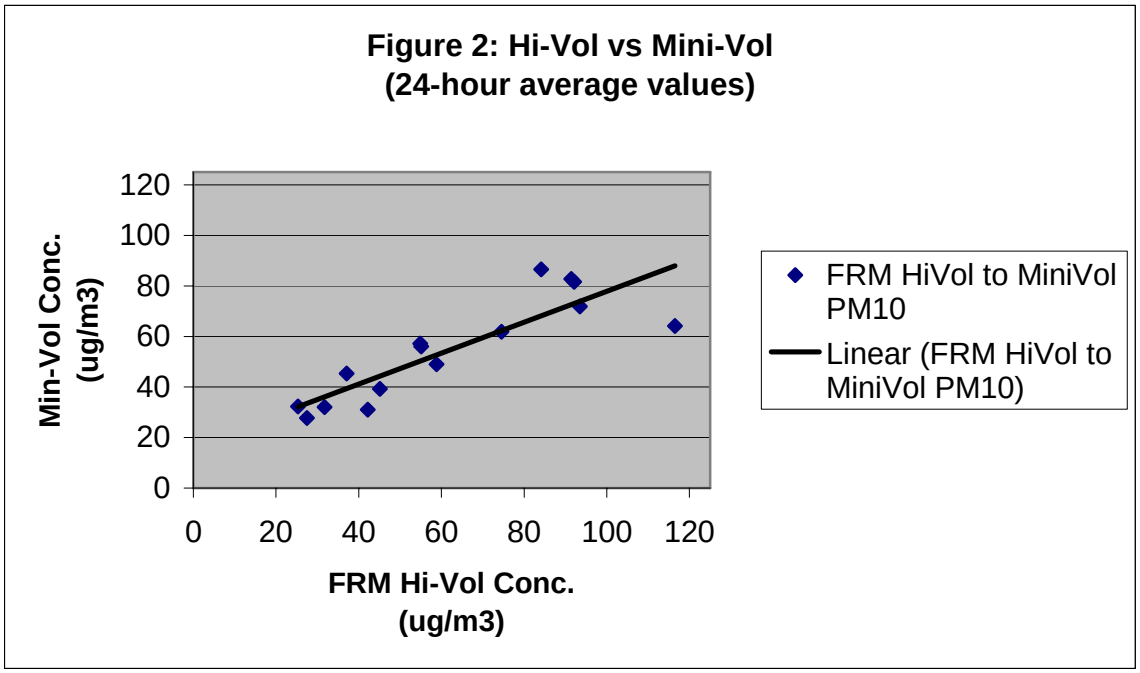
The Mini-Vol samplers utilized for this project are not designated as Federal Reference Method (FRM) monitors. The Environmental Protection Agency (EPA) lists precise methodology for quantifying ambient concentrations of pollutants in 40 Code of Federal Regulations (CFR) Part 50. These precise methodologies are then referred to as FRMs. The monitoring sites chosen for this project all had an existing FRM PM_{10} sampler and one site, Casa Grande, also had an existing FRM $PM_{2.5}$ sampler.

Figure 1 illustrates how the PM_{10} Mini-Vol filter concentrations compare with the PM_{10} FRM Hi-Vol filter concentrations. Throughout all five sites there were fifteen samples in which Hi-Vol data and Mini-Vol data were collected at the same location and time. Figure 1 shows the two samplers generally had reasonable agreement, except the samples shown as run #10 and run #14.



Run #10 was collected at the Pinal County Housing site on October 30, 2003 and run #14 was collected at the Stanfield site on October 30, 2003. In both cases the Mini-Vol samplers recorded a concentration significantly below the Hi-Vol concentration. This could point to an ambient condition affecting both sites that prevented the Mini-Vols from operating properly or these two Mini-Vols did not mechanically operate correctly on October 30, 2003. Overall the Mini-Vol concentrations toggled back and forth as to whether they were higher or lower than the Hi-Vol concentrations.

Figure 2 also illustrates how the PM_{10} Mini-Vol filter concentrations compare with the PM_{10} Hi-Vol filter concentrations. Here the slope of the line equals 0.613 and the correlation coefficient (R^2) equals 0.747. (A slope of 1.0 and a R^2 of 1.0 would represent the ideal situation where the two methods have the exact same concentration.) The scatterplot again shows that the two samplers generally have reasonable agreement with the exception of October 30, 2003. The Pinal County Housing October 30, 2003 run is depicted as the outlier point on the right-hand side of the graph.



Slope: 0.613
R^2: 0.747

Figure 3 depicts how PM_{10} Mini-Vol filter concentrations compare with FRM PM_{10} TEOM filter concentrations. Two of the sites involved in this project, Pinal County Housing and Cowtown, were equipped with a FRM PM_{10} TEOM. At both sites there were a combined nineteen samples in which TEOM data and Mini-Vol data were collected at the same location and time. Figure 3 shows the Mini-Vol concentrations were always below the TEOM concentrations. All the data points, except run #17, show reasonable agreement between these two methods. Run #17 is again October 30, 2003 at the Pinal County Housing site.

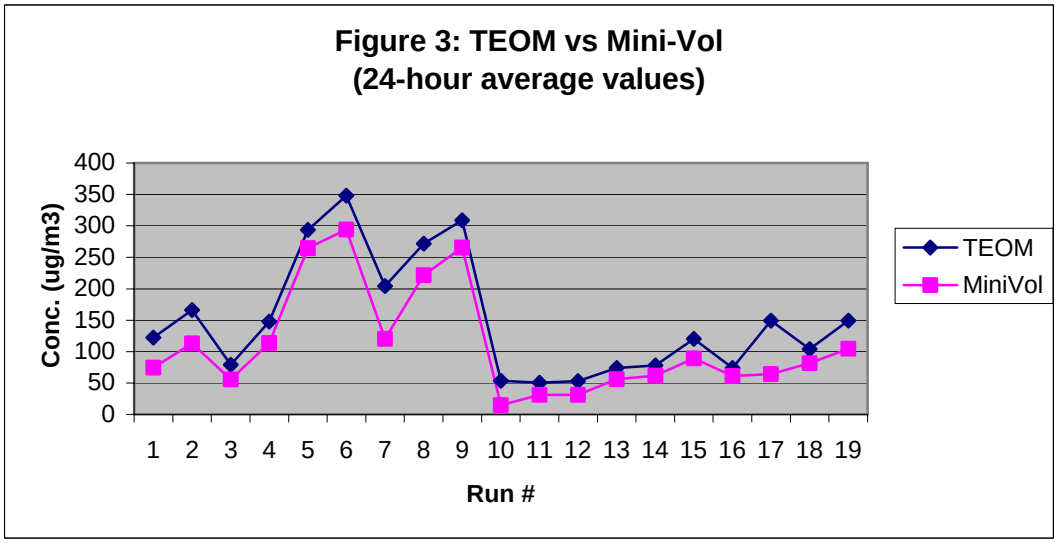
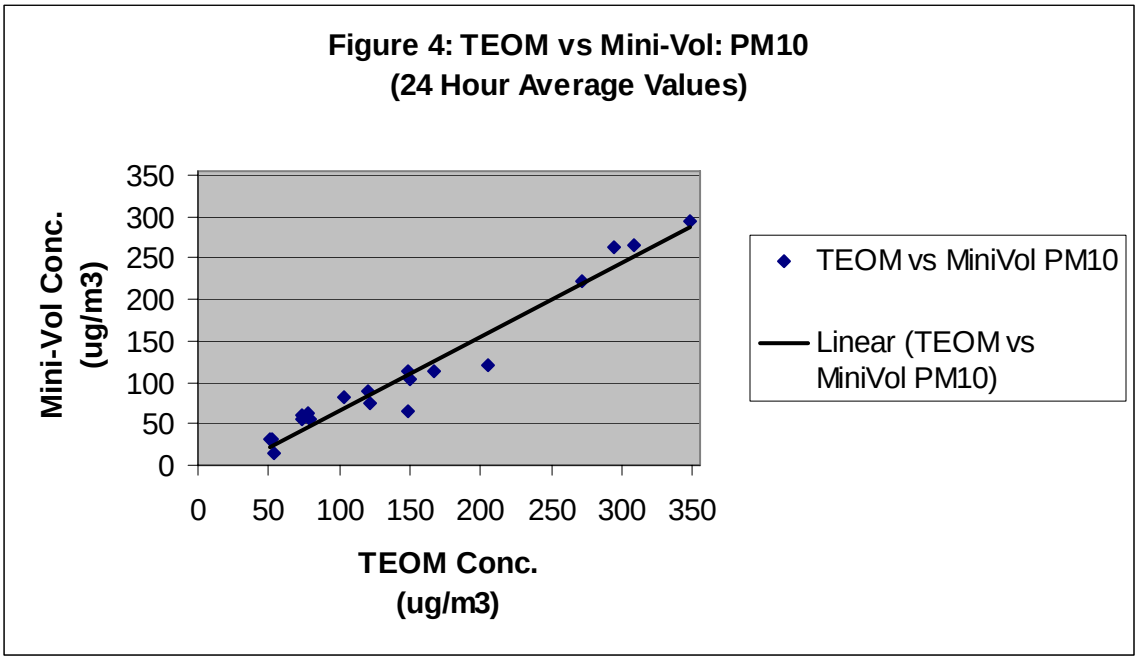


Figure 4 shows that the Mini-Vol concentrations have a very good linear relationship with the TEOM concentrations. Here the slope equals 0.892 and R^2 equals 0.954.



Slope: 0.892
R^2: 0.954

The Casa Grande site was the only location at which a FRM $PM_{2.5}$ sampler, the Andersen $PM_{2.5}$ sampler described in section 1.5.1, was located with a $PM_{2.5}$ Mini-Vol sampler. As shown in Table 1, this produced only three samples in which FRM $PM_{2.5}$ data and $PM_{2.5}$ Mini-Vol data were collected at the same location and time. The methods do differ significantly in two of the three data points. Still, due to the small data set, it is difficult to draw conclusions on the agreement between the two methods.

Table 1: FRM $PM_{2.5}$ vs Mini-Vol $PM_{2.5}$

Date	FRM $PM_{2.5}$ ($\mu g/m^3$)	Mini-Vol $PM_{2.5}$ ($\mu g/m^3$)
10/18/2003	10.1	14.1
10/30/2003	26.7	49.5
11/5/2003	10.7	20.2

PM_{10} and $PM_{2.5}$ samples were collected at all five sites using the Mini-Vol samplers. Table 2 shows the average PM_{10} and $PM_{2.5}$ concentrations as recorded by the Mini-Vol samplers for the duration of this study. The average Mini-Vol $PM_{2.5}/PM_{10}$ ratio, shown in Table 2, ranges from 0.32 at the Stanfield site to 0.53 at the Coolidge and Cowtown sites. When compared to the historical average FRM $PM_{2.5}/PM_{10}$ ratios shown in Table 3 the

Mini-Vol ratio appears too high. Since Casa Grande is the only site included in the study at which a $PM_{2.5}$ FRM sampler is located, there is limited historical data. Still, for the last three years the Casa Grande annual average FRM $PM_{2.5}/PM_{10}$ ratio has consistently averaged 0.27 (+/-0.01). Since there were only three FRM $PM_{2.5}$ samples taken during this project, the Study Duration Casa Grande FRM $PM_{2.5}/PM_{10}$ ratio listed in Table 3 is only based on three runs. Still this ratio of 0.30 is very close to the three-year average ratio of 0.27. The $PM_{2.5}/PM_{10}$ ratio analysis and difference in the FRM to Mini-Vol $PM_{2.5}$ concentrations suggest that the Mini-Vol samplers likely over estimated the ambient $PM_{2.5}$ concentrations.

Table 2: Mini-Vol $PM_{2.5}/PM_{10}$ ratios

Site	**Avg. Mini-Vol PM_{10} ($\mu g/m^3$)**	**Avg. Mini-Vol $PM_{2.5}$ ($\mu g/m^3$)**	**Avg. Mini-Vol $PM_{2.5}/PM_{10}$ Ratio**
Casa Grande	44	18	0.41
Coolidge	47	25	0.53
Cowtown	127	67	0.53
Pinal County Housing	60	25	0.42
Stanfield	55	18	0.32

Table 3: Casa Grande FRM $PM_{2.5}/PM_{10}$ ratios

Annual Casa Grande FRM $PM_{2.5}/PM_{10}$ ratios			
Year	**Annual Avg. PM_{10} ($\mu g/m^3$)**	**Annual Avg. $PM_{2.5}$ ($\mu g/m^3$)**	**Avg. FRM $PM_{2.5}/PM_{10}$ Ratio**
2001	29.2	7.7	0.26
2002	30.4	8.5	0.28
2003	31.5	8.4	0.27
Study Duration Casa Grande FRM $PM_{2.5}/PM_{10}$ ratio (Based on 10/18/03, 10/30/03, 11/5/03 data)			
Site	**Avg. Hi-Vol PM_{10} ($\mu g/m^3$)**	**Avg. FRM $PM_{2.5}$ ($\mu g/m^3$)**	**Avg. FRM $PM_{2.5}/PM_{10}$ Ratio**
Casa Grande	52.9	15.8	0.30

2.2 Source Apportionment Results

DRI performed a source apportionment modeling exercise (CMB version 8) on ten of the thirteen run dates encompassed by this project. The ten runs with the highest data recovery were the runs chosen for the speciation analysis. The remaining three runs were not analyzed due to budgetary constraints and thus are not included in this report. The runs included in this report occurred on October 3, 2003, October 9, 2003, October 12, 2003, October 15, 2003, October 18, 2003, October 21, 2003, October 27, 2003, October 30, 2003, November 5, 2003 and November 8, 2003. The data recovery for these ten runs was excellent at 95.5%. Out of two hundred filters, eight filters ran less than the scheduled twenty-four hours and the laboratory voided one filter.

PCAQCD utilized meteorological data collected at the Pinal County Housing, Casa Grande Airport, Cowtown, Coolidge AZMET and Maricopa Agricultural Research Station AZMET sites to construct wind roses for each of the dates listed above. The wind roses are included in Appendix D-1. PCAQCD also utilized the National Oceanic and Atmospheric Administration (NOAA) Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model to construct a backward trajectory for air masses starting 0700 the day of the run date until 0700 the day after the run date (the ambient filters were collected midnight to midnight). The Casa Grande area was chosen for the termination point of the model due to its central location. The 0700 to 0700 time frame was chosen to account for the fact that monitoring sites were located both east and west of Casa Grande. Given the resolution of the HYSPLIT analysis this was not a necessary consideration. The graphical product produced by the NOAA HYSPLIT model is included in Appendix D-2. Information on the model and the data inputs used in the model can be found at http://www.arl.noaa.gov/ready/hysp_info.html

Appendix C contains the source apportionment results as compiled by DRI. The information listed in this appendix is based on the filters collected by the Mini-Vol samplers. No FRM filters were speciated as part of this project. Appendix C - Table 1 lists the average measured $PM_{2.5}$ and PM_{10} concentrations as measured by the Mini-Vol samplers at each site. Appendix C - Figure 1 shows the concentrations of each run in a graphical format.

Appendix C - Table 2 explains the color-coding scheme used in the pie charts that represent the modeled source attribution for each run date. Appendix C - Table 3 further explains the source profiles used in this CMB modeling. Each site has a table listing the modeled chemical mass balance for each PM_{10} run along with the modeled and measured concentrations for each run. This same information is also represented in pie chart figures directly below each table. Additionally, each site has a table and pie chart figure detailing the modeled chemical mass balance for each $PM_{2.5}$ run along with the modeled and measured concentrations for each run. This information is detailed in Appendix C - Table 4 through Table 13 and Appendix C - Figure 2 through Figure 11. Appendix C - Table 14 lists the CMB modeled $PM_{2.5}$ species for the resuspended agricultural field, dirt road and feedlot samples. Appendix C - Table 15 lists the CMB modeled PM_{10} species for the resuspended agricultural field, dirt road and feedlot samples.

The pie charts depicted in Appendix C - Figure 2 through Figure 11 are all based on the corresponding information listed in Appendix C - Table 4 through Table 13. Generally, dividing the individual modeled source component (soil, feedlot, motor vehicle, vegetative burning, coal power plants, ammonium sulfate, or ammonium nitrate) by the modeled mass produces the pie charts percentages. Whenever the CMB model was unable to attribute a portion of the analysis to a known source an “other” category was created. For samples with an “other” category dividing the individual modeled source component by the measured mass produces the pie chart percentages. This was done to account for the fact the modeled mass number does not include the concentration listed in the other category. The following sections include PM_{10} pie charts and $PM_{2.5}$ pie charts that illustrate the averaged results for each site. These pie charts also take into account the two mechanisms for creating percentages.

Appendix C – Addendum contains an explanation of how DRI derived the feedlot chemical fingerprint. Each composite soil sample from the Cowtown site was individually resuspended and two sets of air samples were taken from each resuspension. These filters were then analyzed using the same methods as the ambient filters obtained from the Pinal County monitoring sites.

Using the results from the resuspension filters DRI constructed a chemical fingerprint for feedlot soil emissions, agricultural soil emissions and dirt road soil emissions. Figure 5 illustrates these three chemical fingerprints for PM_{10} and Figure 6 illustrates these three chemical fingerprints for $PM_{2.5}$. Shown in both figures are concentrations of 17 chemical species and their analytical uncertainties (⊥), including water soluble nitrate, sulfate and ammonium, the eight carbon species (Organic Carbon (OC) 1 thru 4, Optical Pyrolyis by Thermal/Optical Reflectance (OPT) and Elemental Carbon (EC) 1 thru 3), as well as total carbon (TC), and five metals typical of most soils aluminum, silicon, potassium, calcium and iron. The PM_{10} and $PM_{2.5}$ Feedlot Dust samples differ from the PM_{10} and $PM_{2.5}$ Agricultural and Road Dust samples in that they contain a substantial amount of total carbon (TC), which is the total of the concentrations of the carbon species, particularly OC2, OC3, OC4, OPT and EC1.

Figure 5: PM_{10} Surface Material Chemical Fingerprints

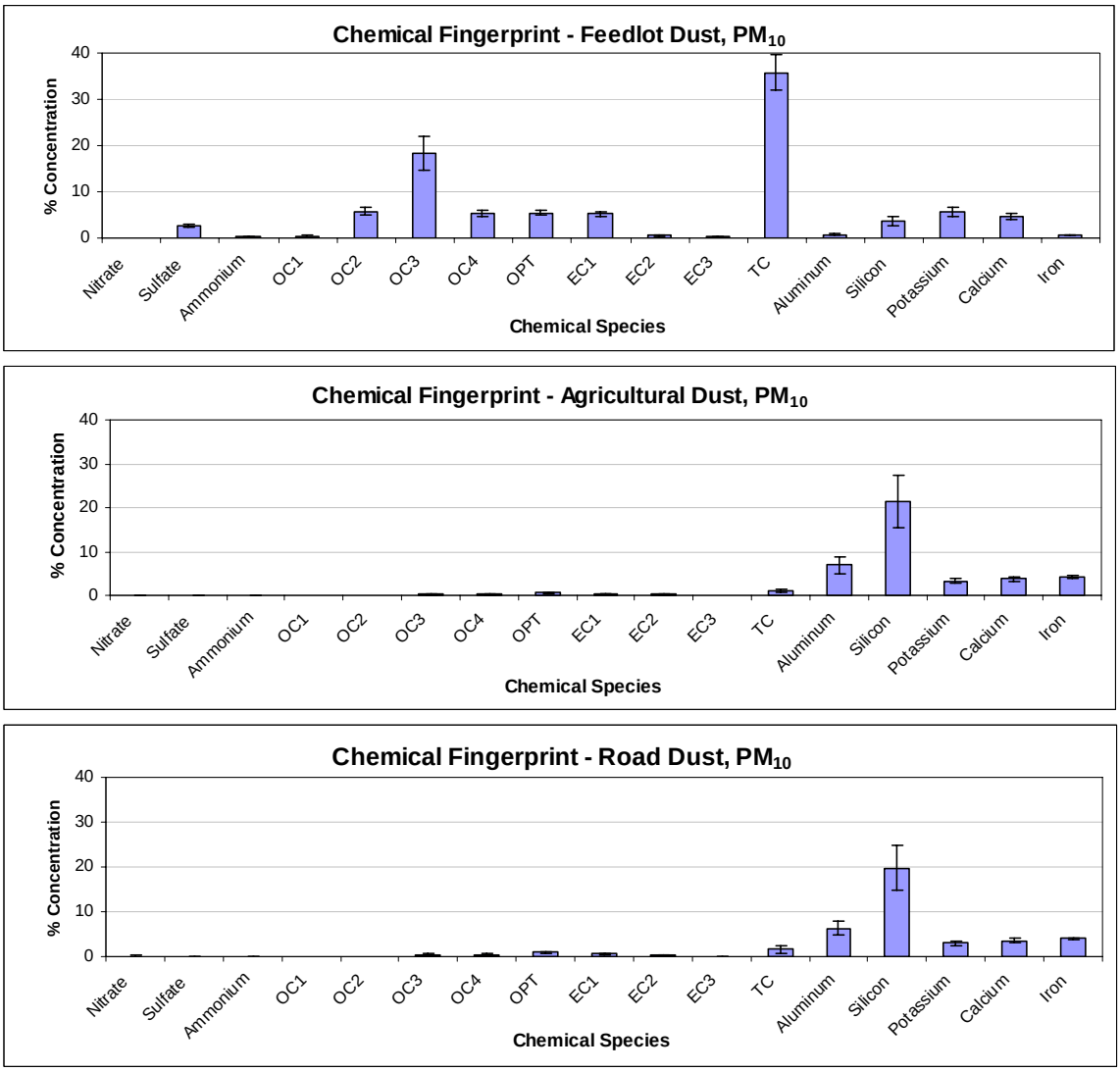
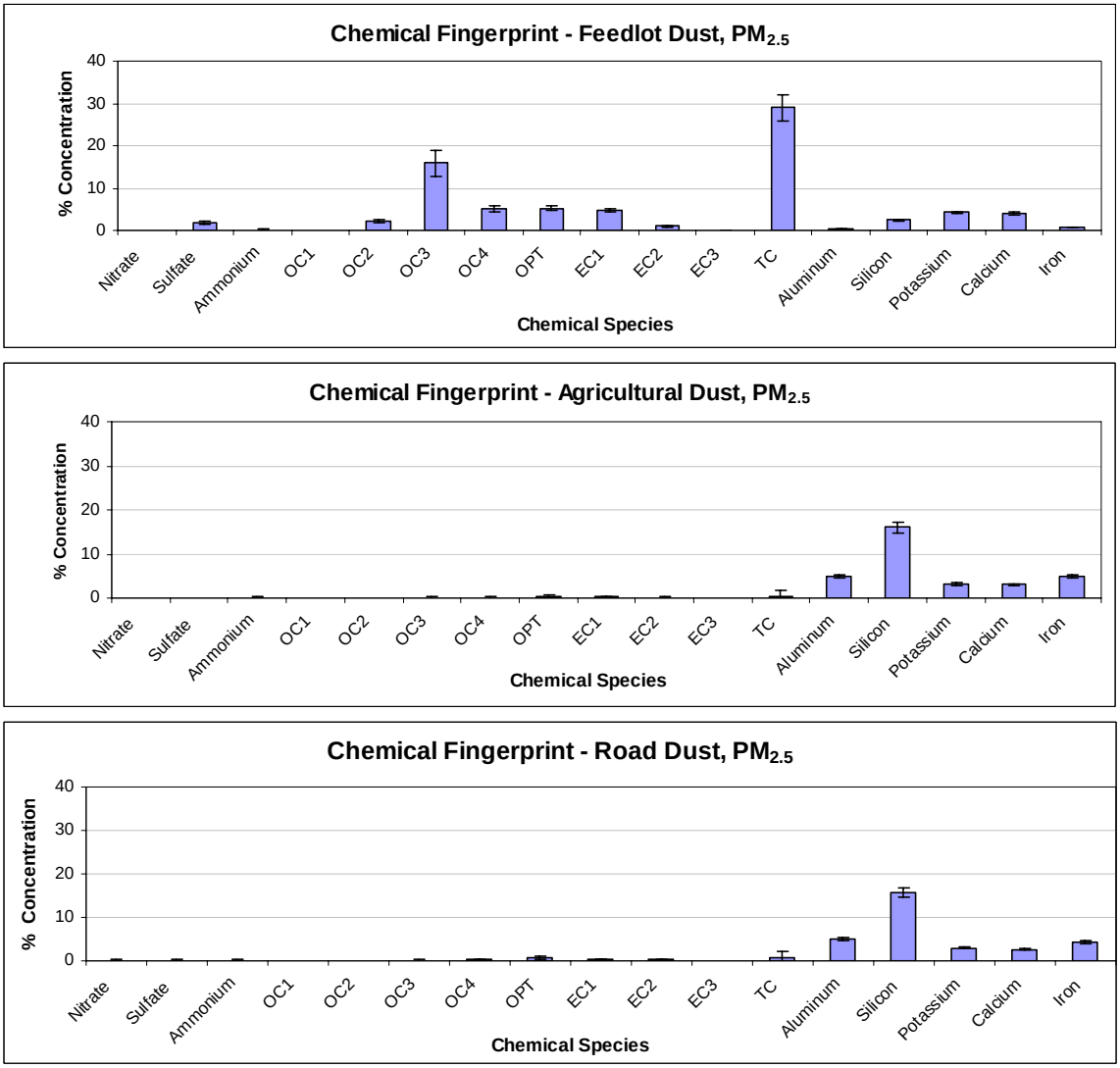


Figure 6: $PM_{2.5}$ Surface Material Chemical Fingerprints



2.2.1 Casa Grande Source Apportionment Results

The Casa Grande site was the control site for the project due to its central location and the area surrounding the site being well stabilized. Since the site is located in the downtown area of Casa Grande there are no agricultural fields, dirt roads, feedlots or large construction projects in the area immediately surrounding the monitoring site. The average 24-hour PM_{10} concentration for the site as recorded by the Mini-Vol sampler was 44 $\mu g/m^3$ during this project. This is the lowest of the sites included in the study.

Appendix C – Table 4 and Figure 2 show the CMB modeled PM_{10} source attributions for Casa Grande. The highest source contribution in all ten runs was the geological soil

category with an average contribution of 62 %. The second highest source contribution, for all runs except 10/9/03, was the feedlot soil category with an average of 20%. (The 10/9/03 run had a large percentage, 25.8%, which could not be attributed to any of the identified source profiles.) The nearest dairy is approximately two miles to the southeast of the site. The wind roses shown in Appendix D-1 do not always support the feedlot soil emissions coming from this dairy. Dairies and feedlots further to the northeast, west and northwest could be contributing.

Throughout the study feedlot emissions appeared in unexpected areas. It is possible that the numerous dairies and feedlots located throughout the agricultural basin are contributing significantly to the recorded PM_{10} concentrations. It is also possible that agricultural field soils are contributing to the modeled feedlot emissions. It is common practice to spread manure on agricultural fields for fertilizer. Either one of these conclusions would explain feedlot emissions being identified in many samples where they cannot be linked to a specific feedlot or dairy using the wind roses.

Vegetative burning and coal power plant emissions were the remaining two prominent source contributions. The percentages of both of these categories reduced as the PM_{10} concentrations increased. Vegetative burning averaged 6% and coal power plant emissions averaged 5% over the ten runs.

The vegetative burning emissions were expected at all the sites. Open burning is a common practice throughout Pinal County. Countywide PCAQCD issued 253 burn permits during October 2003 that allowed plant material to be disposed of by burning.[2] The burning of prohibited substances such as household garbage is also a substantial compliance issue throughout the County.

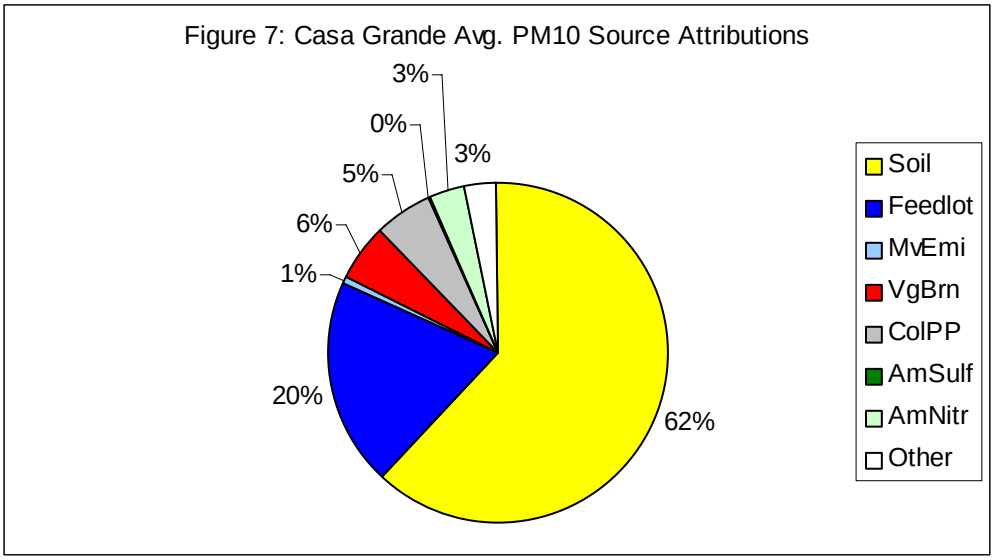
The coal power plant emissions were not an expected source. The nearest coal power plant is approximately 70 miles to the southeast in Tucson. The wind roses in Appendix D-1 and the HYSPLIT analysis in Appendix D-2 do not support attributing these emissions to the Tucson plant. Since the coal power plant emissions are identified in each sample it appears the emissions are originating from multiple sources.

Ammonium Nitrate was the only remaining source contribution identified in all the samples with an average of 3%. One sample, 10/9/03, identified ammonium sulfate with 3.8% and motor vehicle emissions with 5.3% as contributing sources. Since only one sample identified these two sources the average contribution for both was insignificant, less than 1% for each source.

The 10/9/03 run had a large contribution, 25.8%, which could not be identified. The only other run with an unidentified contribution was 10/27/05 with 5.0%. When averaged over all ten runs this produces a 3% unidentified source contribution.

Figure 7 graphically depicts the PM_{10} average percentage source contributions for all ten runs. Refer to Appendix C – Table 4 and Figure 2 for individual run data.

[2] Pinal County Air Quality burn permit records



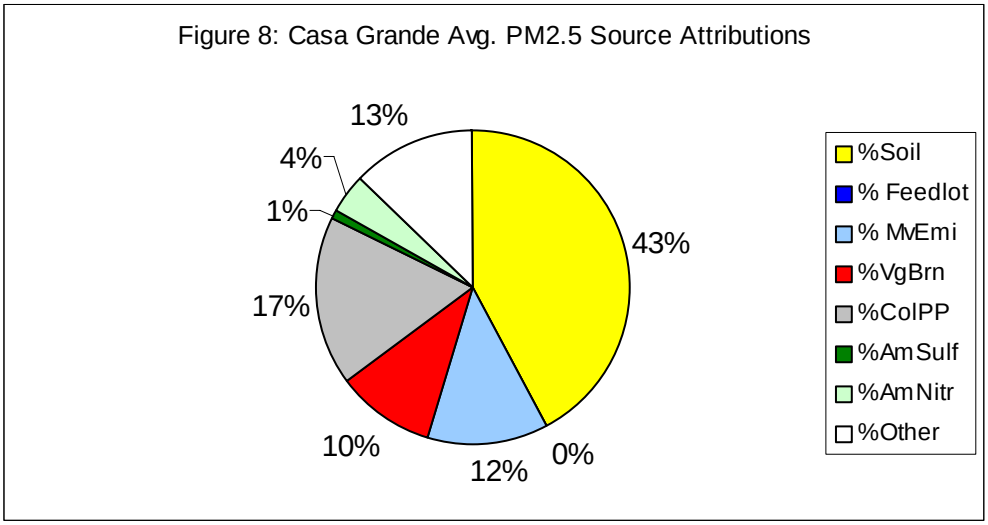
Appendix C – Table 5 and Figure 3 show the CMB modeled $PM_{2.5}$ source attributions for Casa Grande. The highest source contribution in all ten runs was the geological soil category with an average contribution of 43%. On average the second highest source contribution was coal power plants with 17%. In relative terms the coal power plant contribution generally decreased as the concentrations increased.

Two runs, 10/27/03 and 10/30/03, have a large unidentified contribution, 47.8% and 74.1% respectively. As in all instances with an unidentified component, the modeled mass (or concentration) was below the measured mass for the run (see Appendix C – Table 5). It is likely that the cut point on the Mini-Vol $PM_{2.5}$ sampler was not accurate for these two runs and the sampler overestimated the $PM_{2.5}$ concentrations. This would also in part explain the increased $PM_{2.5}/PM_{10}$ ratio discussed in Section 2.1.

Vegetative burning with an average source contribution of 10% and motor vehicle emissions with an average source contribution of 12% were the remaining significant sources. As discussed earlier, vegetative burning was an expected source contribution at all the sites. The motor vehicle contribution was expected due to the proximity of several busy nearby city streets. Ammonia nitrate and Ammonia sulfate were the remaining two identified sources with average contributions of 4% and 1% respectively.

The Casa Grande site was only one of two sites in which feedlot emissions were not identified in the $PM_{2.5}$ source apportionment. The other site that did not include feedlot emissions in the $PM_{2.5}$ source apportionment was Stanfield. While the closest dairy to the Casa Grande site is approximately two miles to the southeast, the Stanfield site is near several large dairies and feedlots. (The Stanfield source apportionment results will be further discussed in Section 2.2.5.) Further sampling and analysis will be needed to discuss why these two dramatically different sites lack feedlot emissions in the $PM_{2.5}$ source apportionment.

Figure 8 graphically depicts the $PM_{2.5}$ average percentage source contributions for all ten runs. Refer to Appendix C – Table 5 and Figure 3 for individual run data.



2.2.2 Coolidge Source Apportionment Results

The Coolidge site was utilized in this study due to its location on the eastern side of the agricultural basin and due to its location near the edge of town. The site is located in a residential neighborhood and approximately ¼ of a mile west of active agricultural fields. The agricultural basin extends north of the Coolidge site a substantial distance. Although, approximately six miles east of the Coolidge site the landscape generally changes back to native desert and this landscape continues to the eastern boundary of the County with increasing elevations further to the east.

The average 24- hour PM_{10} concentration during the project as recorded by the Mini-Vol sampler was one of the lowest in the study at 47 $\mu g/m^3$. Even though this value is elevated when compared to the annual PM_{10} standard, it should be noted that this average only included nine runs and the time period in which the study was conducted is generally when the highest particulate matter concentrations are recorded.

Nine runs were analyzed and included in the PM_{10} source apportionment analysis for this site. The November 8, 2003 run was voided by DRI since the Teflon filter deposit appeared to be much lighter than the quartz filter deposit. The Teflon filter for October 3, 2003 only ran seventeen hours out of the scheduled twenty-four. The quartz filter for October 15, 2003 only ran seven hours out of the scheduled twenty-four. In both cases the filters were still included in the source apportionment analysis.

Appendix C – Table 6 and Figure 4 show the CMB modeled PM_{10} source attributions for Coolidge. The highest source contribution in all ten runs was the geological soil category with an average contribution of 73%. On average the second highest contribution was the feedlot soil category with 9%, even though feedlot emissions were only identified in four of the nine runs analyzed. The nearest dairy is located approximately four miles

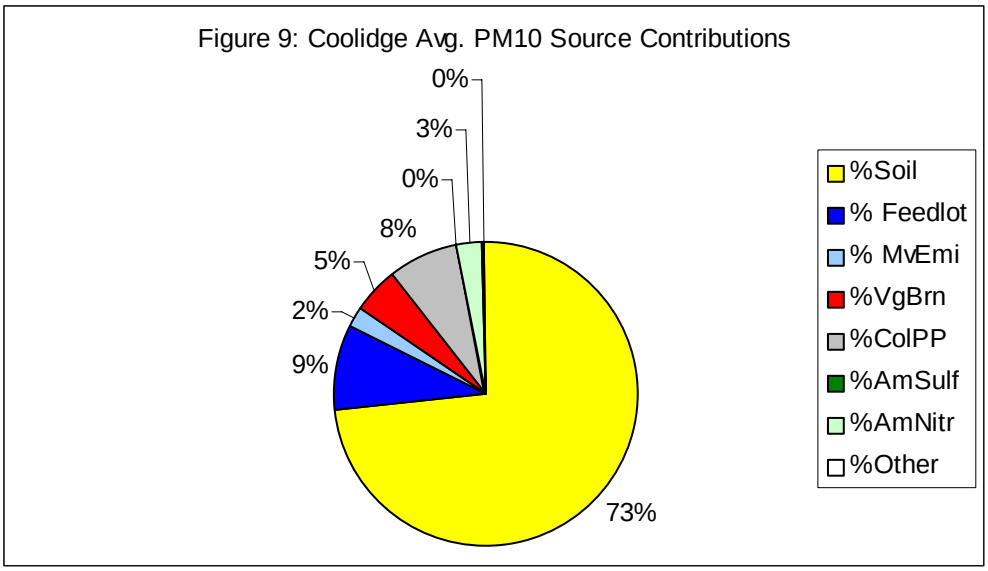
northeast of the site. Another dairy is located approximately five miles northwest of the site. In three of the four runs with feedlot emissions the wind roses created for the site do not support attributing the emissions to these dairies. The remaining run, October 12, 2003, appears to have been a very calm day with winds generally coming across the dairy northeast of the site and towards the monitor.

Coal power plant and vegetative burning emissions were the remaining two predominant source contributions. Coal power plant emissions averaged 8% over the nine runs and were identified in all the runs. Vegetative burning emissions averaged 5% and were identified in seven of the runs.

Ammonium nitrate and motor vehicle emissions were the lowest source contributions with ammonium nitrate averaging 3% and motor vehicle emissions averaging 2%. The small contribution from motor vehicle emissions was expected since the monitor is located along a residential street. Throughout the project ammonium nitrate was identified in small quantities in all but two PM_{10} runs, or 96% of the PM_{10} runs. It is common practice to supplement agricultural soils by bubbling gaseous ammonia into irrigation canals. The ammonia dissolves readily in water and forms ammonium ions. Sewage treatment plants and animal manure are also local sources of ammonia that in turn can create ammonium ions. Ammonium nitrate is then formed through chemical reactions with nitrogen oxides emitted by burning fossil fuels.

The Coolidge PM_{10} source attribution resulted in very little unidentified emissions. Only three runs included an unidentified, or other, component. In these three runs this component was a very small percentage and on average the other component made up less than 1% of the PM_{10} source attribution.

Figure 9 graphically depicts the PM_{10} average percentage source contributions for all nine runs. Refer to Appendix C – Table 6 and Figure 4 for individual run data.



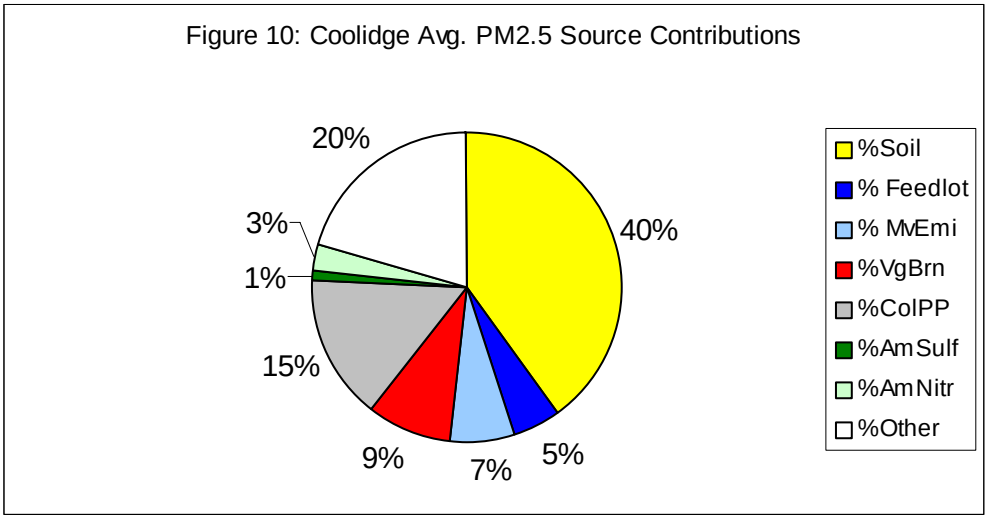
Appendix C – Table 7 and Figure 5 show the CMB modeled $PM_{2.5}$ source attributions for Coolidge. The highest identified source contribution in all ten runs was the geological soil category with an average contribution of 40%. On average the second highest source contribution was the unidentified or other category with 20%. Eight runs included an other category with four runs having greater than 30% of the source attribution unidentified. Three of the four runs with a large unidentified contribution, October 15, 2003, October 18, 2003, and November 21, 2003 had a larger than expected $PM_{2.5}/PM_{10}$ ratio, 0.69, 0.59 and 0.70 respectively. In other words, the measured $PM_{2.5}$ concentration seemed too large when compared to the measured PM_{10} concentration. Historical data suggests we would expect a ratio closer to 0.30 (see section 2.1). A $PM_{2.5}/PM_{10}$ ratio could not be calculated for the fourth date, November 8, 2003, since the corresponding Mini-Vol PM_{10} filter was voided. It is likely that the Mini-Vol $PM_{2.5}$ samplers did not operate properly on these days and over estimated the $PM_{2.5}$ concentrations.

Coal power plant emissions made up the third largest source with an average of 15%. As seen throughout the study coal power plant emissions reduced dramatically as concentrations increased. In all cases where coal power plant emissions made up a significant portion of the individual run source attribution, 23.9%, 29.3% and 37.7%, the corresponding measured $PM_{2.5}$ concentration was fairly low, 11.4 $\mu g/m^3$, 10.5 $\mu g/m^3$ and 8.4 $\mu g/m^3$ respectively.

Vegetative burning with an average contribution of 9%, motor vehicle emissions with an average contribution of 7%, and feedlot soil emissions with an average contribution of 5% were the remaining significant sources. Vegetative burning was an expected source contribution at all the sites. Motor vehicle emissions were an expected source due to the site's proximity to a residential street. Only two samples included a feedlot soil component in the $PM_{2.5}$ source attribution, October 15, 2003 with 9.0% and October 30, 2003 with 40.6%. The wind rose for October 30, 2003 does not support attributing the elevated feedlot component directly to either of the nearby dairies.

Ammonium nitrate and ammonium sulfate were the remaining two identified sources with 3% and 1% respectively. Ammonium nitrate is an expected source contribution as discussed in the Coolidge PM_{10} source attribution description. Ammonium sulfate was only identified in three $PM_{2.5}$ runs at Coolidge, two $PM_{2.5}$ runs in Stanfield, two $PM_{2.5}$ runs in Casa Grande, and one PM_{10} run in Casa Grande. The contribution was relatively small at all the sites, except Stanfield. (The Stanfield source apportionment will be discussed further in Section 2.2.5) Sulfur dioxide gas is introduced into the atmosphere primarily from fossil fuel combustion. The gas in turn converts to sulfuric and sulfurous acids and then reacts with ammonia to form ammonium sulfate. The Coolidge and Casa Grande sites are both near heavily traveled railroad tracks. The diesel emissions, including sulfur dioxide, from the railroad locomotives may have contributed to the formation of ammonium sulfate at these sites. A third site, Cowtown, is also near heavily traveled railroad tracks and ammonium sulfate was not identified in either the $PM_{2.5}$ or PM_{10} source attribution. (The Cowtown source apportionment results will be further discussed in Section 2.2.3.)

Figure 10 graphically depicts the $PM_{2.5}$ average percentage source contributions for all ten runs. Refer to Appendix C – Table 7 and Figure 5 for individual run data.



2.2.3 Cowtown Source Apportionment Results

The Cowtown site was utilized in this study due to its proximity to several large feedlots. The site is approximately 300 yards from the closest feedlot and a grain handling operation. Also, the site is completely surrounded by active and retired agricultural fields.

Appendix C – Table 8 and Figure 6 show the CMB modeled PM_{10} source attributions for Cowtown. Nine runs were analyzed and included in the PM_{10} source apportionment analysis for this site. The October 27, 2003 run was voided by DRI since no mass was recorded on the Teflon filter.

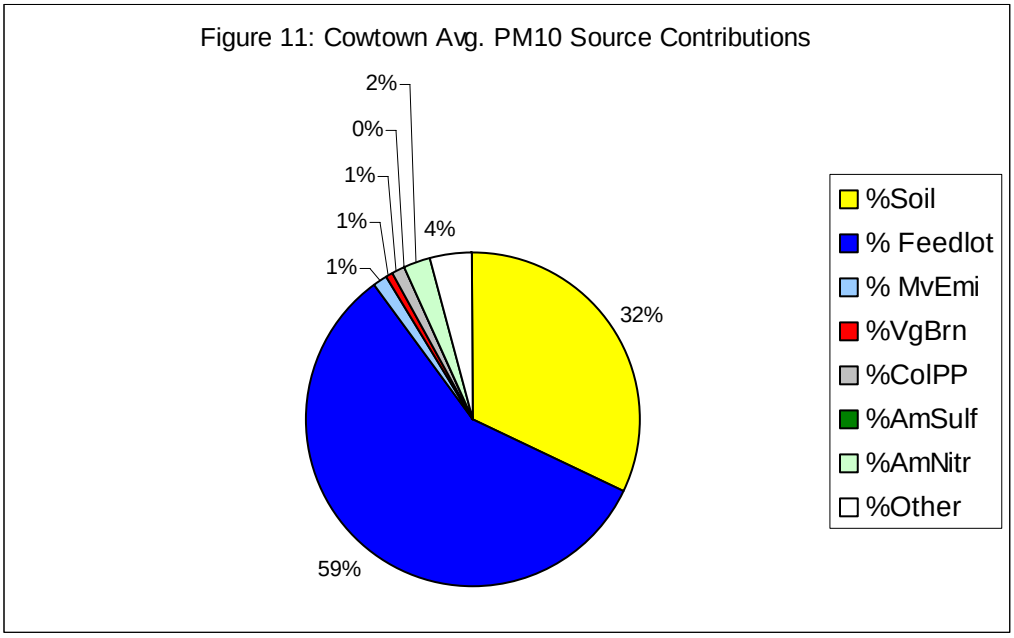
The highest PM_{10} source contribution in all nine runs was the feedlot soil category with an average contribution of 59%. The second highest source contribution for all the runs was the geological soil category with an average of 32%. This was the only site in the study where the geological soil category was not the highest source contribution.

The average 24-hour PM_{10} concentration at Cowtown was well above any other site at 127 $\mu g/m^3$, as recorded by the Mini-Vol PM_{10} sampler. Four samples had a recorded PM_{10} Mini-Vol concentration above 200 $\mu g/m^3$, October 18 2003, October 21, 2003, November 5, 2003, and November 8, 2003. In all four cases the wind roses created for the site show inversion conditions with very light winds throughout the day.

On average the remaining source categories made up small percentages of the attribution. Ammonium nitrate contributed on average 2% and was expected due to the nearby feedlots serving as a large source of ammonia. Motor vehicle, open burning and coal power plant emissions each only contributed 1% on average.

Four runs included an unidentified category, October 3, 2003 with 4.9% listed as other, October 21, 2003 with 8.7% listed as other, November 5, 2003 with 5.8% listed as other and November 8, 2003 with 17.2% listed as other. Averaged over the nine runs this leaves 4% in the unidentified category.

Figure 11 graphically depicts the PM_{10} average percentage source contributions for all nine runs. Refer to Appendix C – Table 8 and Figure 6 for individual run data.



Appendix C – Table 9 and Figure 7 show the CMB modeled $PM_{2.5}$ source attributions for Cowtown. Ten runs were analyzed and included in the $PM_{2.5}$ source apportionment analysis for this site, although one filter did not have a complete run. The Teflon filter for November 5, 2003 only ran fourteen hours out of the scheduled twenty-four.

The highest source contribution in nine of the ten runs was the feedlot soil category with an average of 49%. The second highest source contribution for nine of the ten runs was the geological soil category with an average of 24%. Again, this was the only site in the study where the geological soil category was not the highest source contribution.

The average 24- hour $PM_{2.5}$ concentration at Cowtown was also well above any other site at 67µg/m^3, as recorded by the Mini-Vol $PM_{2.5}$ sampler. Three samples had a recorded $PM_{2.5}$ Mini-Vol concentration above 100 µg/m^3, October 21, 2003, October 27, 2003, and November 8, 2003. In all three cases the wind roses created for the site show inversion conditions with light winds throughout the day.

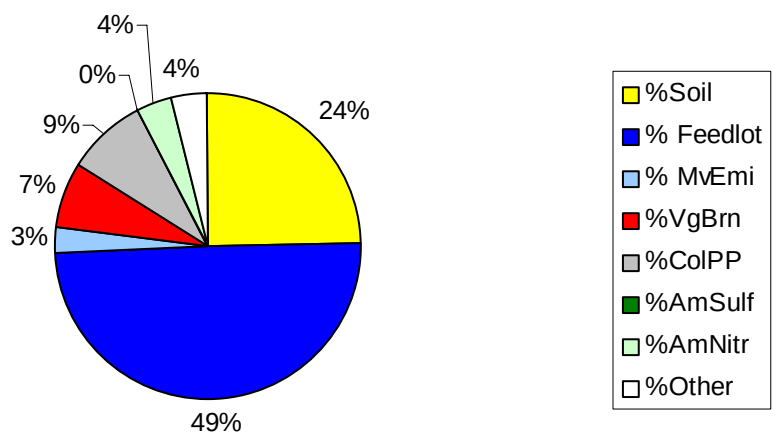
Coal power plant emissions were the third largest contributor with an average of 9%. As seen at other sites the coal power plant emission percentages dramatically decreased as the measured concentrations increased. Vegetative burning was also a significant contributor with an average of 7%. The October 12, 2003 run was unique in that coal

power plant emissions made 26% of the source attribution, vegetative burning emissions contributed 21%, and geological soil emissions contributed 18%. The $PM_{2.5}$ measured concentration for this date was the lowest recorded at the site at 15.7 µg/m^3. A specific source for the elevated coal power plant emissions and vegetative burning emissions could not be identified.

Ammonium nitrate with an average contribution of 4% and motor vehicle emissions with an average contribution of 3% were the remaining identified source contributions. Both of these sources were expected to have a larger contribution due to the nearby feedlots serving as a source of ammonia and the proximity of a heavily traveled road. As noted earlier this is the only site that was near a heavily traveled railroad track that did not show ammonium sulfate as a small source contribution. It is possible that the large feedlot soil contribution affected these three source categories. An unidentified component was apparent in seven of the ten runs, although on average the other category only accounted for 4%.

Figure 12 graphically depicts the $PM_{2.5}$ average percentage source contributions for all ten runs. Refer to Appendix C – Table 9 and Figure 7 for individual run data.

Figure 12: Cowtown Avg. PM2.5 Source Contributions



2.2.4 Pinal County Housing Source Apportionment Results

The Pinal County Housing site was included in this study due to its location in the heart of the agricultural basin. The site is immediately surrounded by native desert; beyond that open field agriculture dominates the landscape for at least ten miles in all directions. The average 24-hour PM_{10} concentration for this site during the project as recorded by the Mini-Vol sampler was elevated at 60 µg/m^3.

Appendix C – Table 10 and Figure 8 show the CMB modeled PM_{10} source attributions for Pinal County Housing. Ten runs were analyzed and included in the PM_{10} source

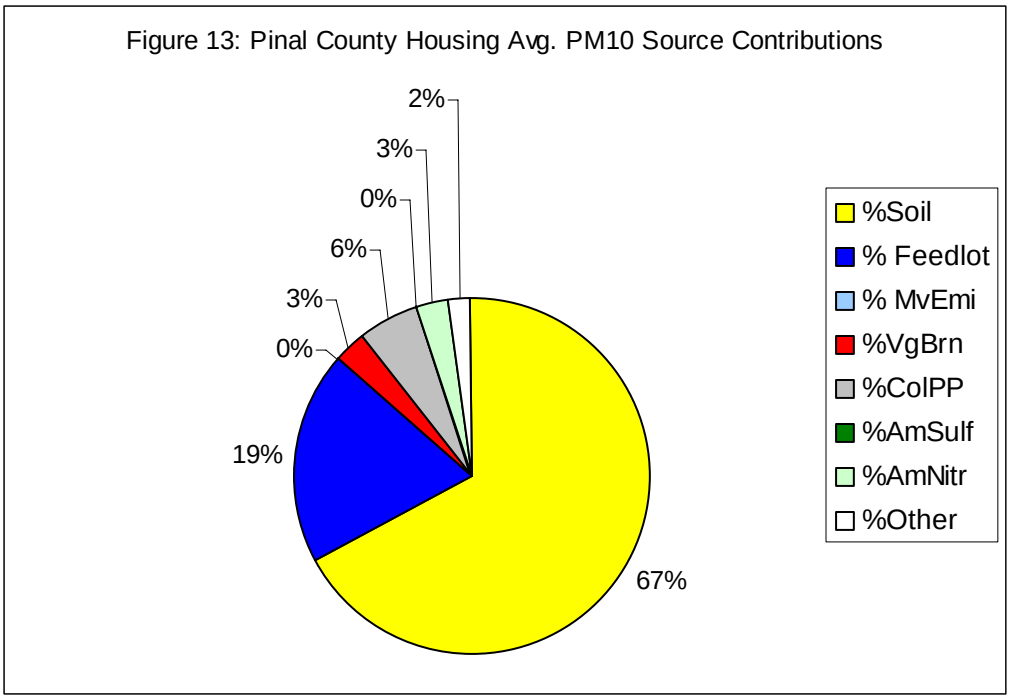
apportionment analysis for this site, although one filter did not have a complete run. The quartz filter for November 5, 2003 only ran twenty-two hours out of the scheduled twenty-four.

The highest source contribution in all ten runs was the geological soil category with an average contribution of 67%. The second highest source contribution for all the runs was the feedlot soil category with an average of 19%. The nearest dairy is approximately one mile south of the site. Three additional dairies are approximately five miles west of the site. The wind roses do not always support attributing the feedlot soil emissions to these dairies. As discussed earlier, the feedlot soil emissions could be attributed to the large number of dairies and feedlots throughout the agricultural basin or manure spread over agricultural fields.

Coal power plant emissions made up the third largest category with an average of 6%. This site is immediately surrounded by native desert and a small group of houses with vast tracks of agricultural fields beyond that. The only significant industrial processes nearby are a cotton gin ¾ of a mile to the south and a natural gas power plant approximately 2.5 miles north of the site. This power plant operates solely on natural gas and is operated only during peak power demands. As seen at other sites, the coal power plant emissions did reduce as concentrations increased. Considering there is not a local source that could contribute to this source category and the HYSPLIT analysis included in Appendix D-2 does not support attributing the emissions to the nearest coal power plant in Tucson, it appears that there is a long-range transport mechanism affecting this source category.

Vegetative burning and ammonium nitrate emissions were the remaining two identified source categories with both averaging 3% over the ten runs. Only two runs had an unidentified component, November 5, 2003 with 9.0% listed as other and November 8, 2004 with 10.2% listed as other. Averaged over the ten runs this leaves 2% in the unidentified category.

Figure 13 graphically depicts the PM_{10} average percentage source contributions for all ten runs. Refer to Appendix C – Table 10 and Figure 8 for individual run data.



Appendix C – Table 11 and Figure 9 show the CMB modeled $PM_{2.5}$ source attributions for Pinal County Housing. Nine runs were analyzed and included in the $PM_{2.5}$ source apportionment analysis for this site. The Teflon filter for October 18, 2003 ran for 17 hours, although no mass was recorded on the filter. Since there was not a valid Teflon filter for the date it was not included in the source apportionment.

The largest source contribution in seven of the nine runs was the geological soil category. Geological soil emissions were still the dominant source category with 50% when averaged over the nine runs. Coal power plant emissions made up the second largest category with an average contribution of 17%. October 3, 2003 had an extremely large contribution identified as coal power plant emissions with 44.8%. The $PM_{2.5}$ concentration recorded by the Mini-Vol on this day was relatively small at 7.1 $\mu g/m^3$. As concentrations increased the coal power plant percentages dramatically decreased. As discussed earlier a long-range transport mechanism seems to be affecting this source category.

Motor Vehicle emissions averaged 8% over the nine runs. October 9, 2003 had a large contribution identified as motor vehicle emissions with 39.9%, which was the most significant source for that run. The Mini-Vol $PM_{2.5}$ concentration for that day was 9.5 $\mu g/m^3$ and the motor vehicle contribution did generally reduce as concentrations increased. The site is located in an area where very few vehicles drive directly by the monitors. There are major thoroughfares located approximately ½ mile east of the site and ¾ of a mile south of the site. This still does not explain the high motor vehicle source contribution on October 9, 2003. Field notes also do not note any activities that could have contributed to this source category. It is possible that an unidentified localized activity contributed significantly to this source category on October 9, 2003.

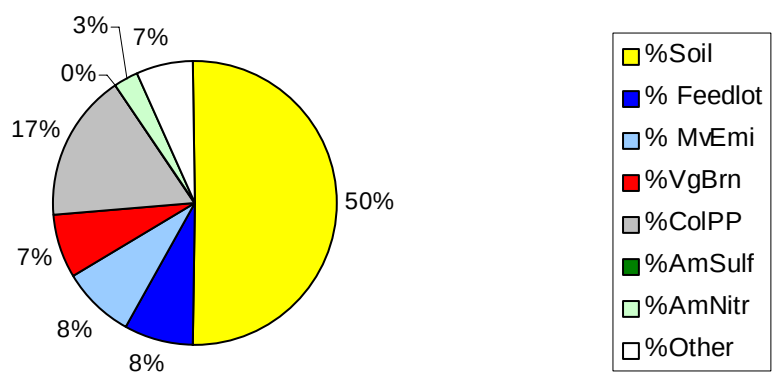
Feedlot soil emissions also averaged 8% over the nine runs. October 30, 2003 had a large contribution identified as feedlot emissions with 39.9%, which was the most significant source contribution for that run. The Mini-Vol $PM_{2.5}$ concentration for that day was elevated at 35.4 µg/m^3. The wind rose included in Appendix D-1 for Pinal County Housing on October 30, 2003 did show sustained winds blowing across the nearest dairy and towards the monitor.

Vegetative burning and ammonium nitrate were the remaining two identified source contributions with an average of 7% and 3% respectively. As discussed previously vegetative burning was an expected source at all the sites. The Pinal County Housing site is located within a fenced area that houses the sewer lift station for the nearby County Housing subdivision. Even though this does create a localized source of ammonia it does not appear to have affected the source apportionment for the site. Ammonium sulfate was not identified in either the PM_{10} or $PM_{2.5}$ source apportionment and ammonium nitrate concentrations were comparable to all the other sites.

An unidentified component was apparent in five of the nine runs. Three runs had a significant percentage in the other category, October 30, 2003 with 20.3%, November 5, 2003 with 17.0% and November 8, 2003 with 20.8%. When averaged over the nine runs this left 7% of the source contribution unidentified. As seen at other sites the $PM_{2.5}/PM_{10}$ ratio on two of these days was higher than expected, 0.55 for October 30, 2003 and 0.57 for November 8, 2003.The $PM_{2.5}/PM_{10}$ ratio for November 5, 2003 was slightly elevated at 0.39. It is likely that the Mini-Vol samplers over estimated the $PM_{2.5}$ concentrations on these days.

Figure 14 graphically depicts the $PM_{2.5}$ average percentage source contributions for all nine runs. Refer to Appendix C – Table 11 and Figure 9 for individual run data.

Figure 14: Pinal County Housing Avg. PM2.5 Source Contributions



2.2.5 Stanfield Source Apportionment Results

The Stanfield site was utilized in this study due to it proximity to several feedlots and dairies and since it is generally surrounded by open field agriculture. The community of Stanfield only extends ¼ to ½ a mile in all directions from the site, beyond that open field agriculture dominates the landscape. Sizeable feedlot operations and dairies lie approximately three miles to the north, east, and west. The average 24-hour PM_{10} concentration during the project as recorded by the Mini-Vol sampler was elevated at 55 $\mu g/m^3$.

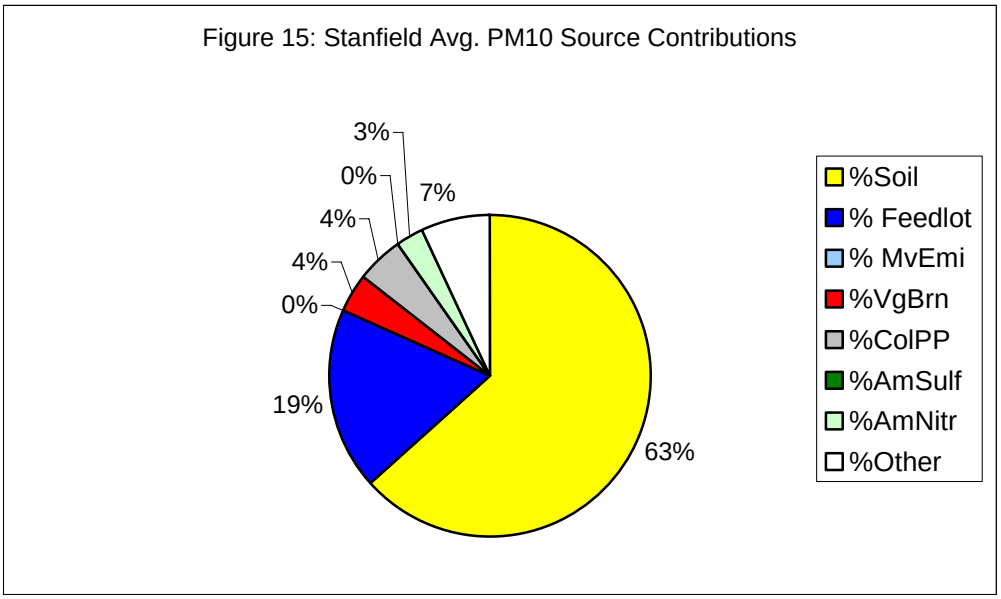
Appendix C – Table 12 and Figure 10 show the CMB modeled PM_{10} source attributions for the Stanfield site. Ten runs were analyzed and included in the PM_{10} source apportionment analysis for this site, although two filters did not have a complete run. The Teflon filter for October 9, 2003 only ran twenty hours out of the scheduled twenty-four. The quartz filter for October 15, 2003 did not run at all. This date was still included in the source apportionment since a mass and concentration could be computed using the corresponding Teflon filter. Sources identified using the quartz filter analysis, such as ammonium nitrate and ammonium sulfate, were not accounted for on October 15, 2003. This explains why this is one of the two PM_{10} runs throughout the entire study that did not have a small ammonium nitrate component.

The highest identified source contribution in all ten runs was the geological soil category with an average contribution of 63%. The second highest contribution for all the runs was the feedlot soil category with an average of 19%. Since this site does not have localized meteorological data available no wind roses were constructed for the area. Several dairies and feedlots are located approximately three miles to the north, east and west of the site.

Coal power plant and vegetative burning emissions made up the third and fourth largest categories, each with an average of 4%. There are no industrial sources in the area that could be attributed to the coal power plant category. As discussed earlier it appears there is a long-range transport mechanism affecting this source category. Ammonium nitrate was the remaining identified source category with an average of 3%. Both vegetative burning and ammonia nitrate emissions are expected given the local conditions explained earlier.

An unidentified component was only apparent in one run, October 3, 2003. This run had a large unidentified component with 67.3% in the other category. It appears both the Teflon and quartz PM_{10} Mini-Vol samplers operated properly and ran for the full twenty-four hours on October 3, 2003. The measured concentration for the PM_{10} Mini-Vol sampler was 43.1 $\mu g/m^3$ and this does not seem abnormally high or low. The reasoning for this unusually large unidentified fraction in the PM_{10} source attribution is not readily apparent. When averaged over all ten runs the unidentified component was 7% of the source attribution.

Figure 15 graphically depicts the PM_{10} average percentage source contributions for all ten runs. Refer to Appendix C – Table 12 and Figure 10 for individual run data.



Appendix C – Table 13 and Figure 11 show the CMB modeled $PM_{2.5}$ source attributions for the Stanfield site. The geological soil category was the largest source contribution in eight of the ten runs. Geological soil emissions were still the dominant source category with 48% when averaged over ten runs. Coal power plant emissions made up the second largest category with an average contribution of 17%. In nine of the ten runs coal power plant emissions were the second largest source and on October 12, 2003 coal power plant emissions were the dominant source with 22.8%. As mentioned previously this seems to be a long-range transport issue.

Vegetative burning also made up a significant portion of the source attribution with 15% when averaged over the ten runs. Two runs had a significant portion of the run attributed to vegetative burning, October 12, 2003 with 22.1% and October 30, 2003 with 43.8%. Vegetative burning was the largest source contribution for October 30, 2003. It is likely that on both of these days a local brush disposal fire affected the $PM_{2.5}$ source apportionment.

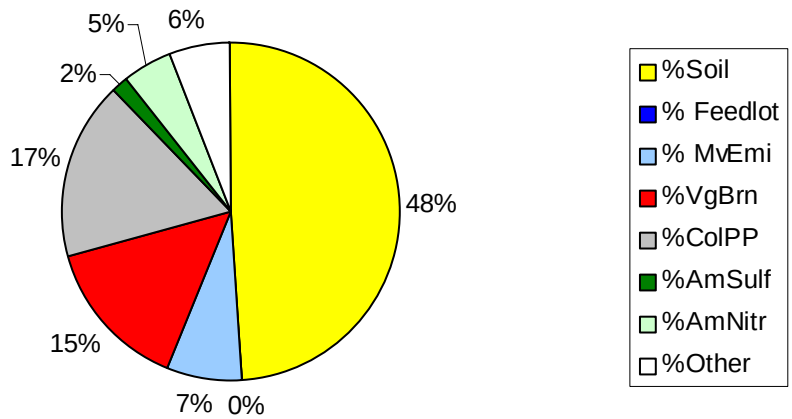
Motor vehicle emissions with an average contribution of 7%, ammonium nitrate with an average contribution of 5%, and ammonium sulfate with an average contribution of 2% made up the remaining identified source categories. The October 9, 2003 run and the October 12, 2003 run had a significant motor vehicle emission contribution with 19.8% and 12.9% respectively. In both cases an ammonium sulfate component was also identified with 11.4% for October 9, 2003 and 6.7% for October 12, 2003. The $PM_{2.5}/PM_{10}$ ratio for both of these days was well within expectations at 0.27 for October 9, 2003 and 0.28 for October 12, 2003. Thus, the Mini-Vol samplers do not appear to have over estimated the ambient $PM_{2.5}$ concentrations on these days. This site is located adjacent to the Stanfield Fire Department. It is possible that the diesel fumes from an idling fire engine contributed to both the motor vehicle emission category and the ammonium sulfate category on these days. The large number of feedlots and dairies in

the area would serve as a source of ammonia for both the identified ammonium sulfate and ammonium nitrate components.

An unidentified component was apparent in four of the ten runs. November 8, 2003 had a large percentage left unidentified with 37.7% in the other category. The $PM_{2.5}/PM_{10}$ ratio was higher than expect on November 8, 2003 at 0.56. It appears the Mini-Vol sampler over estimated the ambient $PM_{2.5}$ concentration on this day. Averaged over the ten runs 6% of the source attribution was unidentified.

Figure 16 graphically depicts the $PM_{2.5}$ average percentage source contributions for all ten runs. Refer to Appendix C – Table 13 and Figure 11 for individual run data.

Figure 16: Stanfield Avg. PM2.5 Source Contributions



2.3 Road Count Results

The soil sampling and road counts conducted around the Cowtown site were done in an effort to break down the geological soil category. The chemical analysis of the dirt road soil sample and of the agricultural field soil sample did not yield significantly different fingerprints. Thus, the CMB modeling analysis was not able to differentiate between dirt road emissions and agricultural field emissions. This was a known limitation when designing the study and the addition of soil sampling was not able to overcome this limitation.

With this limitation the road count information was not useful in estimating the contribution of dirt road traffic. Road counts conducted for this study and additional counts conducted by PCAQCD do suggest dirt road emissions are a significant contributor to the geological soil category identified in this study. PCAQCD plans on conducting additional analysis to better quantify this emission source. The road count information collected during this study is included in Appendix E.

Section 3

Conclusions

3.0 Conclusions

Soil generally constitutes the dominant source of particulate emissions that contribute to elevated ambient PM_{10} concentrations in the agricultural basin of Pinal County.

Somewhat surprisingly, feedlot emissions also meaningfully contribute to elevated ambient PM_{10} impacts even at monitoring sites well-removed from any actual feedlot. The common use of manure as a soil amendment may account for the apparent finding of widespread impacts from feedlot particulate matter.

Rather unremarkably, at the "Cowtown" monitoring site feedlot emissions constitute the dominant source of PM_{10} emissions. Feedlot emissions consistently contribute more than 50% of elevated concentrations of PM_{10}. Historical FRM data indicates 24-hour PM_{10} concentrations at that site often reach 200% or more of the 24-hour PM_{10} standard, and annual average concentrations exceed 200% of the annual PM_{10} standard.

This study and historical monitoring data both indicate that when PM_{10} concentrations rise, the observed average ratio of $PM_{2.5}$-to-PM_{10} concentrations equals about 0.3-to-1.0. No site-specific FRM $PM_{2.5}$ data currently exists for the "Cowtown" site. However, arithmetic application of the empirical $PM_{2.5}$-to-PM_{10} ratio to the elevated PM_{10} FRM data discussed above produces a rational expectation that $PM_{2.5}$ concentrations at the "Cowtown" site will exceed both the 24-hour and annual $PM_{2.5}$ standards.

The CMB analysis of the $PM_{2.5}$ filters from the "Cowtown" monitoring site indicates feedlot emissions contribute to $PM_{2.5}$ concentrations. When $PM_{2.5}$ ambient concentrations rise, feedlot emissions contribute more than 50% of observed impacts of $PM_{2.5}$.

Appendix A

Site Descriptions

Casa Grande Downtown - CG
401 Marshall St., Casa Grande, Arizona
Latitude: N 32°52.682' **Longitude:** W 111°45.135' **Map Datum:** WGS 84

Table A-1

Parameter	**Instrument #1**	**Instrument #2**	**Instrument #3**
Pollutant Type	$PM_{2.5}$	PM_{10}	PM_{10} / $PM_{2.5}$
Date Established	1999	1989	October 2003
County ID	CG $PM_{2.5}$	CG PM_{10}	CG MV
Sampler Make & Model	Andersen RAAS2.5-100	Wedding HiVol	Airmetrics MiniVol
Inlet Height	5.7 meters	5.7 meters	5.8 meters
Distance from Tree Dripline	15.4 meters	19.0 meters	13.2 meters
Obstacle Description	None	None	None
Height of Obstacle	N/A	N/A	N/A
Distance and Direction	N/A	N/A	N/A
Airflow Arch	360°	360 °	360°
Furnace or Incinerator Flue	Furnace Flue	Furnace Flue	Furnace Flue
Distance and Direction	7.4 meters - S	5.6 meters - S	6.0 meters - SW
Distance between Collocated Samplers	3.3 meters	3.3 meters	6.8 meters (PM_{10}) 5.1 meters ($PM_{2.5}$)
Nearest Road	Marshall St.	Marshall St.	Marshall St.
Distance and Direction to Road	18.9 meters – E	22.9 meters – E	16.7 meters – E
Schedule	1 in 6 days	1 in 6 days	1 in 3 days
Surrounding Area	Business district	Business district	Business District

Notes: The photo was taken while facing north.

Coolidge Maintenance Yard - CLDG
212 E. Broadway, Coolidge, Arizona

Latitude: N 32°58.717' **Longitude:** W 111°30.874' **Map Datum:** WGS 84

Table A-2

Parameter	**Instrument #1**	**Instrument #2**
Pollutant Type	PM_{10}	PM_{10} / $PM_{2.5}$
Date Established	1992	October 2003
County ID	CLDG	CLDG MV
Sampler Make & Model	Wedding HiVol	Airmetrics MiniVol
Inlet Height	3.4 meters	3.3 meters
Distance from Tree Dripline	None	None
Obstacle Description	Building	Building
Height of Obstacle	3.2 meters	3.2 meters
Distance and Direction	6.8 meters – NE	4.5 meters – NE
Airflow Arch	360°	360°
Furnace or Incinerator Flue	None	None
Distance and Direction	N/A	N/A
Distance between Collocated Samplers	1.5 meters	1.5 meters
Nearest Road	Pacific St.	Pacific St.
Distance and Direction to Road	7.9 meters – W	7.2 meters – W
Schedule	1 in 6 days	1 in 3 days
Surrounding Area	Residential	Residential

Notes: The photo was taken while facing west.

Cowtown Road - CWTN
37580 W. Maricopa-Casa Grande Highway, Maricopa, Arizona
Latitude: N 33°00.632' **Longitude:** W 111°58.323' **Map Datum:** WGS 84

Table A-3

Parameter	**Instrument #1**	**Instrument #2**	**Instrument #3**	**Instrument #4**	**Instrument #5**
Pollutant Type	PM_{10}	Wind	Temp & RH /Pressure	Video	PM_{10} / $PM_{2.5}$
Date Established	2001	2002	2002	2003	October 2003
County ID	CWTN TEOM	CWTN MET	CWTN MET	CWTN Video	CWTN MV
Sampler Make & Model	R&P 1400a (A/B)	RM Young 05305 AQ	Viasala HMP35C/PTA427	Panasonic AG-6740	Airmetrics MiniVol
Inlet Height	3.0 meters	3.5 meters	2.9 meters	3.5 meters	2.5 meters
Distance from Tree Dripline	None	None	None	None	None
Obstacle Description	None	None	None	None	Shed
Height of Obstacle	N/A	N/A	N/A	N/A	3.0 meters
Distance and Direction	N/A	N/A	N/A	N/A	4.8 meters – SE
Airflow Arch	360°	360°	360°	360°	360°
Furnace or Incinerator Flue	None	None	None	None	None
Distance and Direction	N/A	N/A	N/A	N/A	N/A
Distance between Collocated Samplers	5.2 meters	N/A	N/A	N/A	5.2 meters
Nearest Road	Casa Grande-Maricopa Hwy	Casa Grande-Maricopa Hwy	Casa Grande-Maricopa Hwy	Casa Grande-Maricopa Hwy	Casa Grande-Maricopa Hwy
Distance and Direction to Road	53.6 meters – S	53.6 meters – S	53.6 meters – S	53.6 meters – S	56.7 meters – S
Schedule	Continuous	Continuous	Continuous	Continuous	1 in 3 days
Surrounding Area	Agricultural / Feedlots	Agricultural / Feedlots	Agricultural / Feedlots	Agricultural / Feedlots	Agricultural / Feedlots

Notes: The picture was taken facing south.

Pinal County Housing Complex - PCH
970 N. Eleven Mile Corner Rd., Casa Grande, Arizona
Latitude: N 32°53.471' **Longitude:** W 111°34.225' **Map Datum:** WGS 84

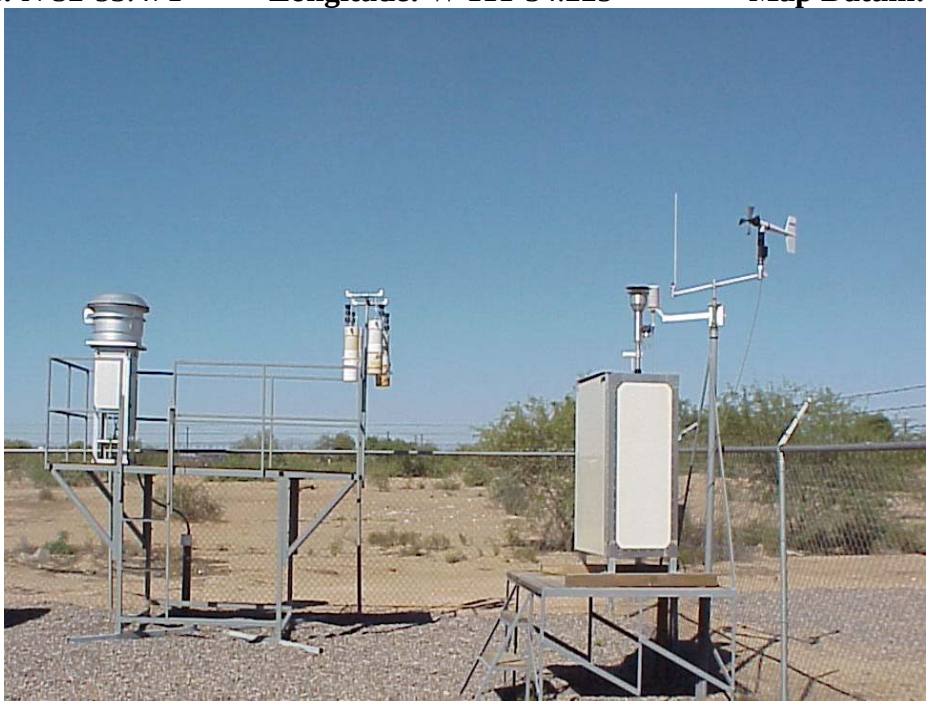


Table A-4

Parameter	**Instrument #1**	**Instrument #2**	**Instrument #3**	**Instrument #4**	**Instrument #5**
Pollutant Type	PM_{10}	PM_{10}	Wind	Temp&RH/Pressure	PM_{10} / $PM_{2.5}$
Date Established	2002	2002	2002	2002	October 2003
County ID	PCH TEOM	PCH PM_{10}	PCH MET	PCH MET	PCH MV
Sampler Make&Model	R&P 1400a (A/B)	Andersen HiVol	RM Young 05305 AQ	Viasala HMP35C/PTA427	Airmetrics MiniVol
Inlet Height	3.0 meters	3.1 meters	3.2 meters	3.1 meters	3.1 meters
Distance from Tree Dripline	13.7 meters	11.6 meters	13.7 meters	13.7 meters	10.0 meters
Obstacle Description	Shed	Shed	Shed	Shed	Shed
Height of Obstacle	2.6 meters	2.6 meters	2.6 meters	2.6 meters	2.6 meters
Distance & Direction	10.8 meters – W	8.6 meters – SW	11.4 meters – W	11.2 meters – W	9.3 meters – W
Airflow Arch	360°	360°	360°	360°	360°
Furnace or Incinerator Flue	None	None	None	None	None
Distance & Direction	N/A	N/A	N/A	N/A	N/A
Distance between Collocated Samplers	5.5 meters	5.5 meters	N/A	N/A	2.2 meters
Nearest Road	Eleven Mile Corner Rd.	Eleven Mile Corner Rd.	Eleven Mile Corner Rd.	Eleven Mile Corner Rd.	Eleven Mile Corner
Distance & Direction to Road	400 meters – E	400 meters – E	400 meters – E	400 meters – E	400 meters – E
Schedule	Continuous	1 in 6 days	Continuous	Continuous	1 in 3 days
Surrounding Area	Agricultural/ Residential	Agricultural/ Residential	Agricultural/ Residential	Agricultural/ Residential	Agricultural/ Residential

Notes: The picture was taken facing north.

Stanfield County Complex - STNF
36697 W. Papago Dr., Stanfield, Arizona
Latitude: N 32°52.876' **Longitude:** W 111°57.717' **Map Datum:** WGS 84

Table A-5

Parameter	**Instrument #1**	**Instrument #2**
Pollutant Type	PM_{10}	PM_{10} / $PM_{2.5}$
Date Established	1988	October 2003
County ID	STNF	STNF MV
Sampler Make & Model	Wedding HiVol	Airmetrics MiniVol
Inlet Height	4.3 meters	4.1 meters
Distance from Tree Dripline	None	None
Obstacle Description	Building	Building
Height of Obstacle	4.0 meters	4.0 meters
Distance and Direction	5.9 meters – N	4.0 meters -N
Airflow Arch	360°	360°
Furnace or Incinerator Flue	None	None
Distance and Direction	N/A	N/A
Distance between Collocated Samplers	1.2 meters	1.2 meters
Nearest Road	Navajo Way	Navajo Way
Distance and Direction to Road	19 meters – W	20 meters – W
Schedule	1 in 6 days	1 in 3 days
Surrounding Area	Residential	Residential

Notes: The picture was taken facing north.

Appendix B

Ambient Monitoring Data

Casa Grande Concentration Data

(24 Hour Avg. µg/m^3)

Table B-1

Date	FRM Hi-Vol PM_{10}	Mini-Vol PM_{10}	FRM $PM_{2.5}$	Mini-Vol $PM_{2.5}$
10/3/2003	N/A	13.3	N/A	3.2
10/9/2003	N/A	36.9	N/A	9.2
10/12/2003	27.5	27.7	Void	6.7
10/15/2003	N/A	39.9	N/A	11.9
10/18/2003	45.1	39.2	10.1	14.1
10/21/2003	N/A	46.9	N/A	12.9
10/27/2003	N/A	61.1	N/A	31.5
10/30/2003	58.8	48.9	26.7	49.5
11/5/2003	54.9	57.2	10.7	20.2
11/8/2003	N/A	64.0	N/A	26.9

Coolidge Concentration Data

(24 Hour Avg. µg/m^3)

Table B-2

Date	FRM Hi-Vol PM_{10}	Mini-Vol PM_{10}	Mini-Vol $PM_{2.5}$
10/3/2003	N/A	25.3	11.4
10/9/2003	N/A	35.0	10.4
10/12/2003	25.3	32.2	8.3
10/15/2003	N/A	50.8	35.2
10/18/2003	37.1	45.3	26.8
10/21/2003	N/A	48.3	34.3
10/27/2003	N/A	41.8	17.1
10/30/2003	84.1	86.6	35.1
11/5/2003	Void	60.8	23.2
11/8/2003	N/A	Void	50.2

N/A = The sampler was <u>not</u> scheduled to run and there is no data available.
Void = The sampler was scheduled to run, but the sample was invalid.

Cowtown Concentration Data

(24 Hour Avg. µg/m^3)

Table B-3

Date	FRM TEOM PM_{10}	Mini-Vol PM_{10}	Mini-Vol $PM_{2.5}$
10/3/2003	122.1	74.5	17.5
10/9/2003	166.32	113.1	33.6
10/12/2003	79.0	55.4	15.7
10/15/2003	147.8	113.8	33.8
10/18/2003	293.7	264.3	76.5
10/21/2003	348.2	294.1	101.7
10/27/2003	577.0	Void	183.3
10/30/2003	204.4	120.5	39.6
11/5/2003	271.7	221.7	56.9
11/8/2003	308.6	265.6	112.3

Pinal County Housing Concentration Data

(24 Hour Avg. µg/m^3)

Table B-4

Date	FRM Hi-Vol PM_{10}	FRM TEOM PM_{10}	Mini-Vol PM_{10}	Mini-Vol $PM_{2.5}$
10/3/2003	N/A	53.3	14.7	7.0
10/9/2003	N/A	50.5	31.0	9.5
10/12/2003	42.2	53.0	31.0	8.4
10/15/2003	N/A	74.1	55.9	22.2
10/18/2003	74.5	77.8	61.9	Void
10/21/2003	N/A	120.1	89.2	30.1
10/27/2003	N/A	73.9	60.9	22.2
10/30/2003	116.5	149.2	64.1	35.3
11/5/2003	92.1	103.7	81.6	32.2
11/8/2003	N/A	149.3	104.6	59.3

N/A = The sampler was not scheduled to run and there is no data available.
Void = The sampler was scheduled to run, but the sample was invalid.

Stanfield Concentration Data

(24 Hour Avg. µg/m^3)

Table B-5

Date	FRM Hi-Vol PM_{10}	Mini-Vol PM_{10}	Mini-Vol $PM_{2.5}$
10/3/2003	N/A	43.1	5.1
10/9/2003	N/A	38.4	10.4
10/12/2003	31.7	32.0	9.1
10/15/2003	N/A	47.0	13.0
10/18/2003	55.1	56.0	16.3
10/21/2003	N/A	57.5	16.7
10/27/2003	N/A	65.2	20.1
10/30/2003	93.5	71.9	27.8
11/5/2003	91.4	82.8	28.4
11/8/2003	N/A	55.5	31.1

N/A = The sampler was not scheduled to run and there is no data available.
Void = The sampler was scheduled to run, but the sample was invalid.

Appendix C

Modeling Data

Report

Pinal County Source Apportionment Study

Prepared for:

Pinal County Air Quality Control District (PCAQCD)

Submitted to:

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May 27, 2004 (amended May 24, 2005)

Table 1. Average measured $PM_{2.5}$ to PM_{10} mass ratios for Pinal County, Arizona

Site ID	Site	Average mass PM_{10} µg/m^3	Average mass $PM_{2.5}$ µg/m^3	Average Mass $PM_{2.5}/PM_{10}$ Ratio
CasGra	Casa Grande	44	18	0.41
CooMai	Coolidge Maintenance Yard	47	25	0.53
Cowtow	Cowtown	127	67	0.53
PinCou	Pinal County Housing	60	25	0.42
StaCou	Stanfield County Complex	55	18	0.32
	Average for Pinal County	66	31	0.46

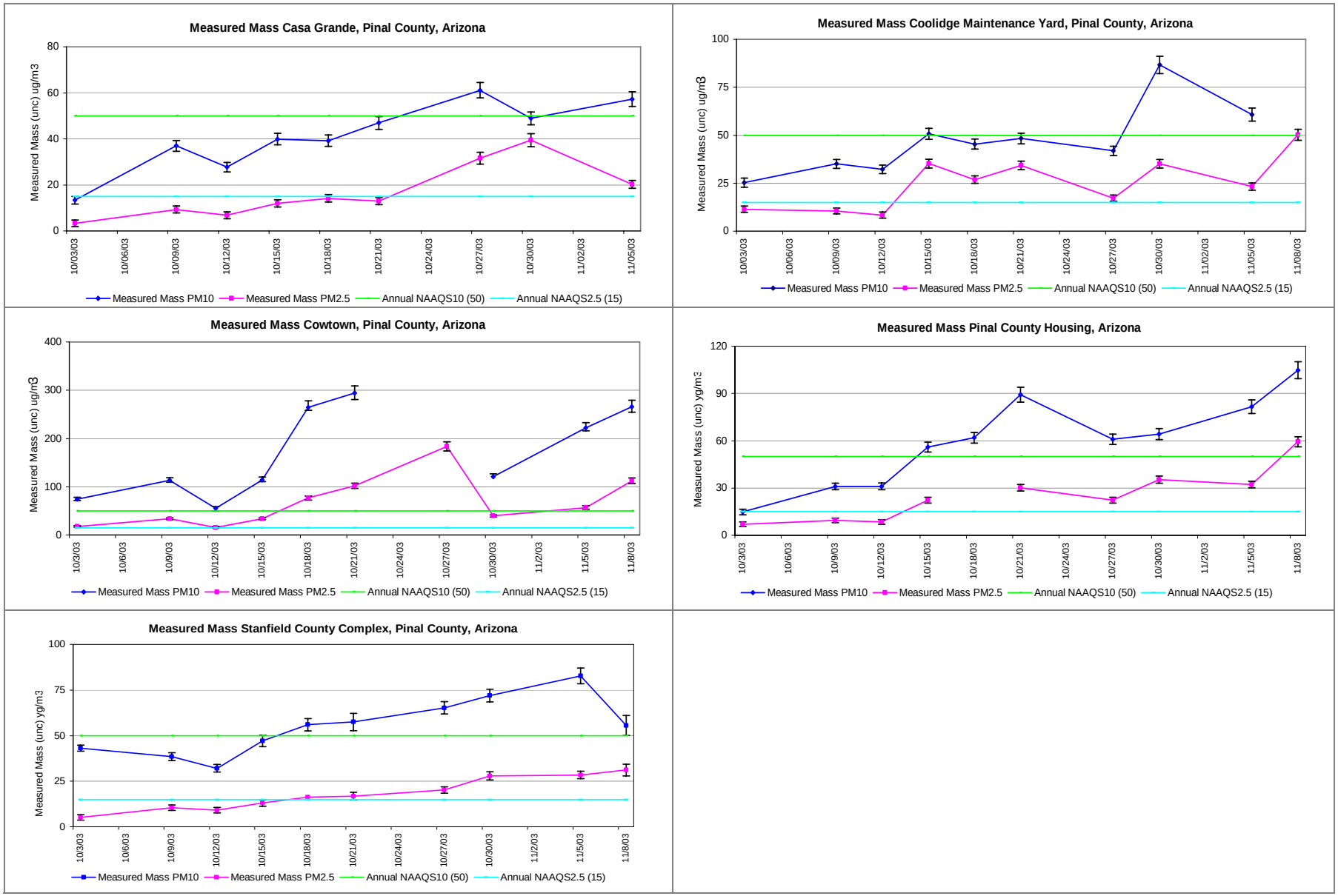


Figure 1. Measured mass for PM_{10} and $PM_{2.5}$ at Casa Grande, Coolidge Maintenance Yard, Cowtown, Pinal County Housing, and Stanfield County Complex, Pinal County, Arizona

Table 2. Legend: CMB source attributions for Pinal County, Arizona

	Source ID	Generic source description	CMB modeled chemical source profiles
	Soil	Geological soil	PHBAREAG agricultural soil, PHUPRD1 unpaved road dust, TUDSOIL desert soil, PINSL688 dirt road, PINSL689 agricultural field
	Feedlot	Feedlot soil	PINSL690 feedlot
	MvEmi	Motor vehicle emissions	PHRDP motor vehicle emissions, BVRSMV01 roadside exhaust
	VgBrn	Vegetative burning	BVBURN15, BVBURN19, BVBURN11, 9RICE,
	ColPP	Coal fired power plant	BVCOAL03, BVCOAL06, BVCOAL18
	AmSulf	Ammonium sulfate	AMSUL
	AmNitr	Ammonium nitrate	AMNIT
	Other	Unclassified sources	

Table 3. Measured source profiles applied in Chemical Mass Balance (CMB) modeling for Pinal County, Arizona

Generic ID	Site Identification (SID)	Particle size	Profile number (PNO)	Description
Soil	PHBAREAG	$PM_{2.5}$	5.002	Phoenix agricultural soil from bare field; composite, 9 bulk samples collected on 1/21/90
	PHBAREAG	PM_{10}	5.001	Phoenix agricultural soil from bare field; composite, 9 bulk samples collected on 1/21/90
	PHUPRD1	$PM_{2.5}$	5.02	Phoenix unpaved road dust W/Hi Calcium; composite, 2 bulk samples collected on 1/20/90
	PHUPRD1	PM_{10}	5.019	Phoenix unpaved road dust W/Hi Calcium; composite, 2 bulk samples collected on 1/20/90
	TUDSOIL	$PM_{2.5}$	5.026	Tucson desert soil; composite, 3 samples.
	TUDSOIL	PM_{10}	5.025	Tucson desert soil; composite, 3 samples.
	PINSL688	$PM_{2.5}$	RDST01	Pinal County dirt road from Hartman Road, Cowtown; composite, N33^{o}00.272' W111^{o}57.767'
	PINSL688	PM_{10}	RDST03	Pinal County dirt road from Hartman Road, Cowtown; composite, N33^{o}00.272' W111^{o}57.767'
	PINSL689	$PM_{2.5}$	AGRI01	Pinal County agricultural field soil from Cowtown; composite, N33^{o}00.697' W111^{o}58.212'
	PINSL689	PM_{10}	AGRI03	Pinal County agricultural field soil from Cowtown; composite, N33^{o}00.697' W111^{o}58.212'
Feedlot	PINSL690	$PM_{2.5}$	FDL01	Pinal County Maricopa feed yard soil from Cowtown; composite, N33^{o}01.288' W112^{o}00.001'
	PINSL690	PM_{10}	FDL03	Pinal County Maricopa feed yard soil from Cowtown; composite, N33^{o}01.288' W112^{o}00.001'
MvEmi	PHRD	$PM_{2.5}$	5.037	Phoenix motor vehicle; composite, 10 roadside samples average after background corrections
	BVRSMV01	$PM_{2.5}$	19.031	BRAVO San Antonio Texas roadside exhaust; 0642-0742,
VgBrn	BVBURN15	$PM_{2.5}$	19.066	BRAVO open burning of cut mesquite shrubs/trees
	BVBURN19	$PM_{2.5}$	19.081	BRAVO open burning of piles of dry grass
	BVBURN11	$PM_{2.5}$	19.082	BRAVO open burning of piles of dry grass
	9RICE	$PM_{2.5}$	20.008	CRPAQS rice straw fireplace; ventilated open fire with grate
ColPP	BVCOAL03	$PM_{2.5}$	19.088	BRAVO stack emission Texas electric utility, plant #1; 0700-1200
	BVCOAL06	$PM_{2.5}$	19.091	BRAVO stack emission Texas electric utility, plant #2; morning
	BVCOAL18	$PM_{2.5}$	19.1	BRAVO stack emission Texas electric utility, plant #3; 1630-0700
AmSulf	AMSUL			Secondary ammonium sulfate
AmNitr	AMNIT			Secondary ammonium nitrate
Other	UNCLASSIFIED			Other sources not modeled

Table 4. CMB modeled PM_{10} source attributions for Casa Grande, Pinal County ($\mu g/m^3$)

Sample Date	Soil	Feedlot	MvEmi	VgBrn	ColPP	AmSulf	AmNitr	Other	Modeled Mass	Measured Mass	Mass Uncertainty
10/3/2003	9.7297	3.2929		1.3352	2.8227		0.6118		17.7923	13.3136	± 1.5866
10/9/2003	17.9317	2.5553	1.9776	1.6980	1.0412	1.3941	0.8529	9.5479	27.4506	36.9985	± 2.3484
10/12/2003	21.8483	5.9633		2.5152	2.6065		1.4292		34.3625	27.7017	± 2.0283
10/15/2003	32.3797	5.9709		3.4125	3.0671		1.3016		46.1318	39.9083	± 2.4895
10/18/2003	34.9460	8.0798		3.2637	3.1637		1.3050		50.7581	39.2037	± 2.4627
10/21/2003	45.5010	10.2731		4.0666	3.4565		1.5383		64.8355	46.9357	± 2.7614
10/27/2003	40.2017	11.9147		2.9034	1.6628		1.3678	3.0769	58.0503	61.1272	± 3.3646
10/30/2003	23.9295	22.0076		3.1029	1.3382		1.8479		52.2261	48.9083	± 2.8263
11/5/2003	44.3616	17.8782		2.0794	1.9869		3.0936		69.3996	57.2872	± 3.1903
11/8/2003	49.0083	19.1029		2.9352	1.7937		3.0068		75.8469	64.0227	± 3.4855

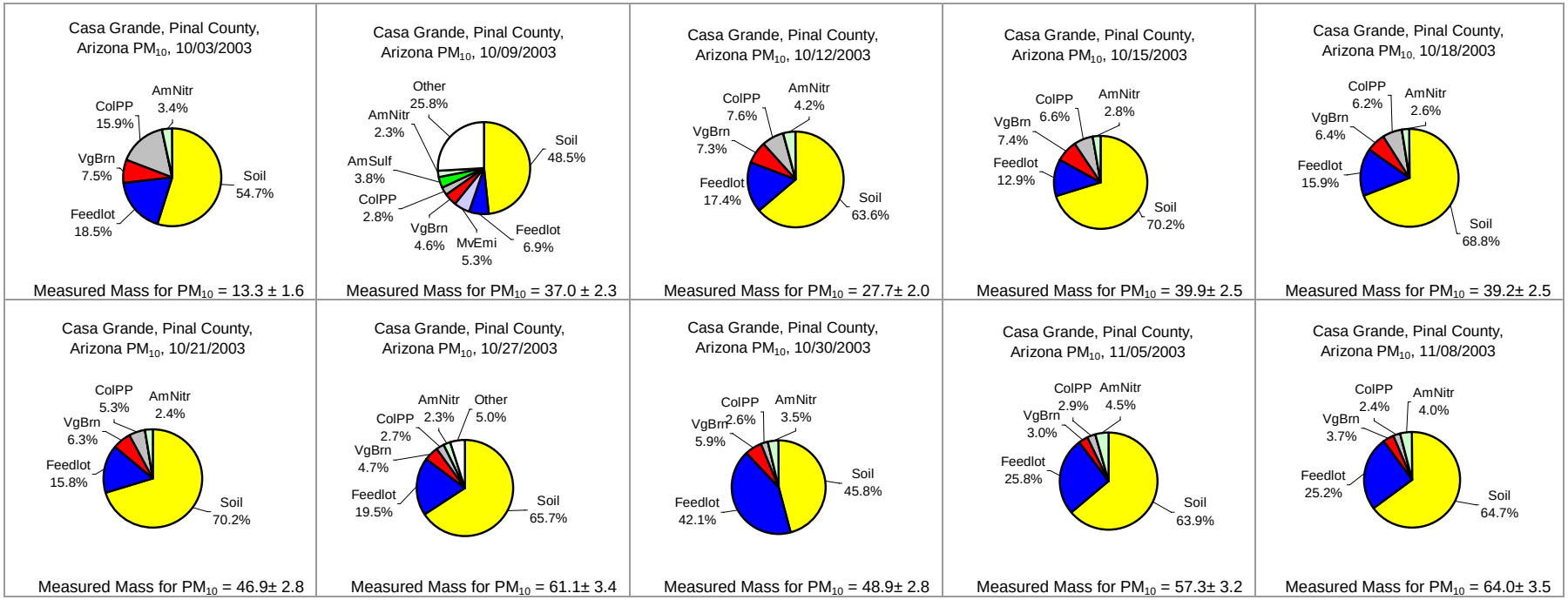


Figure 2. CMB modeled source attributions for PM_{10} data subsets from Casa Grande, Pinal County

Table 5. CMB modeled $PM_{2.5}$ source attributions for Casa Grande, Pinal County ($\mu g/m^3$),

Sample Date	Soil	Feedlot	MvEmi	VgBrn	ColPP	AmSulf	AmNitr	Other	Modeled Mass	Measured Mass	Mass Uncertainty
10/3/2003	1.9390		0.7934	0.6292	1.4039		0.3102		5.0757	3.2764	± 1.3965
10/9/2003	1.8215		2.2396	1.3601	3.0450		0.5091	0.3030	8.9754	9.2784	± 1.5070
10/12/2003	3.7625		2.1156	0.7225	1.3441	0.6728	0.4176		9.0350	6.7947	± 1.4776
10/15/2003	5.5720		2.4022	1.8552	3.4629		0.5751		13.8673	11.9403	± 1.5709
10/18/2003	7.3087		2.2865	1.9044	3.5227		0.5640		15.5863	14.1321	± 1.6540
10/21/2003	11.9098			1.4690	3.2201		0.5066		17.1056	12.9985	± 1.5781
10/27/2003	9.4992		1.8690	1.0689	3.3930		0.6290	15.0971	16.4591	31.5562	± 2.5828
10/30/2003	3.4552			6.0003	1.3186	0.9356	1.1484	36.7122	12.8580	49.5702	± 2.8440
11/5/2003	12.6782		2.4424	1.8207	1.8544		1.0986	0.3536	19.8943	20.2479	± 1.6802
11/8/2003	18.1697		2.2397	2.3256	2.4840		1.3958	0.3358	26.6146	26.9504	± 1.9294

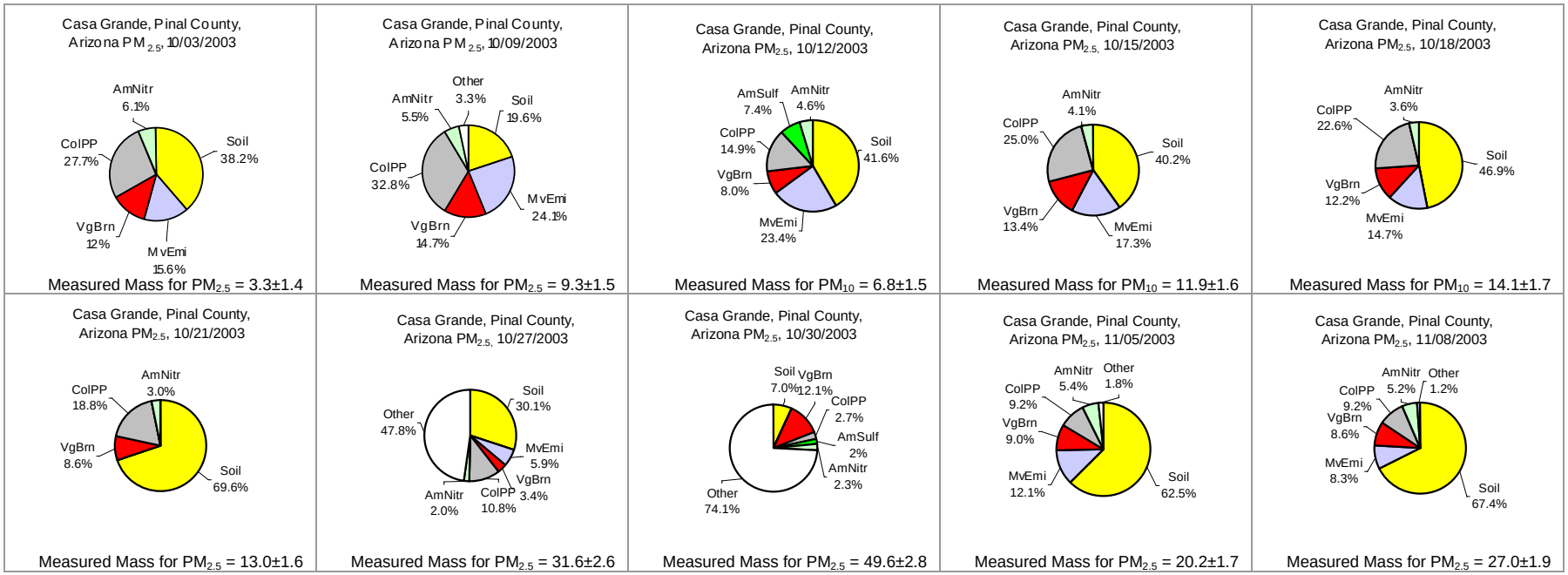


Figure 3. CMB modeled source attributions for $PM_{2.5}$ data subsets from Casa Grande, Pinal County

Table 6. CMB modeled PM_{10} source attributions for Coolidge Maintenance Yard, Pinal County ($\mu g/m^3$)

Sample Date	Soil	Feedlot	MvEmi	VgBrn	ColPP	AmSulf	AmNitr	Other	Modeled Mass	Measured Mass	Mass Uncertainty
10/3/2003	15.8097	3.8870	1.3082		2.9657		0.7396	0.6089	24.7102	25.3191	± 2.4276
10/9/2003	24.5925			4.5911	4.5006		1.2016	0.1968	34.8857	35.0825	± 2.2820
10/12/2003	19.7821	7.6202		2.9127	3.0941		1.2033		34.6125	32.2679	± 2.1906
10/15/2003	42.3824			2.7418	3.9103		1.4120	0.3635	50.4465	50.8100	± 2.9172
10/18/2003	37.3024		3.2504	2.7686	3.9731		0.9111		48.2056	45.3638	± 2.6596
10/21/2003	53.5207		2.0797	2.8359	4.1914		1.0550		63.6828	48.3212	± 2.8031
10/27/2003	35.3002	6.7165	2.1406		2.5336		1.1882		47.8792	41.8571	± 2.5128
10/30/2003	52.0201	27.0692		4.0365	4.2241		2.1544		89.5042	86.6860	± 4.5575
11/5/2003	54.3208			2.3365	1.3575		1.0735		59.0883	60.8069	± 3.3484
11/8/2003	*Void										

*Void - Teflon filter deposit appears to be much lighter than quartz.

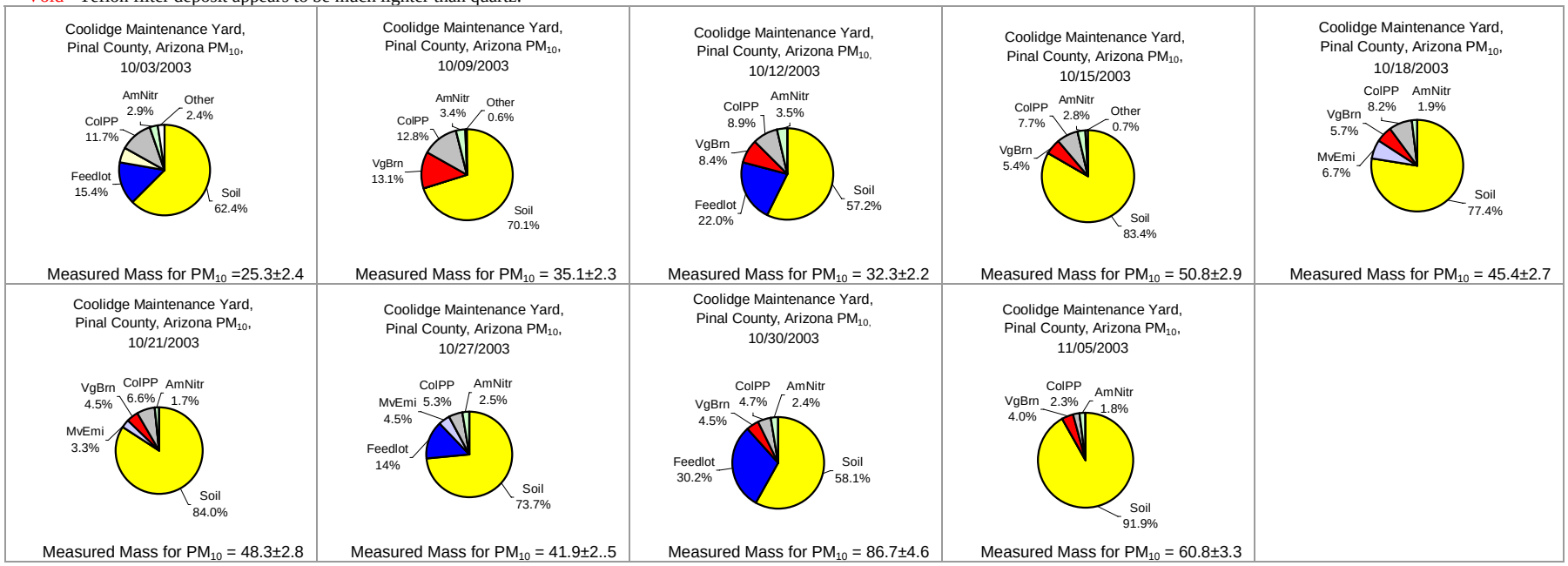


Figure 4. CMB modeled source attributions for PM_{10} data subsets from, Coolidge Maintenance Yard, Pinal County

Table 7. CMB modeled $PM_{2.5}$ source attributions for Coolidge Maintenance Yard, Pinal County ($\mu g/m^3$)

Sample Date	Soil	Feedlot	MvEmi	VgBrn	ColPP	AmSulf	AmNitr	Other	Modeled Mass	Measured Mass	Mass Uncertainty
10/3/2003	5.4433		1.2094	1.0258	2.7349		0.3388	0.6945	10.7522	11.4467	± 1.6502
10/9/2003	4.0483		2.5309	1.8250	3.6521		0.4178		12.4741	10.4634	± 1.5464
10/12/2003	2.3615		0.8999	1.6247	3.1962		0.4070		8.4893	8.3969	± 1.5445
10/15/2003	11.6974	3.1636	2.5551	1.4807	1.7425	0.9801	0.6103	13.0126	22.2297	35.2423	± 2.2691
10/18/2003	9.1212		1.7757	1.9201	2.5961	1.4093		10.0212	16.8225	26.8437	± 1.9655
10/21/2003	10.5251		2.0365	1.4311	3.0954	1.2703		15.9440	18.3583	34.3023	± 2.2235
10/27/2003	10.5979			1.8754	2.2931		0.5133	1.9167	15.2798	17.1965	± 1.6488
10/30/2003	7.7153	14.2376		3.2335	2.7877		1.2948	5.8391	29.2689	35.1079	± 2.2458
11/5/2003	15.4010			1.6810	1.9393		0.8728	3.3279	19.8942	23.2221	± 1.8288
11/8/2003	22.2432		2.6127	2.0177	2.8725		1.1000	19.3630	30.8462	50.2092	± 2.8541

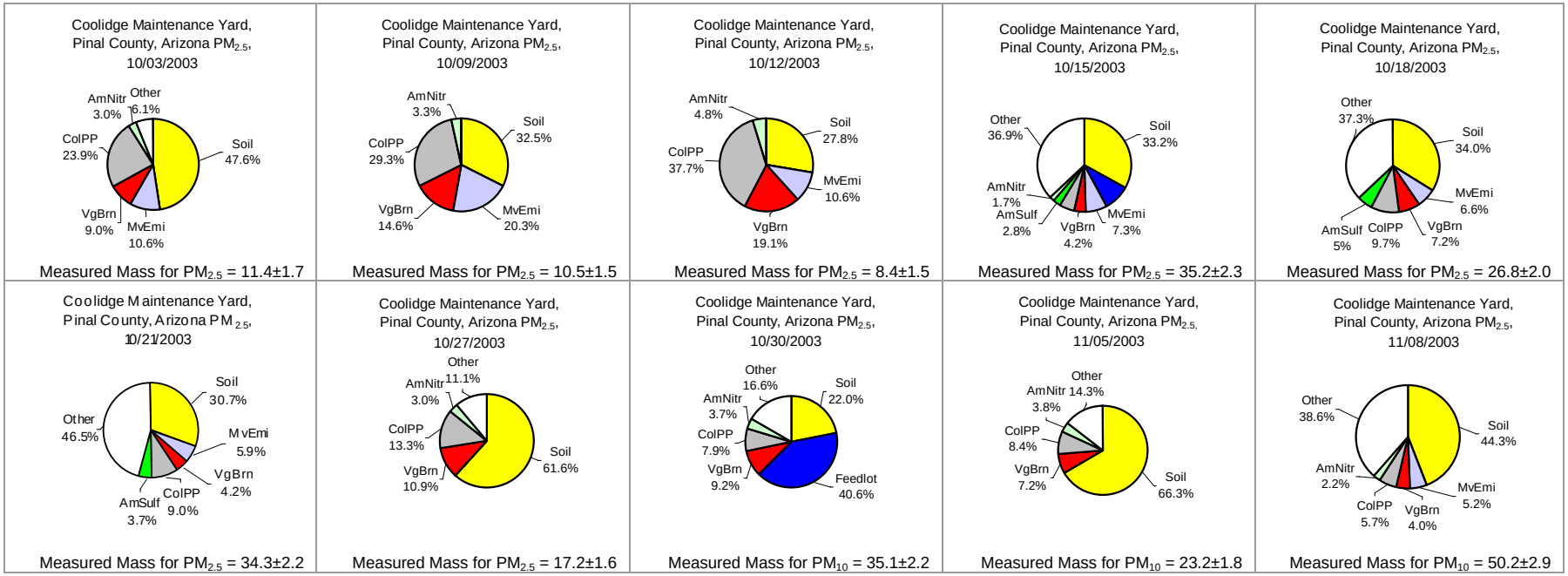


Figure 5. CMB modeled source attributions for $PM_{2.5}$ data subsets from Coolidge Maintenance Yard, Pinal County

Table 8. CMB modeled PM_{10} source attributions for Cowtown, Pinal County ($\mu g/m^3$)

Sample Date	Soil	Feedlot	MvEmi	VgBrn	ColPP	AmSulf	AmNitr	Other	Modeled Mass	Measured Mass	Mass Uncertainty
10/3/2003	25.1033	41.0073	1.5905		2.2148		0.9428	3.6569	70.8587	74.5156	± 3.9983
10/9/2003	45.6091	60.3676	2.4250		3.4559		2.6796		114.5372	113.1195	± 5.8313
10/12/2003	12.0387	36.4932	3.6659		3.5709		3.4876		59.2563	55.4905	± 3.1193
10/15/2003	40.3176	72.1687	2.4969				2.6798		117.6629	113.8643	± 5.8715
10/18/2003	113.8341	154.9450		4.3458			3.8895		277.0144	264.3609	± 13.2989
10/21/2003	93.8503	168.2944		2.7966			3.6637	25.5040	268.6050	294.1090	± 14.7752
10/27/2003	*Void										
10/30/2003	41.8415	78.6916		2.4347			2.8110		125.7788	120.5839	± 6.1944
11/5/2003	72.5156	129.7945		1.8544			4.6339	12.9470	208.7984	221.7454	± 11.1744
11/8/2003	58.8056	147.6984			3.8127		5.8832	49.4339	216.1999	265.6338	± 13.3523

*Void - No recorded mass for Teflon filter

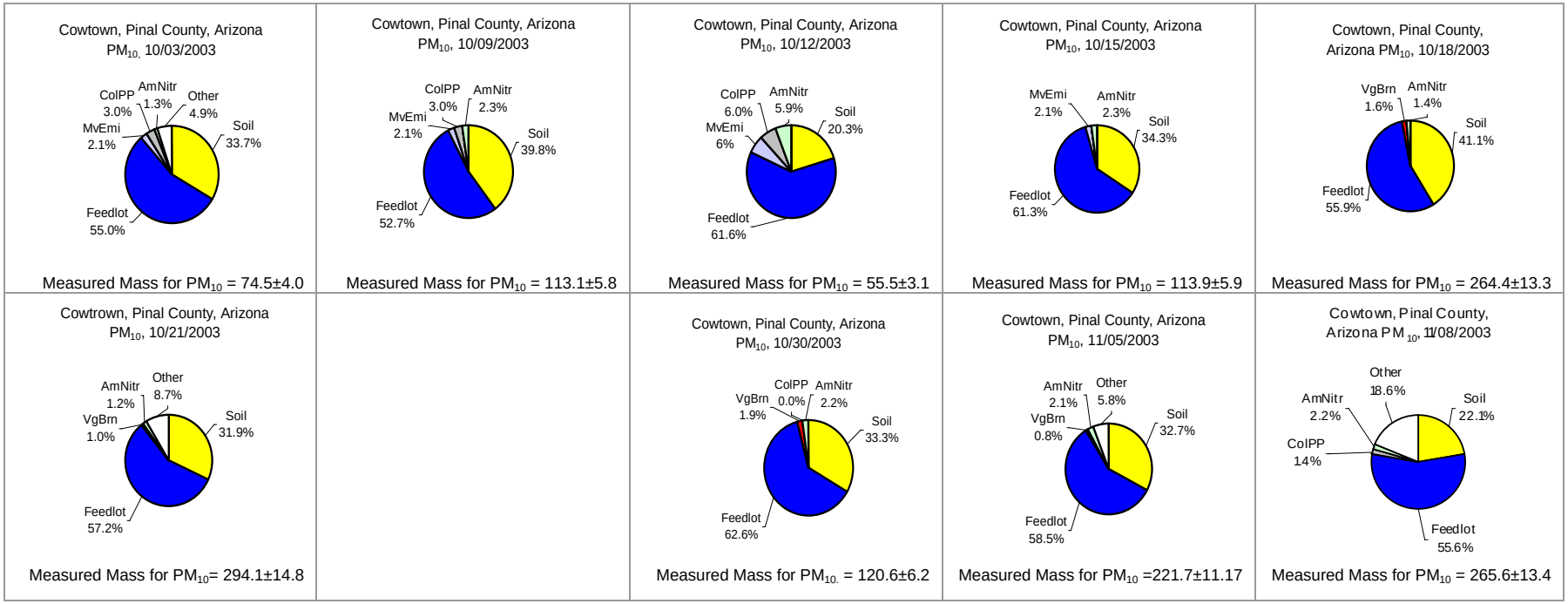


Figure 6. CMB modeled source attributions for PM_{10} data subsets from Cowtown, Pinal County

Table 9. CMB modeled $PM_{2.5}$ source attributions for Cowtown, Pinal County ($\mu g/m^3$)

Sample Date	Soil	Feedlot	MvEmi	VgBrn	ColPP	AmSulf	AmNitr	Other	Modeled Mass	Measured Mass	Mass Uncertainty
10/3/2003	7.2554	6.4645		1.5175	2.2696		0.3079		17.8148	17.5841	± 1.7289
10/9/2003	11.9786	12.8093		2.7656	4.6708		1.2033	0.2034	33.4276	33.6310	± 2.2196
10/12/2003	2.7947	1.4130		3.3627	3.9892		2.0972	2.0532	13.6568	15.7100	± 1.6672
10/15/2003	8.8901	15.9002	2.3095	2.0004	3.8764		1.3907		34.3673	33.8109	± 2.1916
10/18/2003	21.0411	39.7001	1.9249	2.9297	5.0472		1.9682	3.9779	72.6112	76.5891	± 4.1162
10/21/2003	28.2177	56.0196		3.3708	4.0222		1.7199	8.4489	93.3502	101.7991	± 5.2951
10/27/2003	29.7366	146.2936		2.8682			1.4445	3.0382	180.3429	183.3811	± 9.2745
10/30/2003	5.3520	21.7607	4.6372	3.2046	1.7272		1.7788	1.2150	38.4605	39.6755	± 2.4489
11/5/2003	12.9410	36.2181	2.7196	2.7851	3.3337		2.2621		60.2595	56.9682	± 3.7120
11/8/2003	23.4094	71.7697	2.8366	2.1736	2.8420		2.2010	7.0732	105.2323	112.3055	± 5.7816

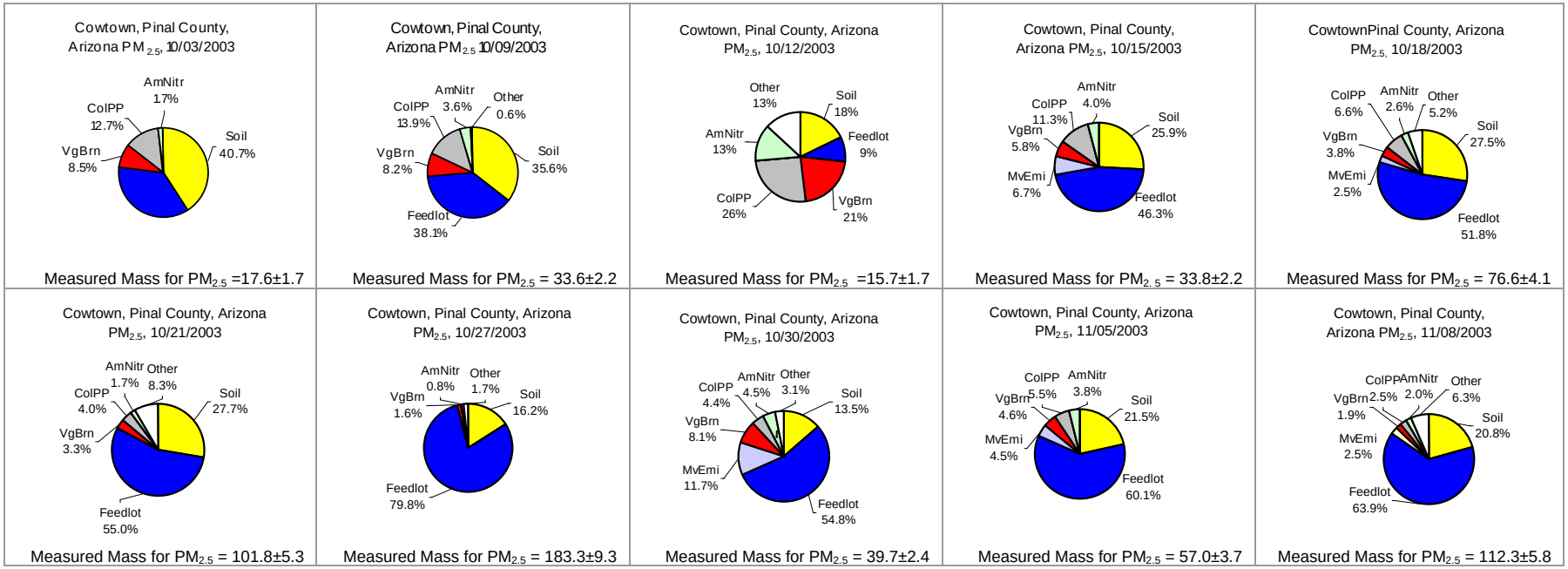


Figure 7. CMB modeled source attributions for $PM_{2.5}$ data subsets from Cowtown, Pinal County

Table 10. CMB modeled PM_{10} source attributions for Pinal County Housing, Pinal County ($\mu g/m^3$)

Sample Date	Soil	Feedlot	MvEmi	VgBrn	ColPP	AmSulf	AmNitr	Other	Modeled Mass	Measured Mass	Mass Uncertainty
10/3/2003	11.8390	3.6292		0.2627	2.6340		0.5602		18.9251	14.7975	± 1.6873
10/9/2003	16.6565	9.2296		1.4347	3.2512		1.1585		31.7305	31.0395	± 2.1072
10/12/2003	22.1080	11.5491		1.9458	2.4384		1.3014		39.3428	31.0811	± 2.1335
10/15/2003	46.4816	12.0915		1.3412	2.7790		1.7929		64.4862	55.9823	± 3.1469
10/18/2003	42.5005	15.2397		2.0932	2.7467		1.5323		64.1124	61.9469	± 3.4140
10/21/2003	90.3516	7.2060		2.3850	3.8753		1.8174		105.6354	89.2489	± 4.6871
10/27/2003	55.2661	4.1926		2.1115	2.5031		1.3932		65.4664	60.9756	± 3.3535
10/30/2003	30.8723	26.7993		2.1743	1.4982		2.1263	0.7236	63.4704	64.1940	± 3.4973
11/5/2003	59.3330	7.7802		2.0084	2.5234		2.6327	7.3332	74.2778	81.6109	± 4.3405
11/8/2003	73.4168	10.3916		2.7366	3.8707		3.5497	10.7088	93.9654	104.6742	± 5.4123

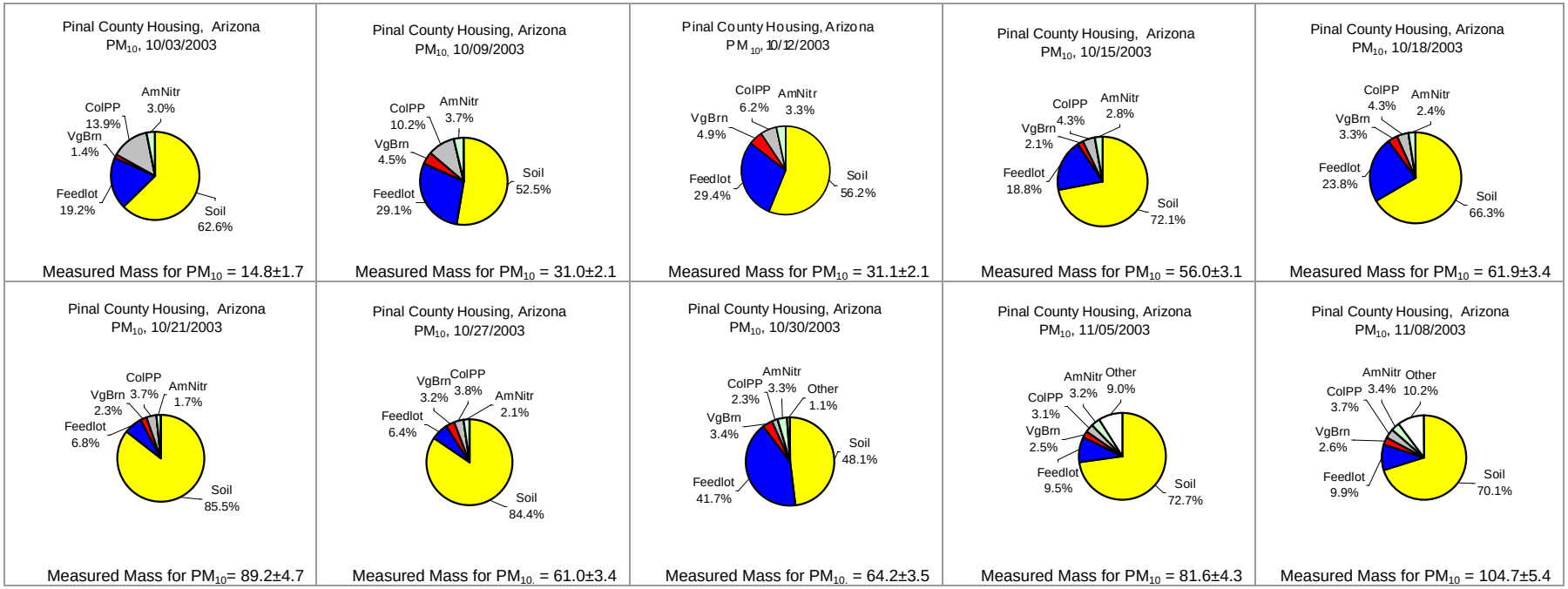


Figure 8. CMB modeled source attributions for PM_{10} data subsets from Pinal County Housing, Pinal County

Table 11. CMB modeled $PM_{2.5}$ source attributions for Pinal County Housing, Pinal County ($\mu g/m^3$)

Sample Date	Soil	Feedlot	MvEmi	VgBrn	ColPP	AmSulf	AmNitr	Other	Modeled Mass	Measured Mass	Mass Uncertainty
10/3/2003	3.3163		0.1434	0.0890	3.1718		0.2419	0.1172	6.9624	7.0796	± 1.4789
10/9/2003	2.2784		4.3886	0.8199	3.0429		0.4589		10.9886	9.5168	± 1.5027
10/12/2003	3.4079		1.5347	1.3555	2.4515				8.7495	8.4720	± 1.5325
10/15/2003	14.5345		2.2287	2.0796	3.3718		0.8034		23.0178	22.2874	± 1.8109
10/18/2003	15.9562	*Void									
10/21/2003	22.2552		1.6591	2.5782	3.6818		0.7552		30.9293	30.1028	± 2.0758
10/27/2003	17.8380			1.3815	2.2300		0.7172	0.1189	22.1668	22.2857	± 1.7821
10/30/2003	8.0248	14.1032		2.8565	1.9250		1.2819	7.1608	28.1913	35.3521	± 2.2371
11/5/2003	15.3498	6.4426		1.4685	2.3703		1.0912	5.4810	26.7224	32.2034	± 2.1174
11/8/2003	34.5003	6.1857		2.6879	2.5080		1.1552	12.3466	47.0372	59.3838	± 3.2673

*Void - No recorded mass for Teflon filter

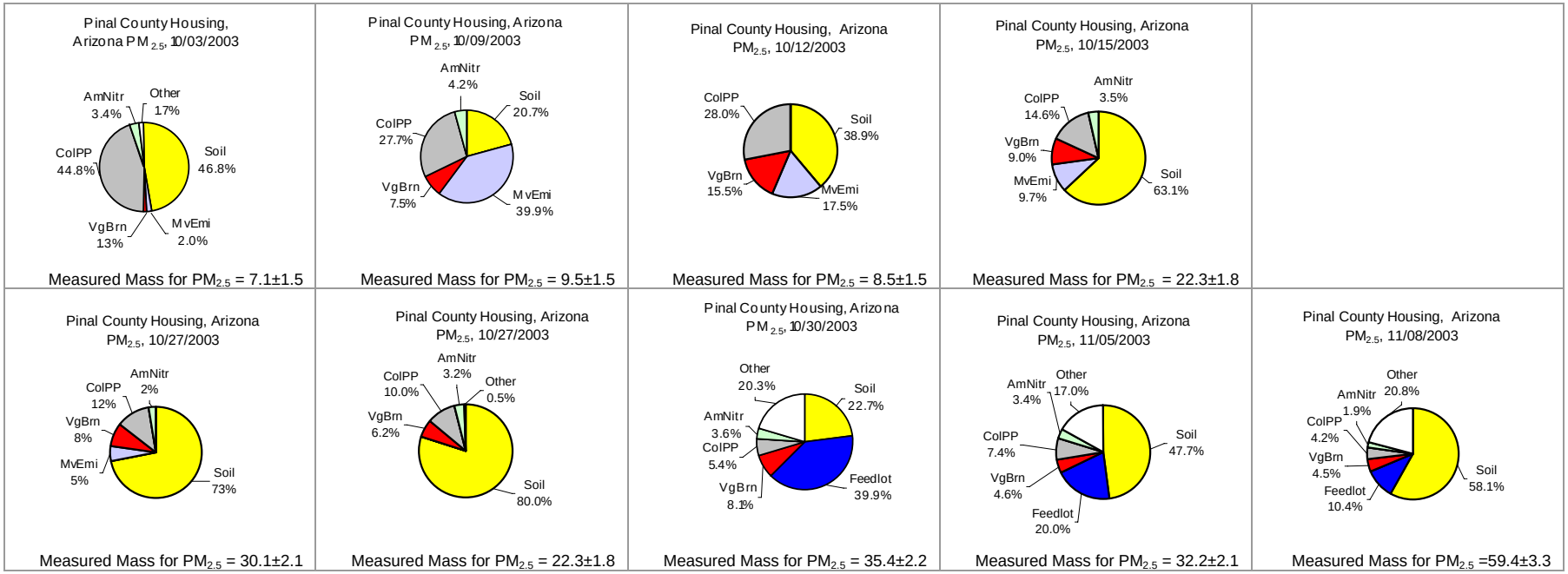


Figure 9. CMB modeled source attributions for $PM_{2.5}$ data subsets from Pinal County Housing, Pinal County

Table 12. CMB modeled PM_{10} source attributions for Stanfield County Complex, Pinal County ($\mu g/m^3$)

Sample Date	Soil	Feedlot	MvEmi	VgBrn	ColPP	AmSulf	AmNitr	Other	Modeled Mass	Measured Mass	Mass Uncertainty
10/3/2003	9.7763			1.8038	2.0908		0.6490	29.5257	14.3198	43.1221	± 2.6292
10/9/2003	28.8353	5.2722		1.9343	4.0190		1.3051		41.3660	38.4755	± 2.6120
10/12/2003	18.9046	9.8856		2.5449	2.7024		1.7271		35.7646	32.0700	± 2.1413
10/15/2003	40.3230	6.6159		1.1093	1.5462				49.5944	47.0414	± 2.7579
10/18/2003	37.1723	12.2687		4.3677	4.0225		1.7027		59.5339	56.0305	± 3.1714
10/21/2003	46.5969	11.0003		1.5494	3.1488		2.0190		64.3145	57.5000	± 3.2118
10/27/2003	55.4105	13.1669		1.4242	2.0269		1.7797		73.8082	65.2361	± 3.5467
10/30/2003	47.9607	36.9905		3.1615			2.1380		90.2507	71.9653	± 3.8635
11/5/2003	74.0029	12.1519		3.5508	2.3266		3.6882		95.7203	82.8035	± 4.3727
11/8/2003	39.9811	13.8272		1.3228	1.6741		3.6921		60.4973	55.5712	± 3.0993

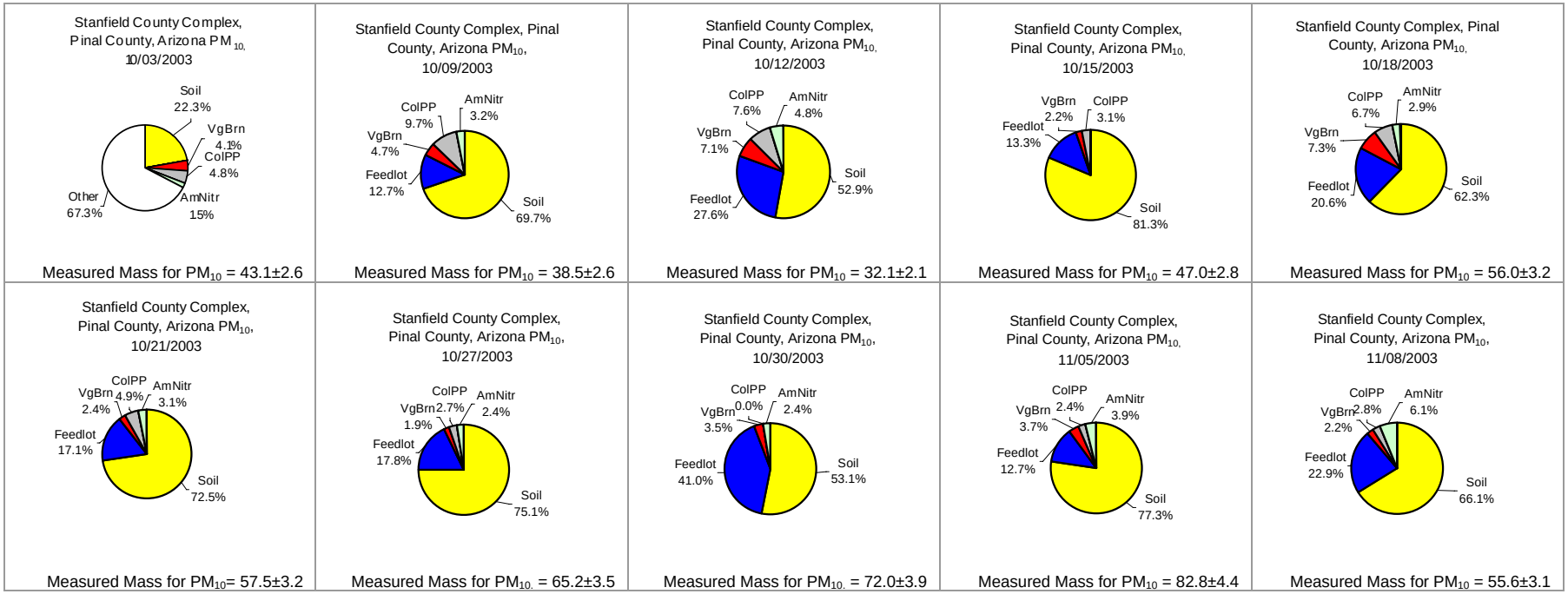


Figure 10. CMB modeled source attributions for PM_{10} data subsets from Stanfield County Complex, Pinal County

Table 13. CMB modeled $PM_{2.5}$ source attributions for Stanfield County Complex, Pinal County ($\mu g/m^3$)

Sample Date	Soil	Feedlot	MvEmi	VgBrn	ColPP	AmSulf	AmNitr	Other	Modeled Mass	Measured Mass	Mass Uncertainty
10/3/2003	32.6025		1.4513	0.4449	2.0449		0.4342		36.9778	5.1095	± 1.4440
10/9/2003	3.7594		2.0740	1.3580	1.6871	1.1954	0.4154		10.4893	10.4520	± 1.4710
10/12/2003	1.7309		1.1724	2.0137	2.0742	0.6111	0.6673	0.8469	8.2695	9.1164	± 1.4395
10/15/2003	7.7159		1.3687	1.6032	3.3220		0.5793		14.5891	13.0802	± 1.5174
10/18/2003	5.6414		0.8037	3.5781	4.2378		0.8494	1.2076	15.1104	16.3180	± 1.5841
10/21/2003	9.1701		1.9422	2.3688	3.4521		0.8103		17.7434	16.7979	± 1.5290
10/27/2003	14.0159		1.1475	1.2476	2.0776		0.6883	0.9724	19.1769	20.1493	± 1.7681
10/30/2003	6.8569			13.1220	9.1066		0.8964		29.9820	27.8940	± 1.9465
11/5/2003	21.9418			2.5971	2.4625		1.8604		28.8618	28.4153	± 1.9461
11/8/2003	12.0812		1.1056	1.5047	2.7614		1.9255	11.7297	19.3784	31.1081	± 2.0270

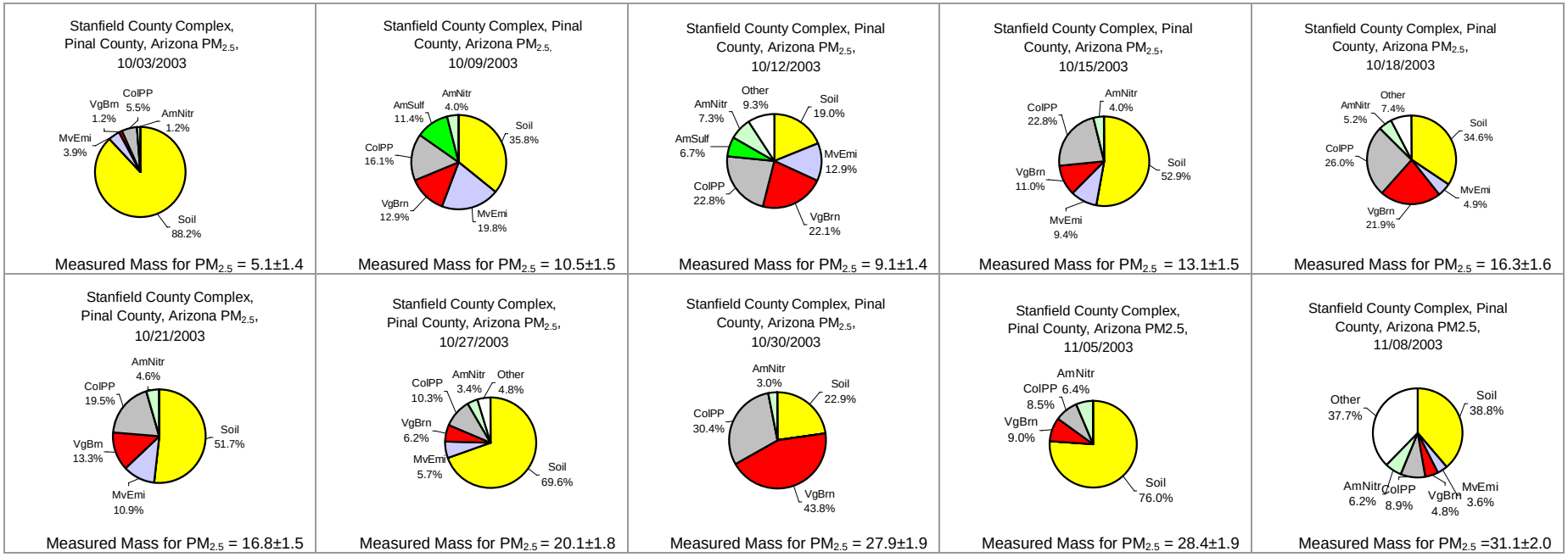


Figure 11. CMB modeled source attributions for $PM_{2.5}$ data subsets from Stanfield County Complex, Pinal County

Table 14. CMB modeled $PM_{2.5}$ species for re-suspended soil and feedlot samples (concentration in fractions), Pinal County, Arizona

SID, PNO	$PM_{2.5}$ Soil (PINSL688, RDST01)			$PM_{2.5}$ Soil (PINSL689, AGRI01)			$PM_{2.5}$ Feedlot (PINSL690, FDLT01)		
	Conc		Unc	Conc		Unc	Conc		Unc
NO_3^-	0.0016	±	0.0006	0.0000	±	0.0006	0.0000	±	0.0006
SO_4^{2-}	0.0017	±	0.0007	0.0000	±	0.0006	0.0189	±	0.0026
NH_4^+	0.0018	±	0.0007	0.0015	±	0.0007	0.0015	±	0.0007
OC1	0.0000	±	0.0034	0.0000	±	0.0034	0.0000	±	0.0033
OC2	0.0000	±	0.0035	0.0000	±	0.0034	0.0212	±	0.0046
OC3	0.0006	±	0.0043	0.0000	±	0.0041	0.1593	±	0.0304
OC4	0.0018	±	0.0035	0.0012	±	0.0035	0.0506	±	0.0064
EC1	0.0030	±	0.0010	0.0018	±	0.0009	0.0481	±	0.0043
EC2	0.0028	±	0.0011	0.0014	±	0.0010	0.0101	±	0.0016
EC3	0.0000	±	0.0008	0.0000	±	0.0008	0.0009	±	0.0009
Al	0.0495	±	0.0036	0.0489	±	0.0036	0.0039	±	0.0005
Si	0.1560	±	0.0113	0.1606	±	0.0116	0.0237	±	0.0017
K	0.0290	±	0.0021	0.0321	±	0.0023	0.0418	±	0.0030
Ca	0.0260	±	0.0027	0.0299	±	0.0029	0.0404	±	0.0035
V	0.0000	±	0.0003	0.0000	±	0.0003	0.0000	±	0.0003
Fe	0.0441	±	0.0032	0.0480	±	0.0035	0.0064	±	0.0005
Cu	0.0001	±	0.0000	0.0001	±	0.0000	0.0001	±	0.0000
Zn	0.0002	±	0.0000	0.0002	±	0.0000	0.0007	±	0.0001
As	0.0000	±	0.0001	0.0000	±	0.0001	0.0000	±	0.0001
Se	0.0000	±	0.0000	0.0000	±	0.0000	0.0000	±	0.0000
Br	0.0000	±	0.0000	0.0000	±	0.0000	0.0000	±	0.0000
Pb	0.0000	±	0.0001	0.0000	±	0.0001	0.0000	±	0.0001

Table 15. CMB modeled PM_{10} species for re-suspended soils and feedlot samples (concentration in fractions), Pinal County, Arizona.

SID, PNO	PM_{10} Soil (PINSL688, RDST03)			PM_{10} Soil (PINSL689, AGRI03)			PM_{10} Feedlot (PINSL690, FDLT03)		
	Conc		Unc	Conc		Unc	Conc		Unc
NO_3^-	0.0014	±	0.0004	0.0007	±	0.0002	0.0000	±	0.0004
SO_4^{2-}	0.0013	±	0.0004	0.0008	±	0.0002	0.0264	±	0.0039
NH_4^+	0.0010	±	0.0004	0.0007	±	0.0003	0.0021	±	0.0006
OC1	0.0000	±	0.0019	0.0000	±	0.0009	0.0035	±	0.0035
OC2	0.0000	±	0.0019	0.0000	±	0.0010	0.0579	±	0.0085
OC3	0.0031	±	0.0025	0.0032	±	0.0015	0.1832	±	0.0377
OC4	0.0037	±	0.0020	0.0022	±	0.0010	0.0524	±	0.0066
EC1	0.0058	±	0.0007	0.0036	±	0.0004	0.0528	±	0.0052
EC2	0.0034	±	0.0007	0.0019	±	0.0004	0.0059	±	0.0012
EC3	0.0003	±	0.0005	0.0000	±	0.0002	0.0020	±	0.0008
Al	0.0626	±	0.0151	0.0687	±	0.0184	0.0082	±	0.0022
Si	0.1980	±	0.0502	0.2141	±	0.0606	0.0364	±	0.0092
K	0.0297	±	0.0047	0.0324	±	0.0056	0.0565	±	0.0091
Ca	0.0346	±	0.0052	0.0380	±	0.0058	0.0473	±	0.0066
V	0.0001	±	0.0002	0.0001	±	0.0002	0.0000	±	0.0002
Fe	0.0400	±	0.0031	0.0421	±	0.0023	0.0077	±	0.0006
Cu	0.0001	±	0.0000	0.0001	±	0.0000	0.0001	±	0.0000
Zn	0.0002	±	0.0000	0.0002	±	0.0000	0.0007	±	0.0001
As	0.0000	±	0.0000	0.0000	±	0.0000	0.0000	±	0.0000
Se	0.0000	±	0.0000	0.0000	±	0.0000	0.0000	±	0.0000
Br	0.0000	±	0.0000	0.0000	±	0.0000	0.0000	±	0.0000
Pb	0.0000	±	0.0000	0.0001	±	0.0000	0.0000	±	0.0001

Appendix C - Addendum

Chemical Fingerprint Analysis

May 18,2005

Mr. Donald P. Gabrielson
Pinal County Air Quality Control District (PCAQCD)
31 N. Pinal Building F
P.O. Box 987
Florence, AZ 85232

Dear Mr. Gabrielson,

Chemical Fingerprint of the Cowtown Feedlot dust, Pinal County, AZ

In addition to the DRI report on the "Pinal County Source Apportionment Study" submitted to the Pinal County Air Quality Control District (PCAQCD) on May 26, 2004, we are adding the following clarification on the Feedlot Dust sample and the Cowtown ambient samples.

1. The Feedlot grab sample, as well as the Dirt Road and Agricultural samples received from the PCAQCD were re-suspended at the DRI's re-suspension facility. The two size fractions, PM_{10} (respirable particulate matter) and $PM_{2.5}$ (fine particulate matter) were collected on filters and thereafter analyzed at the DRI's Environmental Analysis Facility to provide the chemical fingerprint (source profiles, signature) shown for PM_{10} in Figure 1 and for $PM_{2.5}$ in Figure 2. Each chemical signature is characterized by a combination of chemical species. Shown in Figures 1 and 2 are concentrations of 17 chemical species and their analytical uncertainties, including water soluble nitrate, sulfate and ammonium, the eight carbon species (OC1-4, OPT and EC1-3) as well as the total carbon (TC), and five metals typical of most soils (aluminum, silicon, potassium, calcium and iron). The Feedlot Dust source sample differs from the Agricultural and Road Dusts in that it contains a substantial amount of total carbon (TC) which is the sum of the concentrations of the carbon species, with large proportions of OC2, OC3, OC4, OPT and EC1.
2. The chemical results of PM_{10} and $PM_{2.5}$ ambient samples collected at the Cowtown sampling site on three days with above average dust loadings (DRI report, Figure 1), are similar to the Feedlot Dust fingerprint, in that they all contain substantial amounts of total carbon (TC) which is the sum of the concentrations of the carbon species, particularly of OC2, OC3, OC4, OPT and EC1 (Figures 3 and 4). This shows that the ambient samples do contain substantial amounts of the Feedlot Dust, as was confirmed by the Chemical Mass Balance (Version 8) receptor modeling results (see Report Figures 6 and 7).
3. The measured masses on the three selected days (10/18/2003, 10/21/2003 and 11/8/2003) at the Cowtown site were substantially higher than at any of the other four measured sites in Pinal County (Table 1), ranging from 264.4 to 294.1 micrograms per cubic meter for Cowtown compared to 39.2 to 104.7 micrograms

per cubic meter at the other four sites for PM_{10}. Similarly for $PM_{2.5}$ the masses range from 76.6 to 112.3 micrograms per cubic meter for Cowtown and 13.0 to 59.4 micrograms per cubic meter at the other four sites for the same sampling periods. This was the general trend during the month-long intensive sampling campaign, and clearly points to a local polluting source (feedlot?) impacting on the Cowtown sampling site, not impacting on the other four sites in the County to the same extent.

We trust that this additional interpretation of the results from the Cowtown sampling site and the Feedlot Dust sample will be useful to the PCAQCD. Please feel free to contact us should you require any further clarification of the results from the Pinal County Source Apportionment report.

Sincerely,

Johann Engelbrecht

Associate Research Professor
Division of Atmospheric Sciences
Desert Research Institute
2215 Raggio Parkway
Reno NV 89512-1095
tel. (775) 674 7027
fax. (775) 674 7009
e-mail johann@dri.edu
http://www.dri.edu/People/johann/

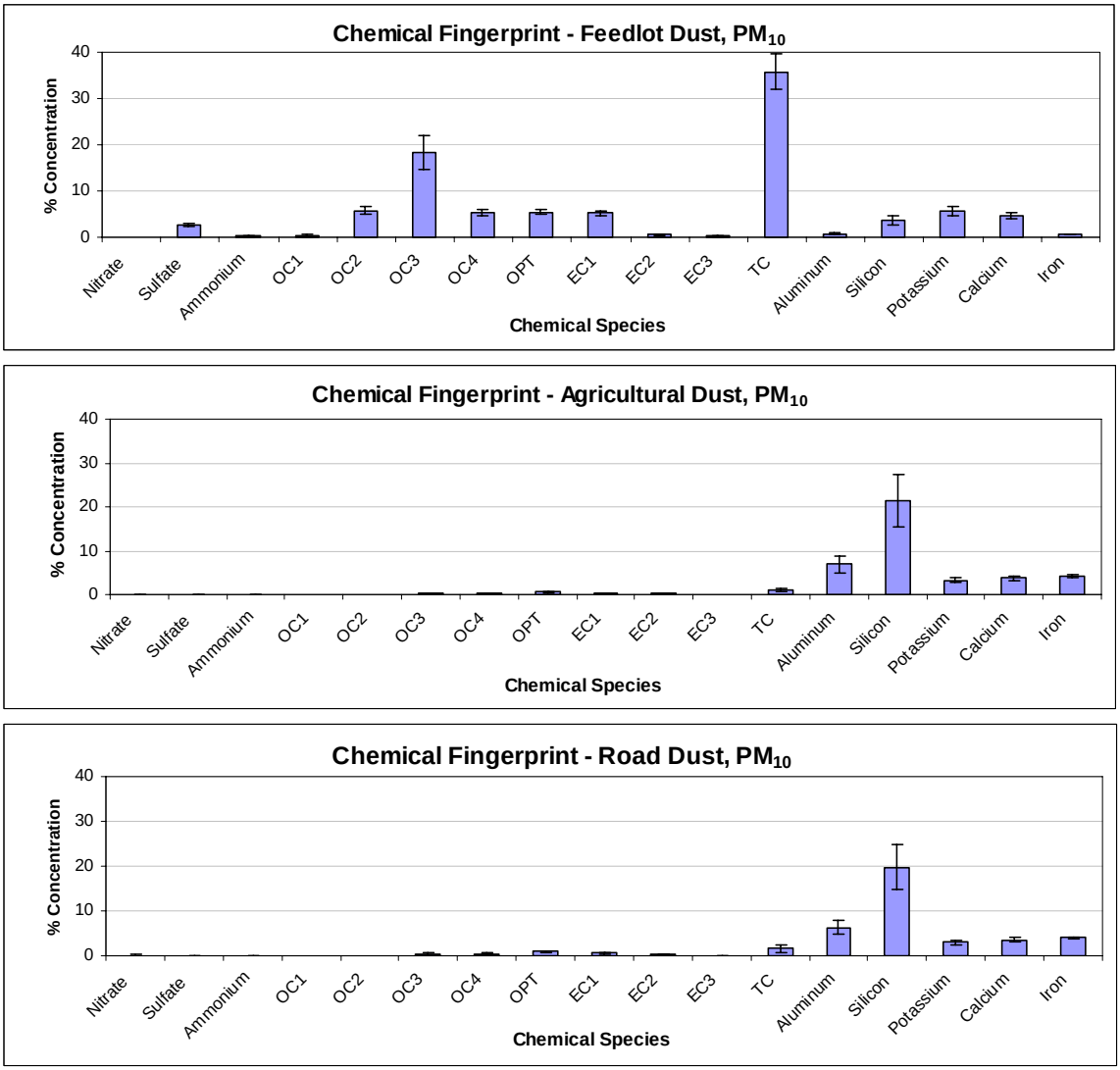


Figure 1. Comparative chemical fingerprints from Pinal County, for respirable particulate matter (PM_{10}). Shown are concentrations of 17 chemical species and their analytical uncertainties (⊥), including water soluble nitrate, sulfate and ammonium, the eight carbon species (OC1-4, OPT and EC1-3) as well as the total carbon (TC), and five metals typical of most soils (aluminum, silicon, potassium, calcium and iron). The Feedlot Dust sample differs from the Agricultural and Road Dusts in that it contains a substantial amount of total carbon (TC) which is the total of the concentrations of the carbon species, particularly of OC2, OC3, OC4, OPT and EC1.

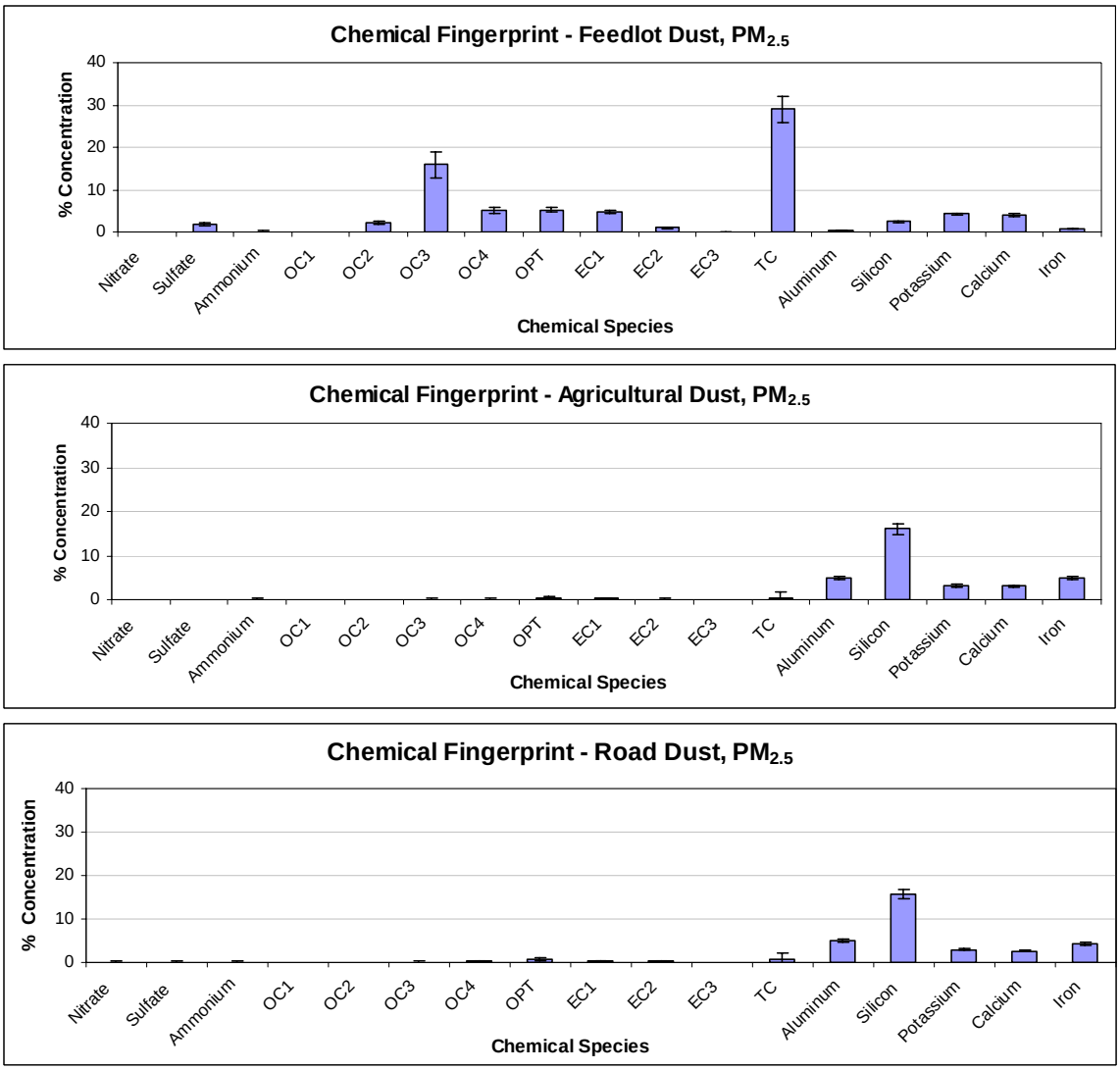


Figure 2. Comparative chemical fingerprints from Pinal County, for fine particulate matter ($PM_{2.5}$). Shown are concentrations of 17 chemical species and their analytical uncertainties (⊥), including water soluble nitrate, sulfate and ammonium, the eight carbon species (OC1-4, OPT and EC1-3) as well as the total carbon (TC), and five metals typical of most soils (aluminum, silicon, potassium, calcium and iron). The Feedlot Dust sample differs from the Agricultural and Road Dusts in that it contains a substantial amount of total carbon (TC) which is the total of the concentrations of the carbon species, particularly of OC2, OC3, OC4, OPT and EC1.

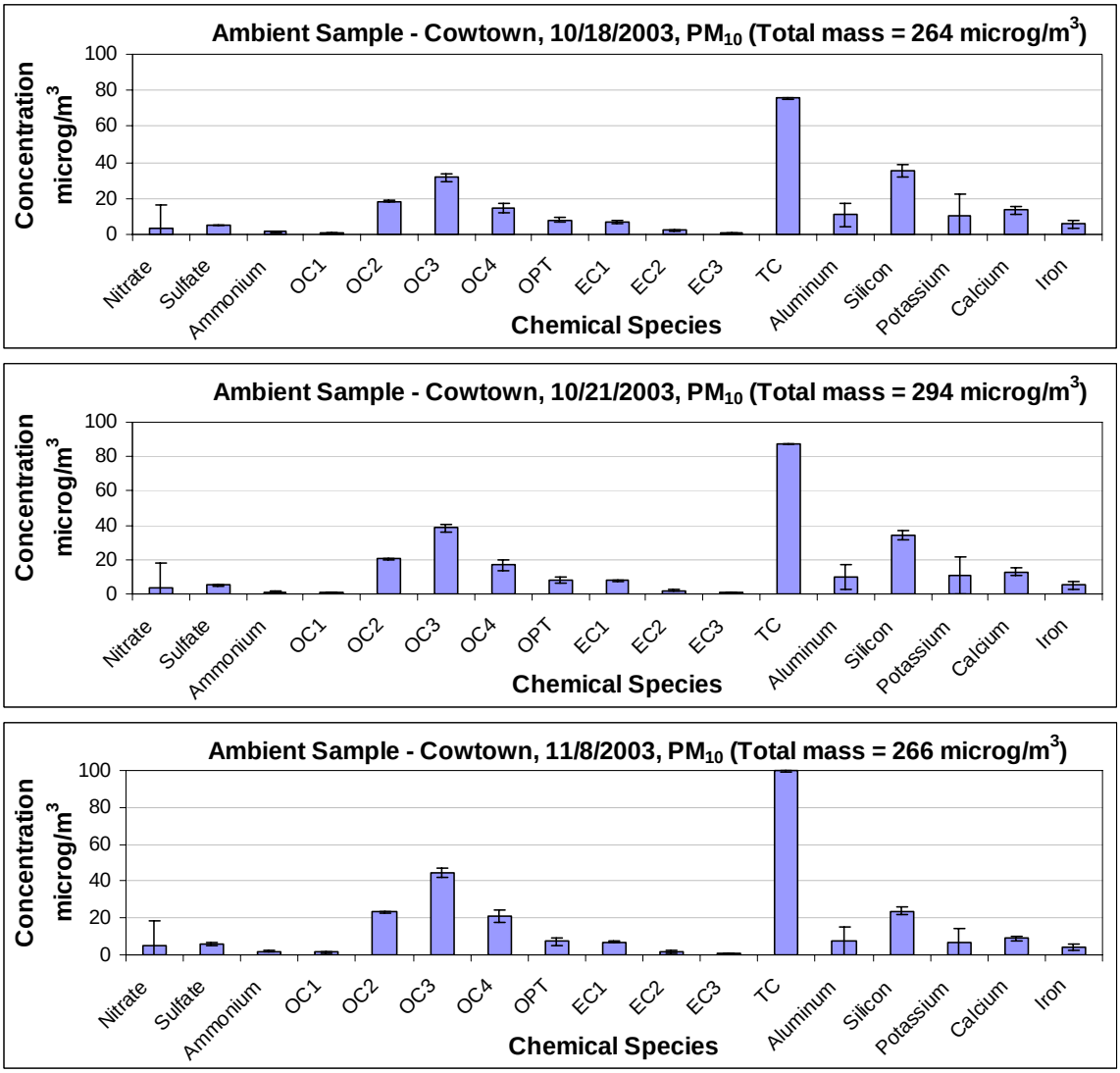


Figure 3. Ambient respirable particulate matter (PM_{10}) samples collected on three high days at the Cowtown sampling site. Shown are concentrations of 17 chemical species and their analytical uncertainties (⊥), including water soluble nitrate, sulfate and ammonium, the eight carbon species (OC1-4, OPT and EC1-3) as well as the total carbon (TC), and five metals typical of most soils (aluminum, silicon, potassium, calcium and iron). The three ambient samples are similar to the Feedlot Dust fingerprint in that they all contain substantial amounts of total carbon (TC) which is the sum total of the concentrations of the carbon species, with large proportions of OC2, OC3, OC4, OPT and EC1. This shows that the ambient samples do contain substantial amounts of the Feedlot Dust, as was confirmed by the Chemical Mass Balance (Version 8) receptor modeling results (see Report Figure 6)

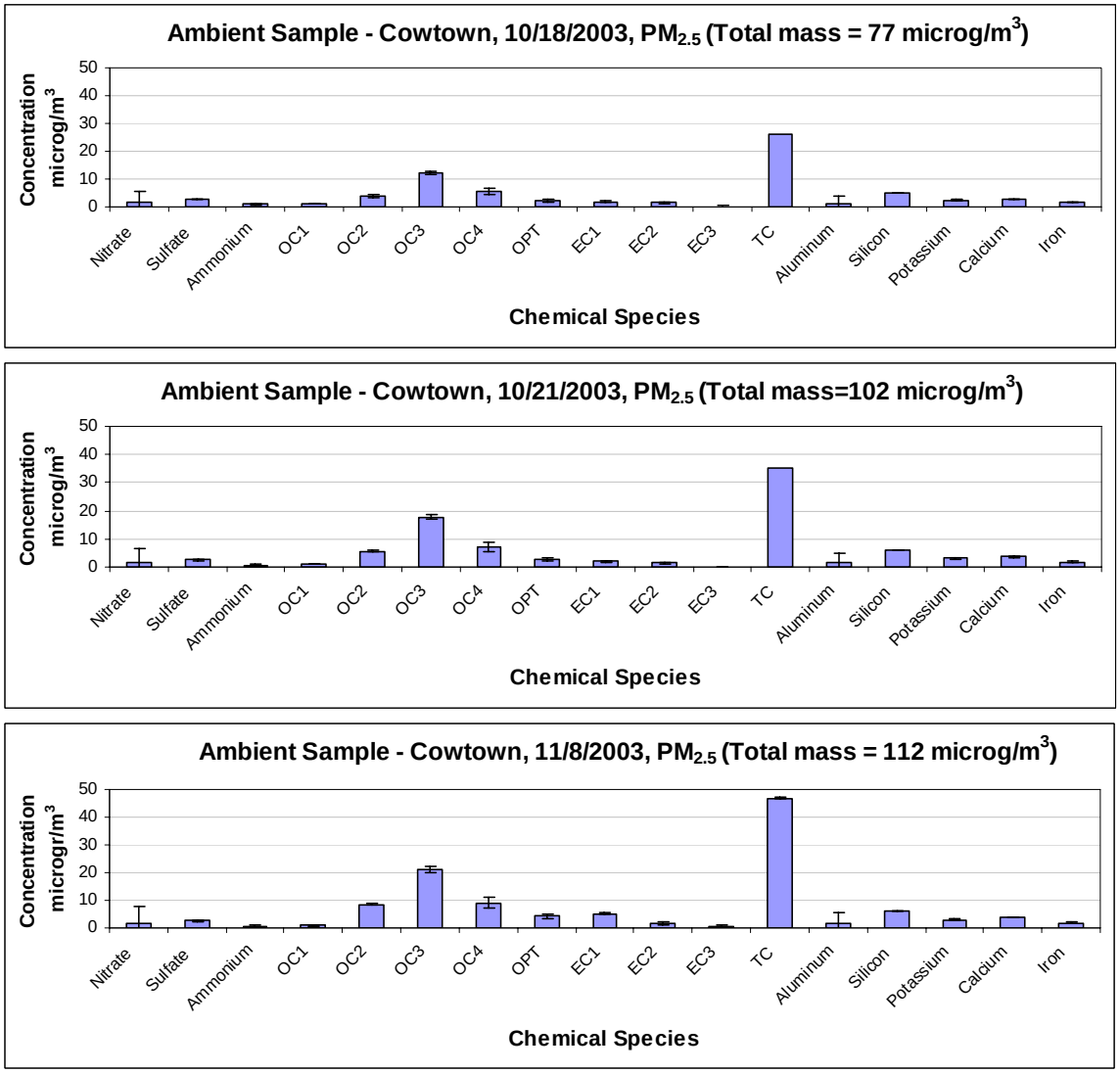


Figure 4. Ambient fine particulate matter ($PM_{2.5}$) samples collected on three high days at the Cowtown sampling site. Shown are concentrations of 17 chemical species and their analytical uncertainties (⊥), including water soluble nitrate, sulfate and ammonium, the eight carbon species (OC1-4, OPT and EC1-3) as well as the total carbon (TC), and five metals typical of most soils (aluminum, silicon, potassium, calcium and iron). The three ambient samples are similar to the Feedlot Dust fingerprint in that they all contain substantial amounts of total carbon (TC) which is the sum total of the concentrations of the carbon species, with large proportions of OC2, OC3, OC4, OPT and EC1. This shows that the ambient samples do contain substantial amounts of the Feedlot Dust, as was confirmed by the Chemical Mass Balance (Version 8) receptor modeling results (see Report Figure 7). Also note that the $PM_{2.5}$ samples have larger proportions of total carbon than the PM_{10} samples, meaning that the organic matter is concentrated in the fine fraction and the geological dust in the coarse fraction.

Table 1. Measured particulate masses from Cowtown on highly polluted sampling days, and of the four other Pinal County sites taken over the same periods.

Sampling Date	PM_{10}, measured mass and uncertainties (micrograms per cubic meter)				
	Cowtown	**Casa Grande**	**Coolidge Maintenance Yard**	**Pinal County Housing**	**Stanfield**
10/18/2003	264.4 ± 13.3	39.2 ± 2.5	45.4 ± 2.7	61.9 ± 3.4	56.0 ± 3.1
10/21/2003	294.1 ± 14.8	46.9 ± 2.8	48.3 ± 2.8	89.2 ± 4.7	57.5 ± 3.2
11/8/2003	265.6 ± 13.4	64.0 ± 3.5	na ±	104.7 ± 5.4	55.6 ± 3.1
	$PM_{2.5}$, measured mass and uncertainties (micrograms per cubic meter)				
	Cowtown	**Casa Grande**	**Coolidge Maintenance Yard**	**Pinal County Housing**	**Stanfield**
10/18/2003	76.6 ± 4.1	14.1 ± 1.7	26.8 ± 2.0	na ±	16.3 ± 1.6
10/21/2003	101.8 ± 5.3	13.0 ± 1.6	34.3 ± 2.2	30.1 ± 2.1	16.8 ± 1.5
11/8/2003	112.3 ± 5.8	na ±	50.2 ± 2.9	59.4 ± 3.2	31.1 ± 2.02

Appendix D

Meteorological Data

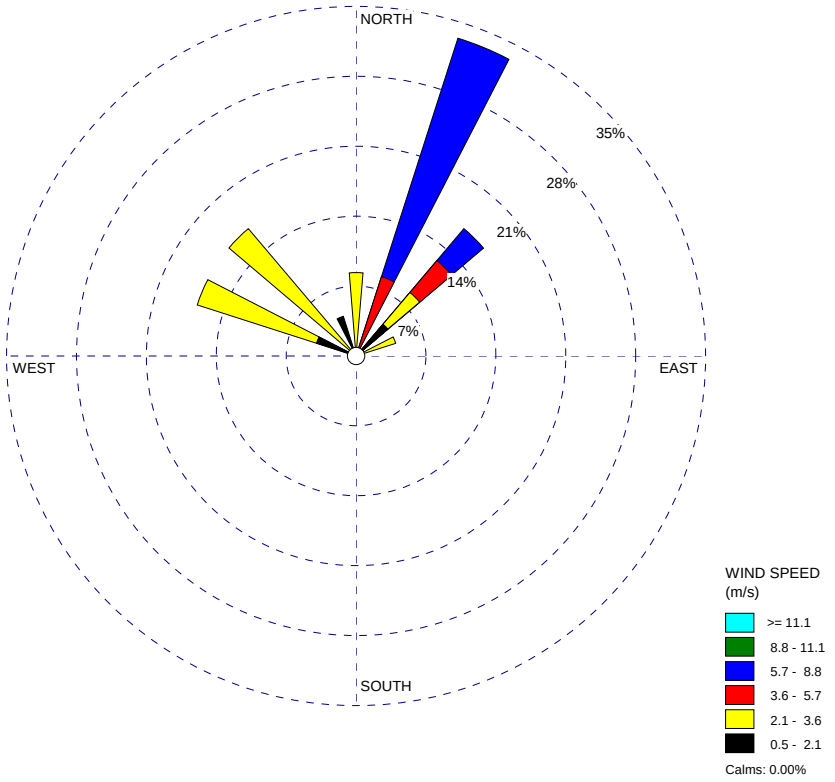
Appendix D-1

Wind Roses

Casa Grande

Wind Roses

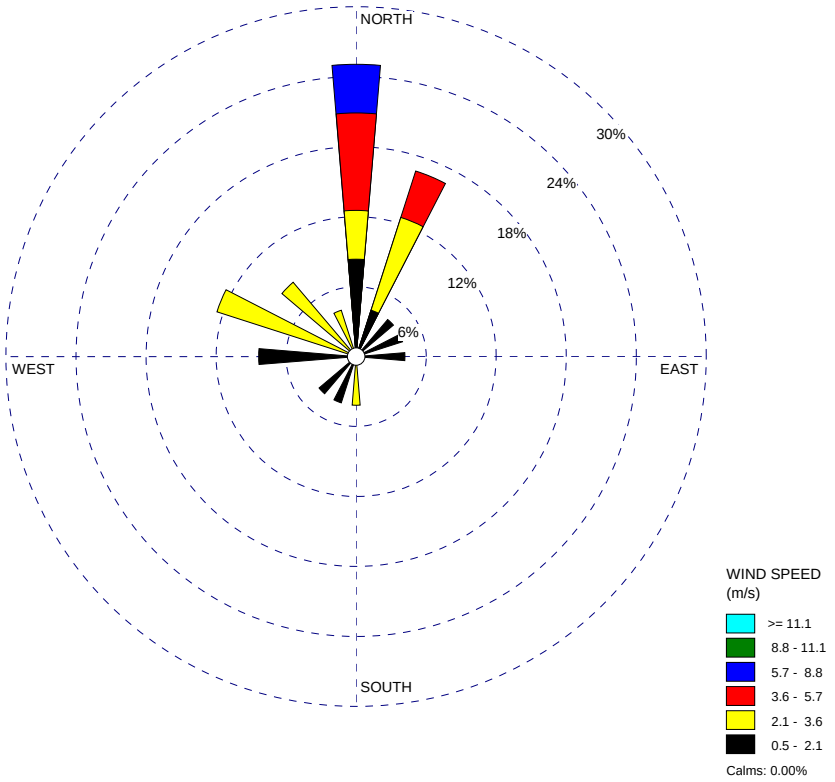
WIND ROSE PLOT:	DISPLAY:
Station # - Casa Grande, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 3 - Oct 3** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **3.88 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

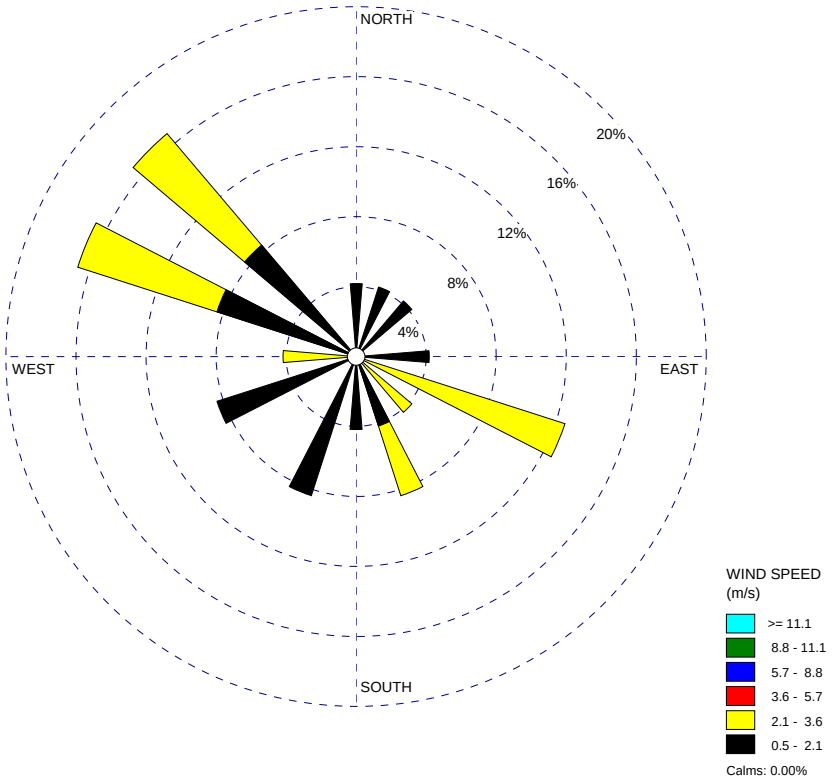
WIND ROSE PLOT:	DISPLAY:
Station # - Casa Grande, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 9 - Oct 9** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **2.69 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:	DISPLAY:
Station # - Casa Grande, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 12 - Oct 12** **00:00 - 23:00**	**Pinal County Air Quality**	
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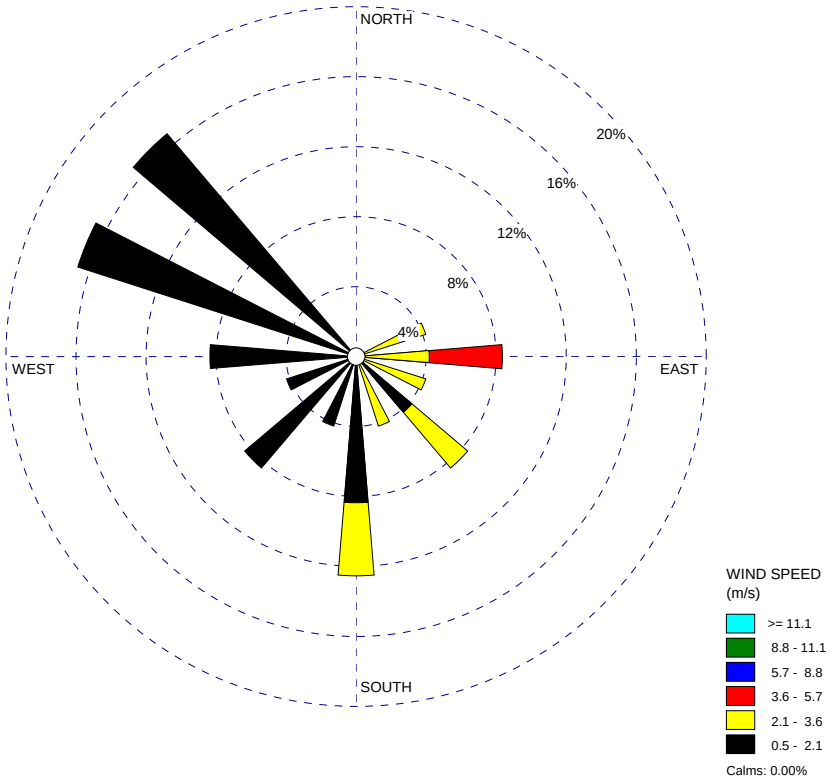
	AVG. WIND SPEED: **2.11 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

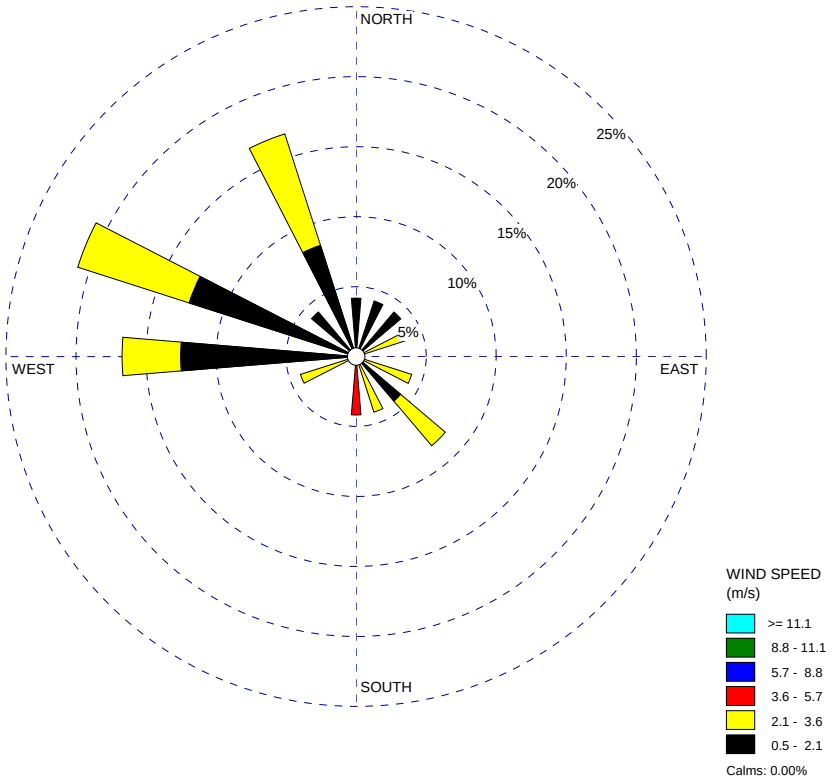
WIND ROSE PLOT:	DISPLAY:
Station # - Casa Grande, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 15 - Oct 15** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.75 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:	DISPLAY:
Station # - Casa Grande, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 18 - Oct 18** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
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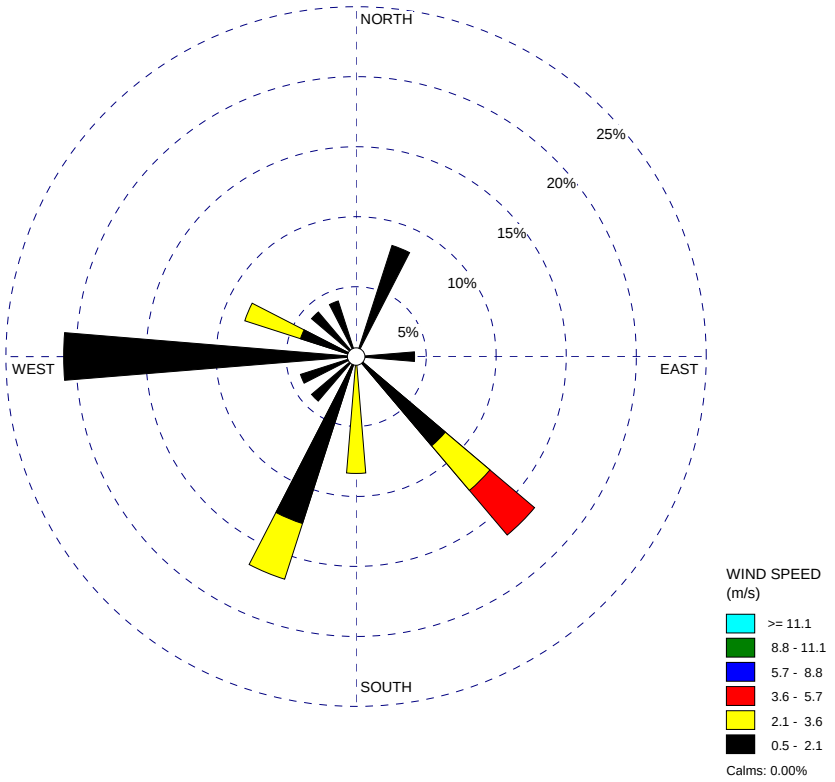
WRPLOT View - Lakes Environmental Software

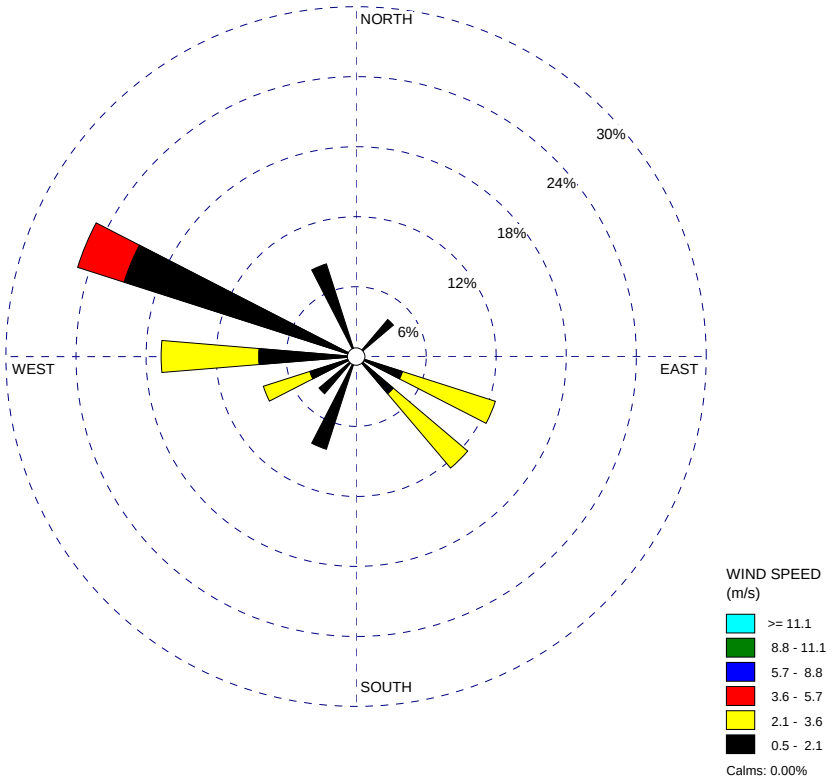
WIND ROSE PLOT:	DISPLAY:
Station #	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 21 - Oct 21** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.82 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:	DISPLAY:
Station # - Casa Grande, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 27 - Oct 27** **00:00 - 23:00**	**Pinal County Air Quality**	
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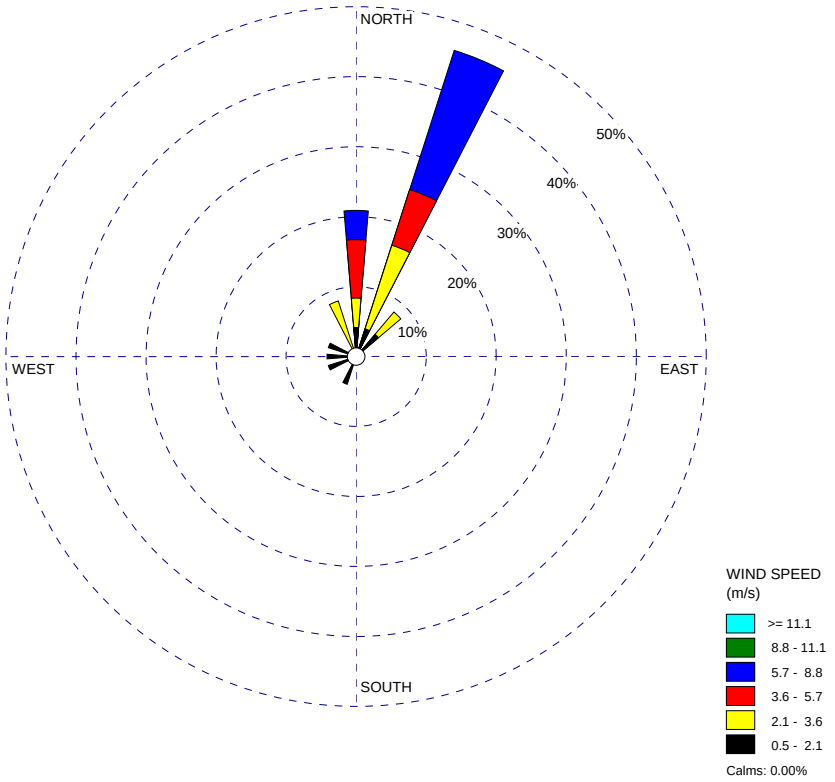
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:	DISPLAY:
Station # - Casa Grande, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
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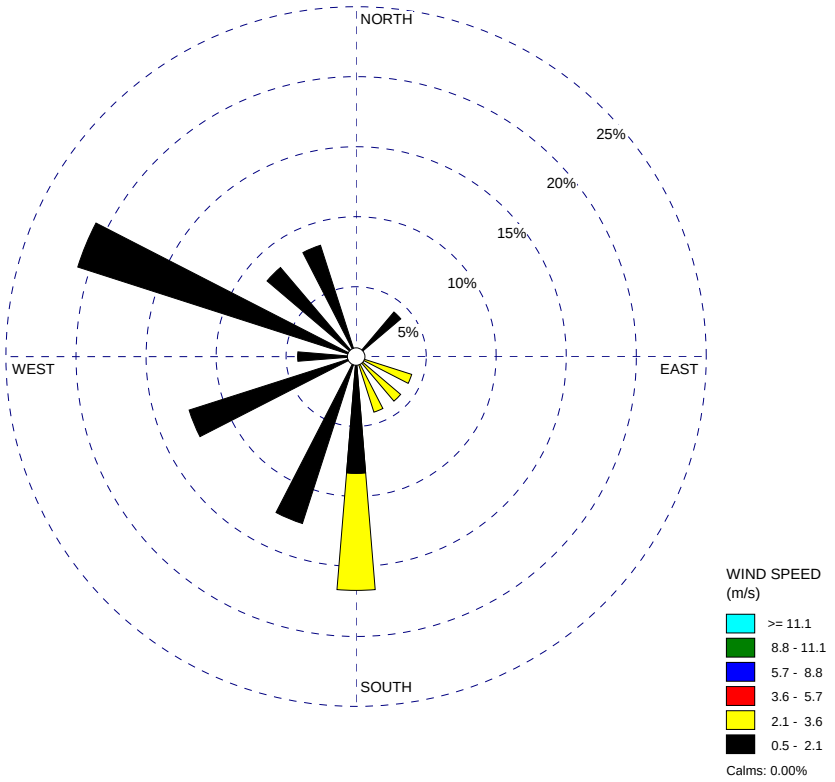
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **3.67 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

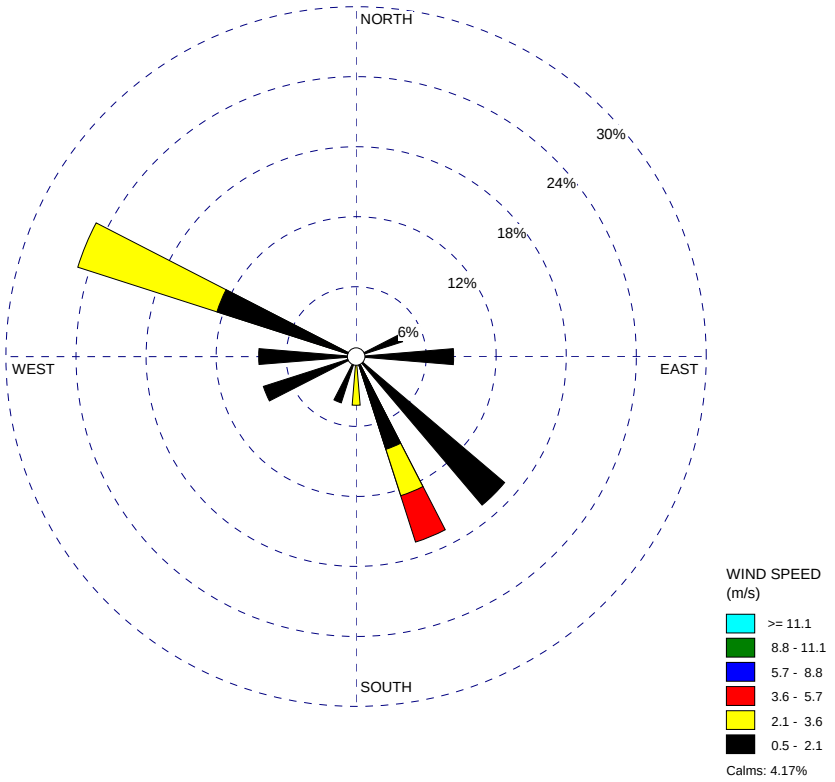
WIND ROSE PLOT:	DISPLAY:
Station # - Casa Grande, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Nov 5 - Nov 5** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.64 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:	DISPLAY:
Station # - Casa Grande, AZ	**Wind Speed** **Flow Vector (blowing to)**



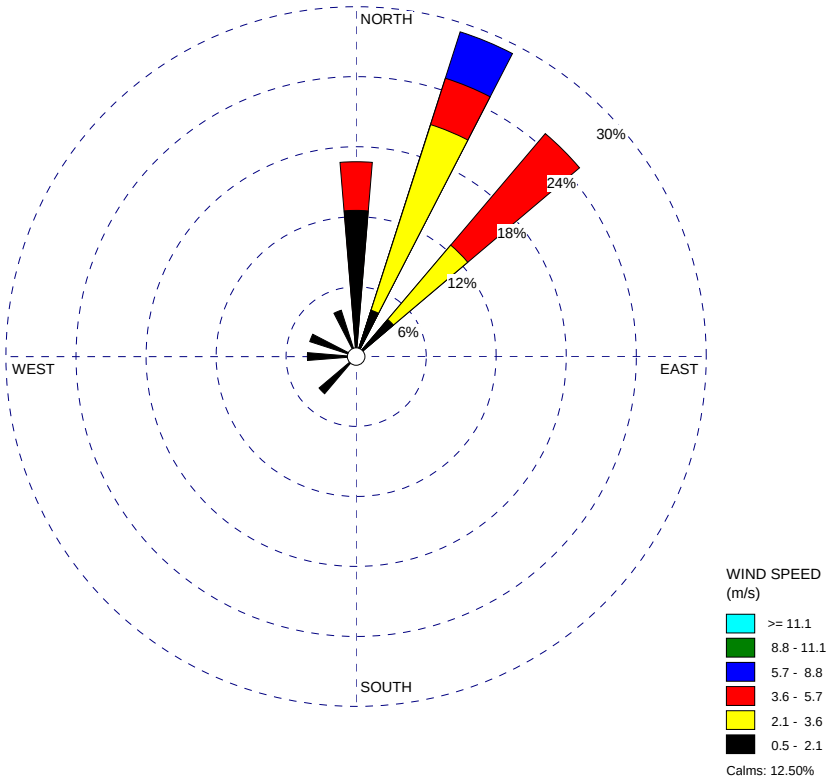
COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Nov 8 - Nov 8** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **4.17%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.64 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

Coolidge
(Coolidge AZMET)

Wind Roses

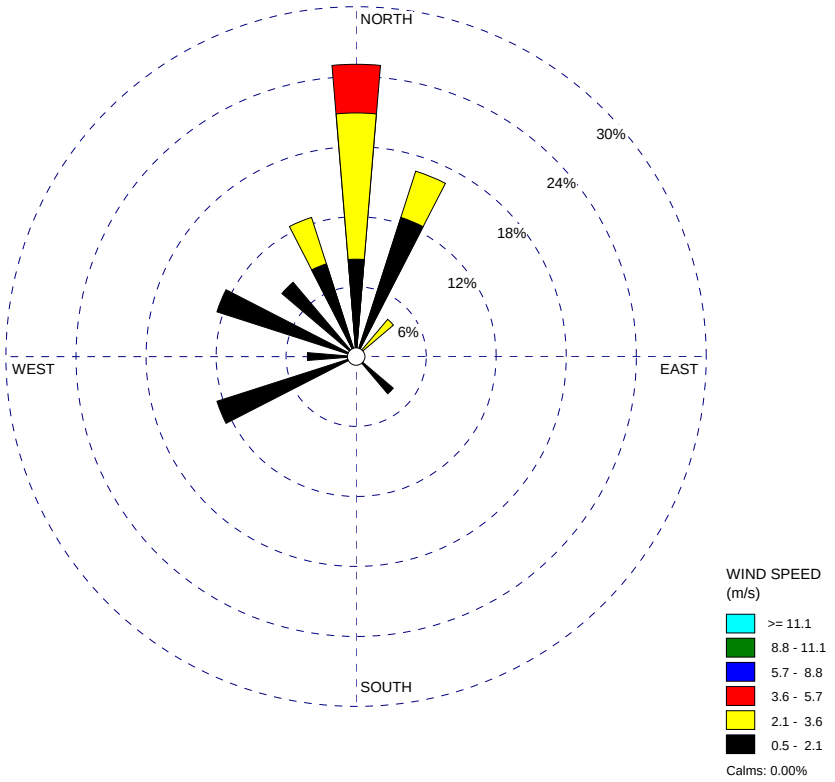
WIND ROSE PLOT:	DISPLAY:
Station # - Coolidge, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 3 - Oct 3** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **12.50%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **2.39 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

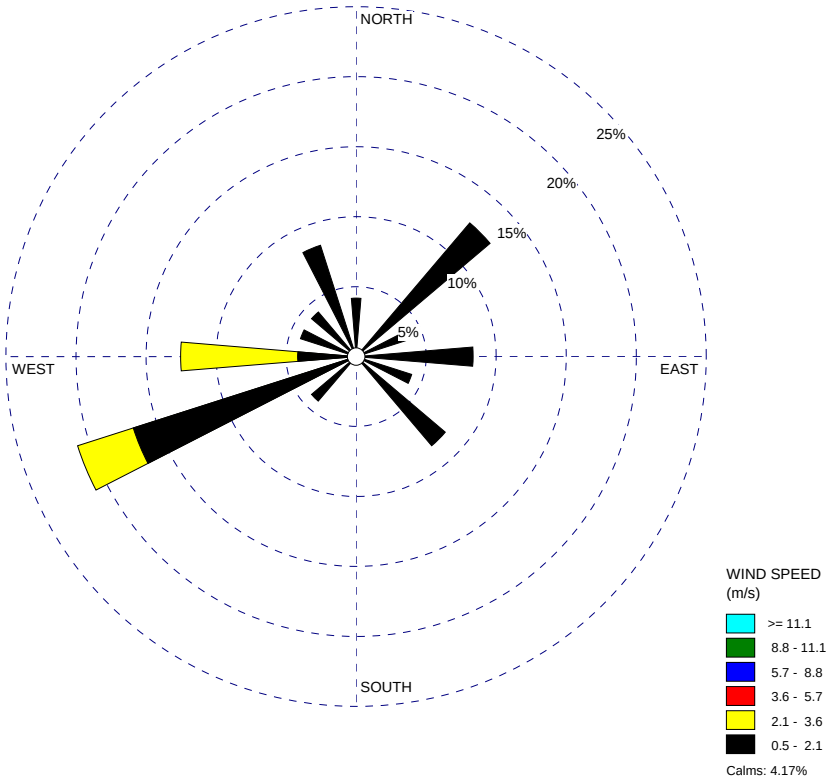
WIND ROSE PLOT:	DISPLAY:
Station # - Coolidge, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 9 - Oct 9** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.75 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

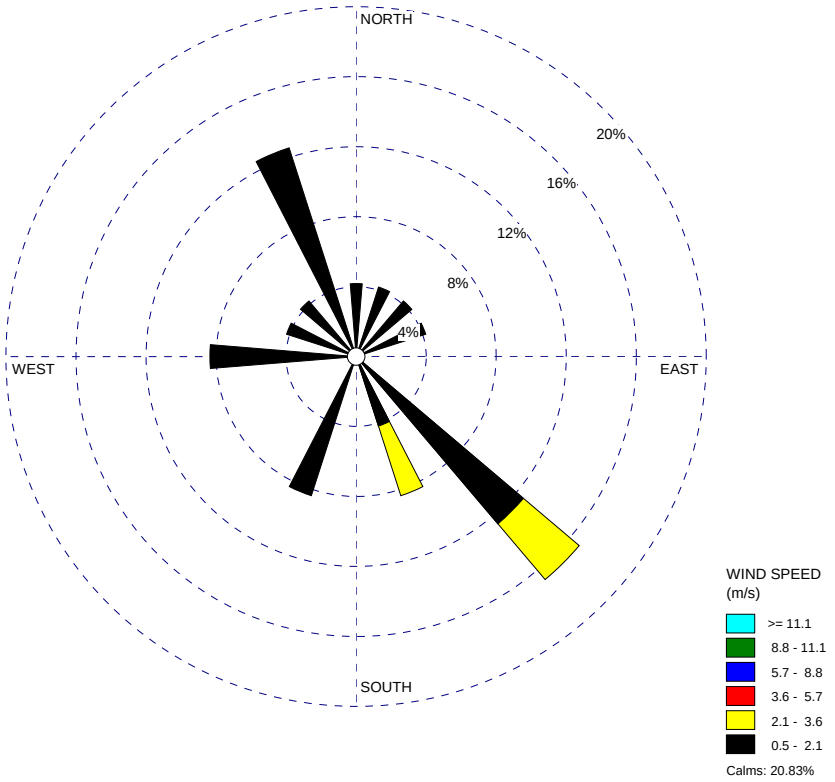
WIND ROSE PLOT:	DISPLAY:
Station # - Coolidge, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 12 - Oct 12** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **4.17%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.37 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

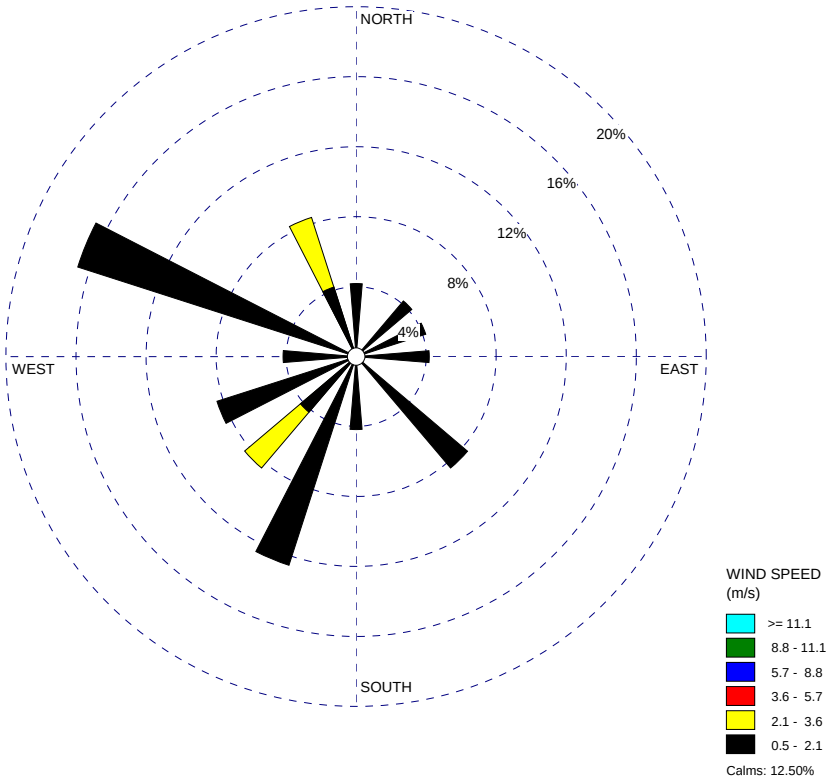
WIND ROSE PLOT:	DISPLAY:
Station # - Coolidge, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 15 - Oct 15** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **20.83%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **0.93 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

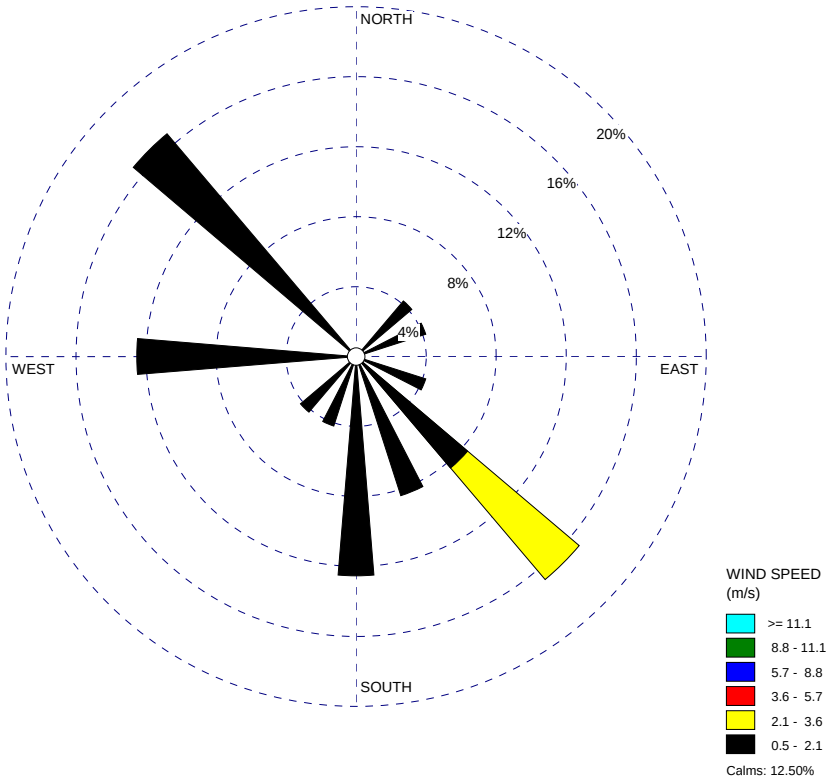
WIND ROSE PLOT:	DISPLAY:
Station # - Coolidge, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 18 - Oct 18** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **12.50%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.03 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

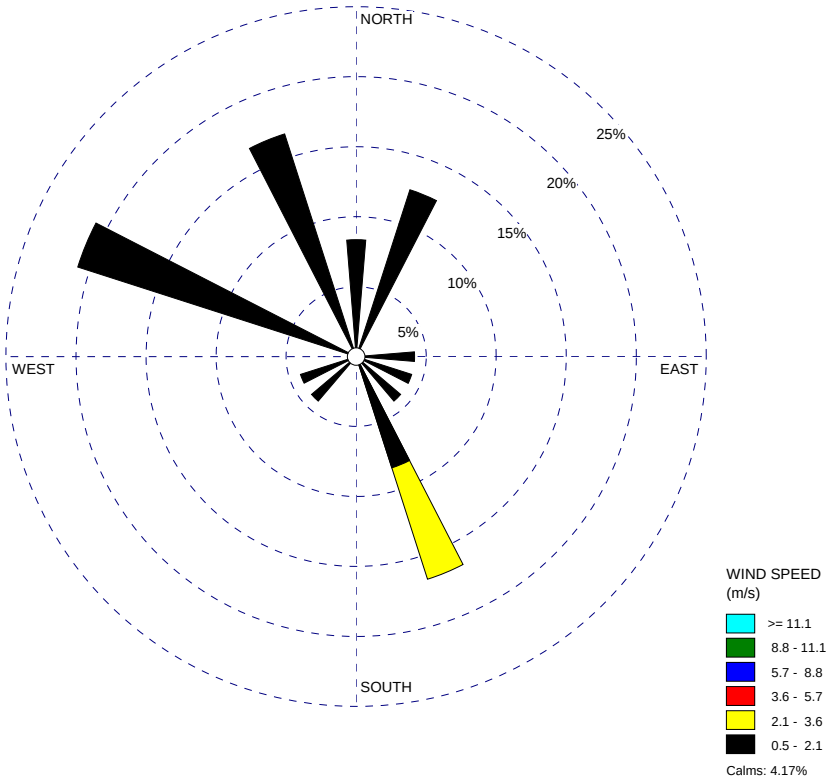
WIND ROSE PLOT:	DISPLAY:
Station # - Coolidge, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 21 - Oct 21** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **12.50%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.15 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

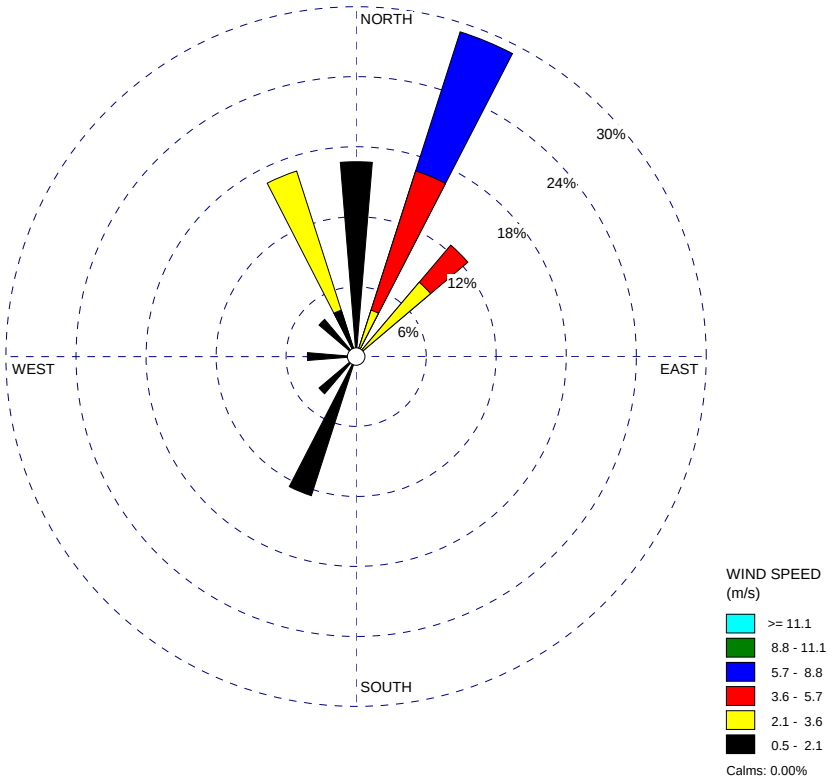
WIND ROSE PLOT:	DISPLAY:
Station # - Coolidge, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 27 - Oct 27** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **4.17%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.15 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

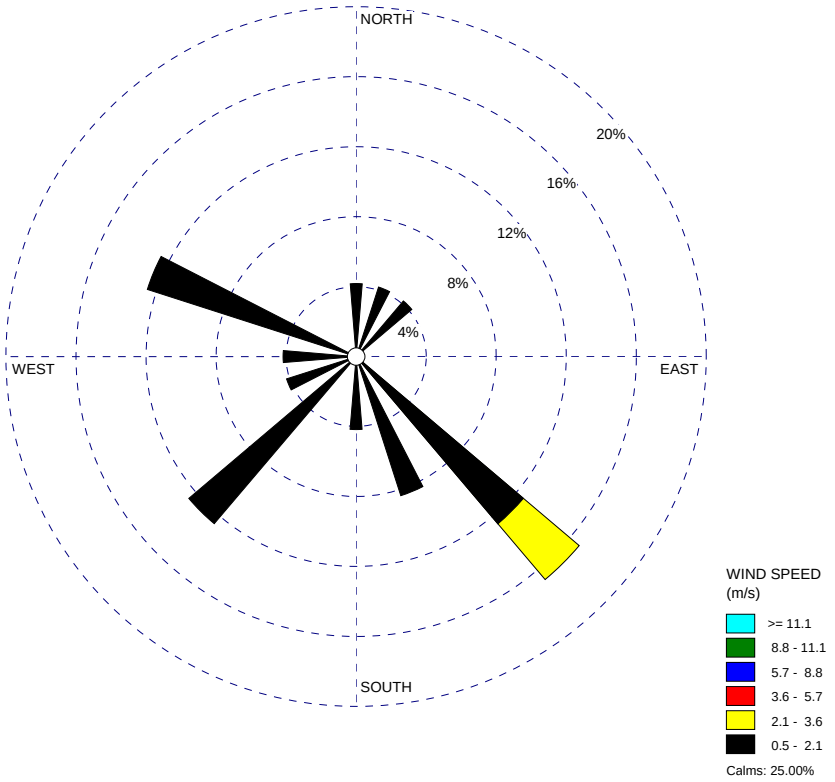
WIND ROSE PLOT:	DISPLAY:
Station # - Coolidge, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 30 - Oct 30** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **2.95 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

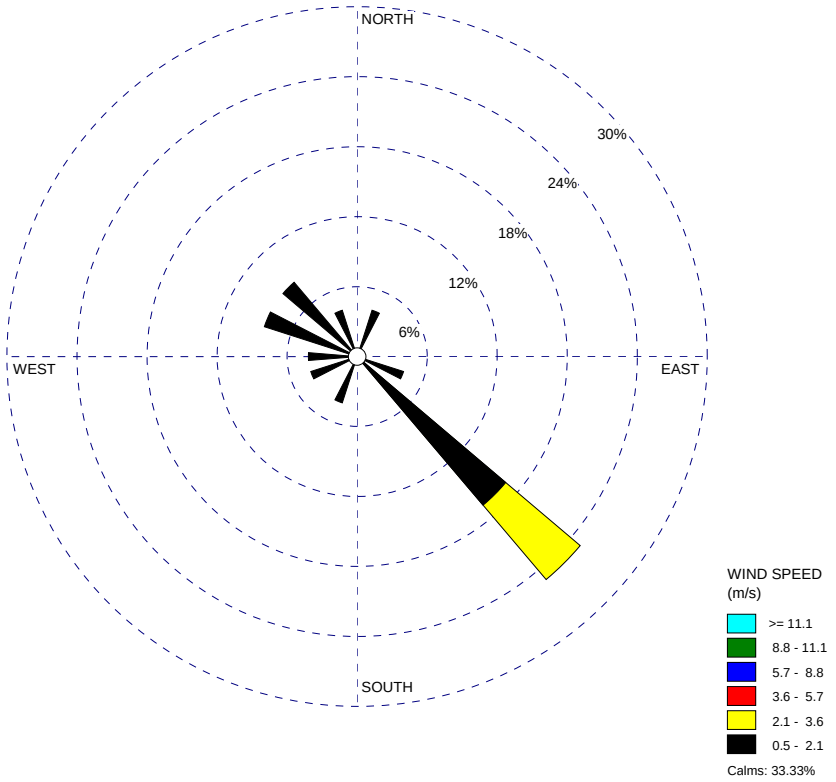
WIND ROSE PLOT:	DISPLAY:
Station # - Coolidge, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Nov 5 - Nov 5** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **25.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **0.91 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:	DISPLAY:
Station # - Coolidge, AZ	**Wind Speed** **Flow Vector (blowing to)**



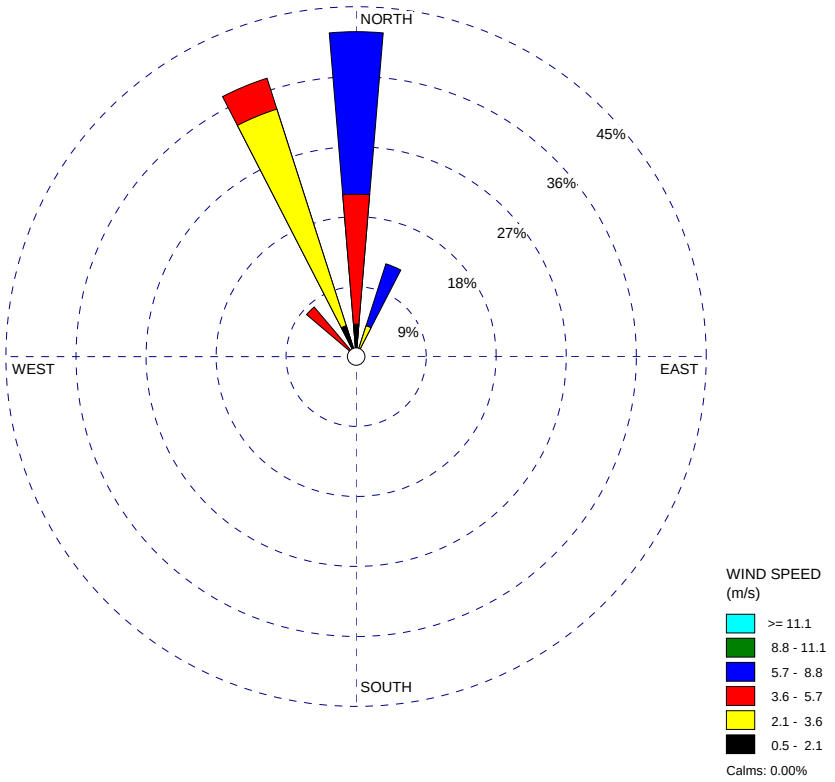
COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Nov 8 - Nov 8** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **33.33%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **0.99 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

Cowtown
(Maricopa Agricultural Research Station AZMET)

Wind Roses

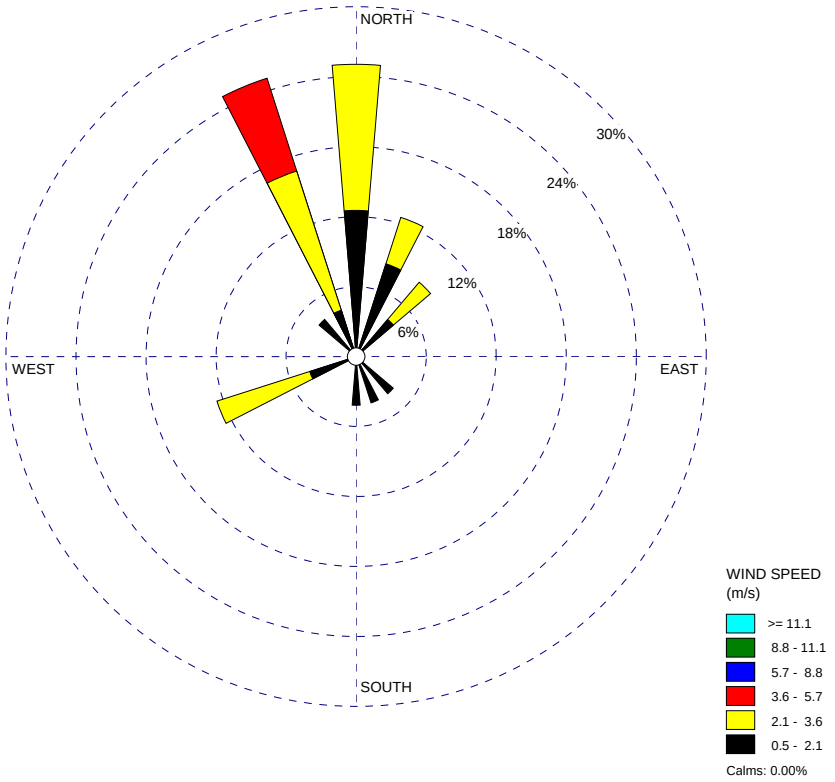
WIND ROSE PLOT:	DISPLAY:
Station # - Maricopa, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 3 - Oct 3** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **4.38 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

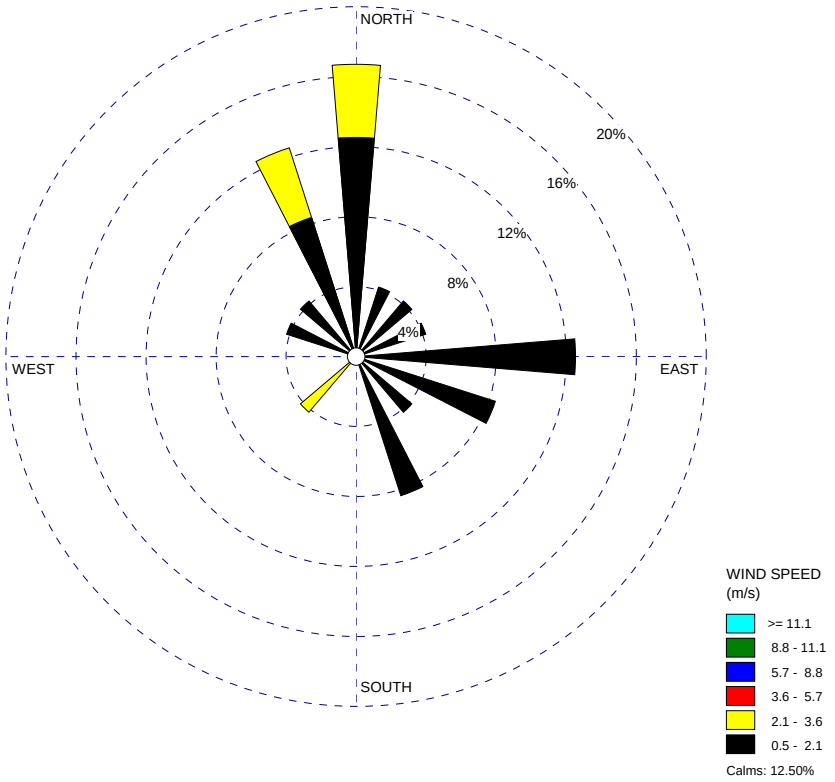
WIND ROSE PLOT:	DISPLAY:
Station # - Maricopa, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 9 - Oct 9** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **2.00 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

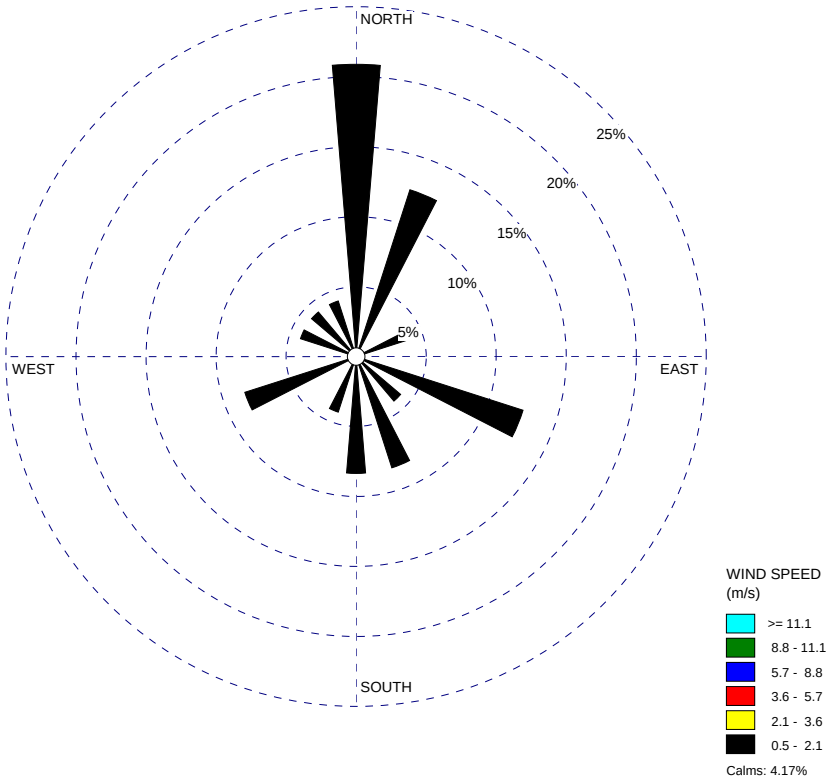
WIND ROSE PLOT:	DISPLAY:
Station # - Maricopa, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 12 - Oct 12** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **12.50%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.34 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:	DISPLAY:
Station # - Maricopa, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 15 - Oct 15** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **4.17%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.01 m/s**	DATE: **04/12/2005**	PROJECT NO.:

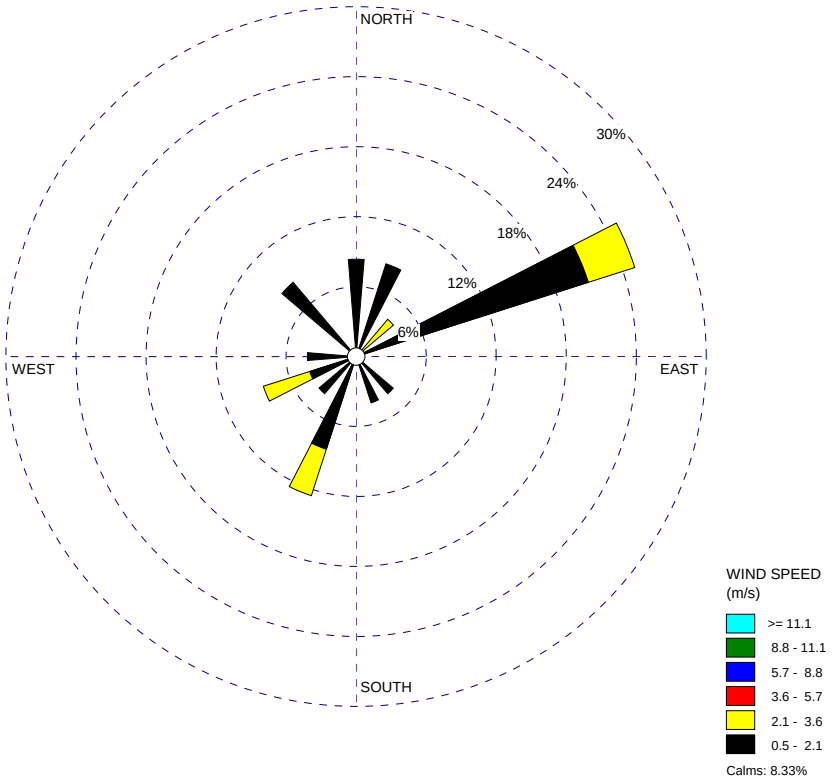
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Station # - Maricopa, AZ

DISPLAY:

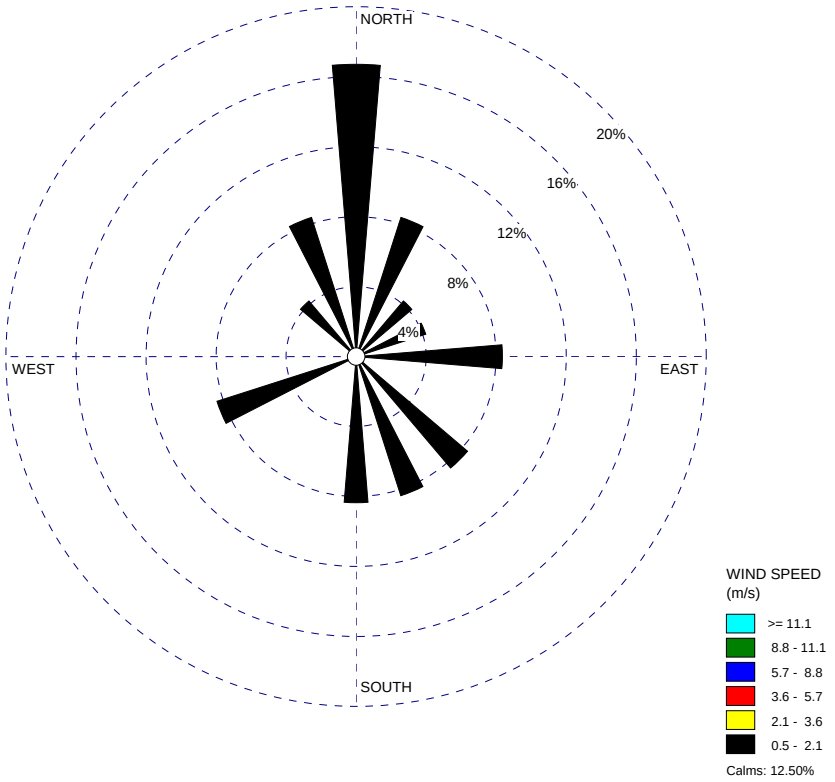
Wind Speed
Flow Vector (blowing to)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 18 - Oct 18** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **8.33%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.21 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

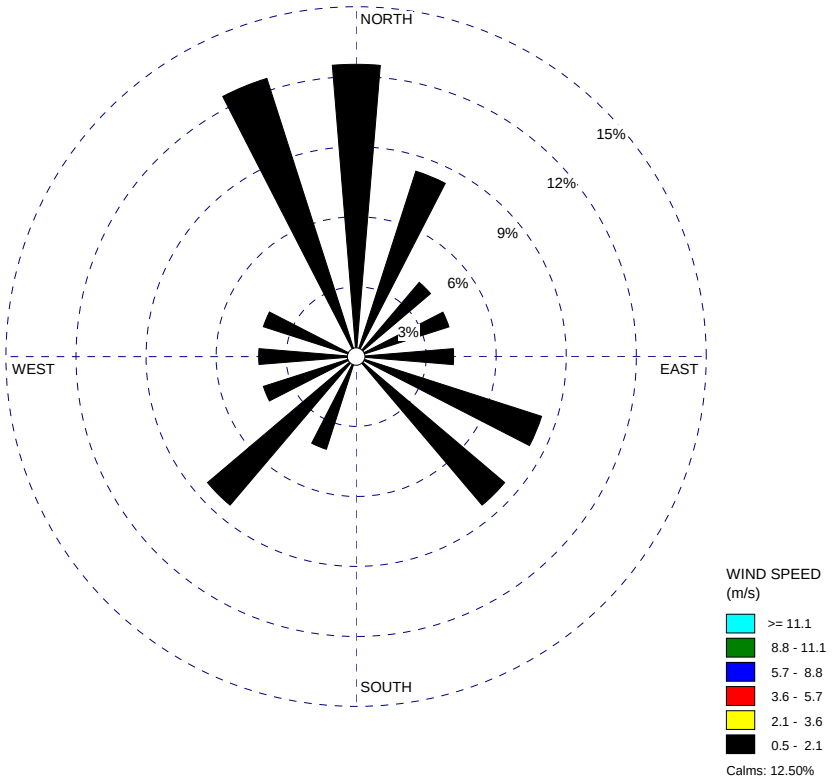
WIND ROSE PLOT:	DISPLAY:
Station # - Maricopa, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 21 - Oct 21** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **12.50%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **0.90 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

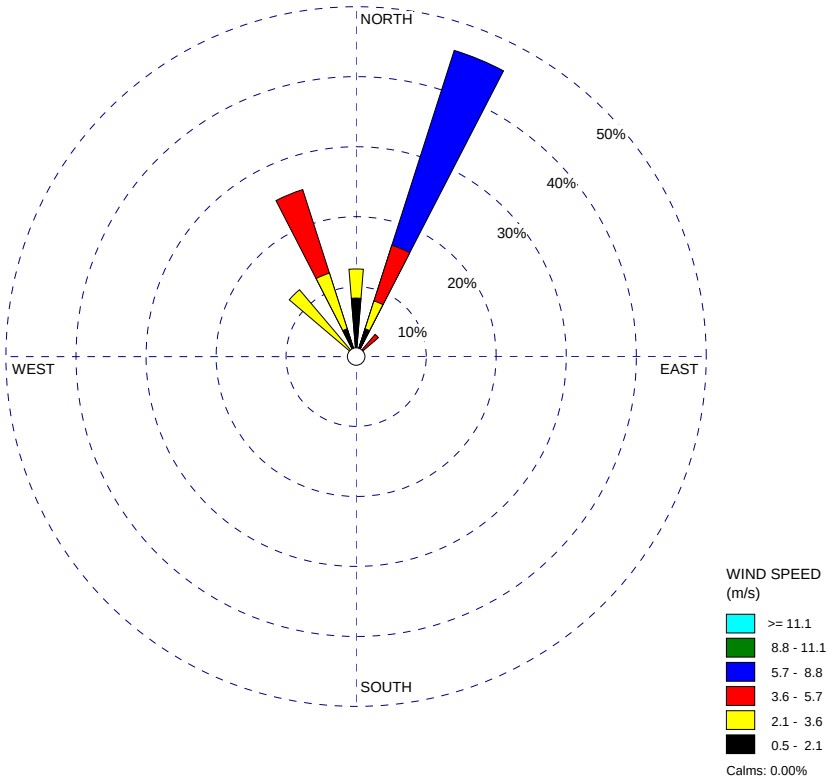
WIND ROSE PLOT:	DISPLAY:
Station # - Maricopa, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 27 - Oct 27** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **12.50%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **0.94 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

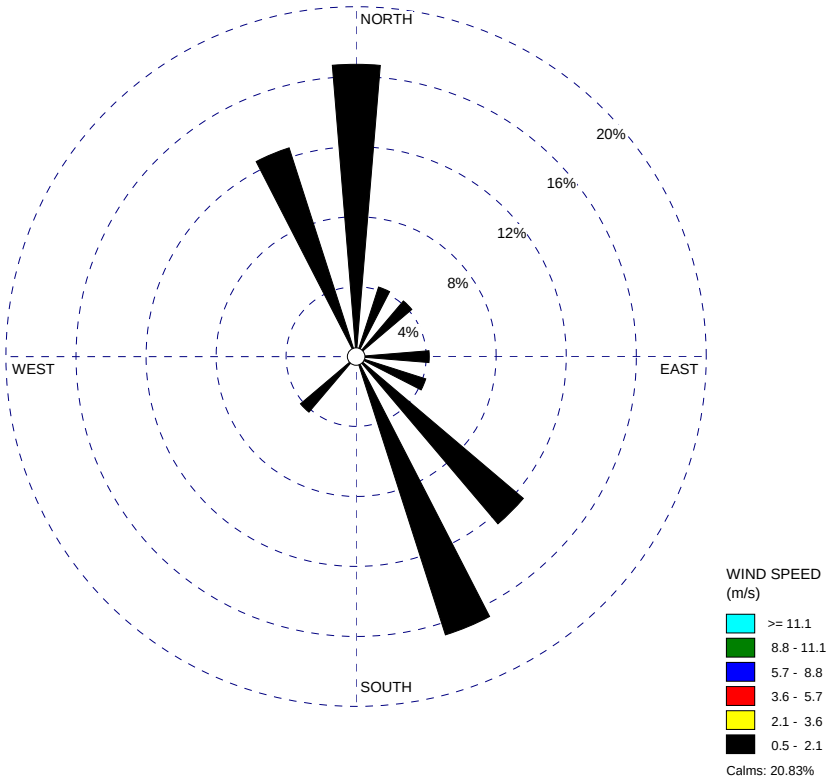
WIND ROSE PLOT:	DISPLAY:
Station # - Maricopa, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 30 - Oct 30** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **3.96 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

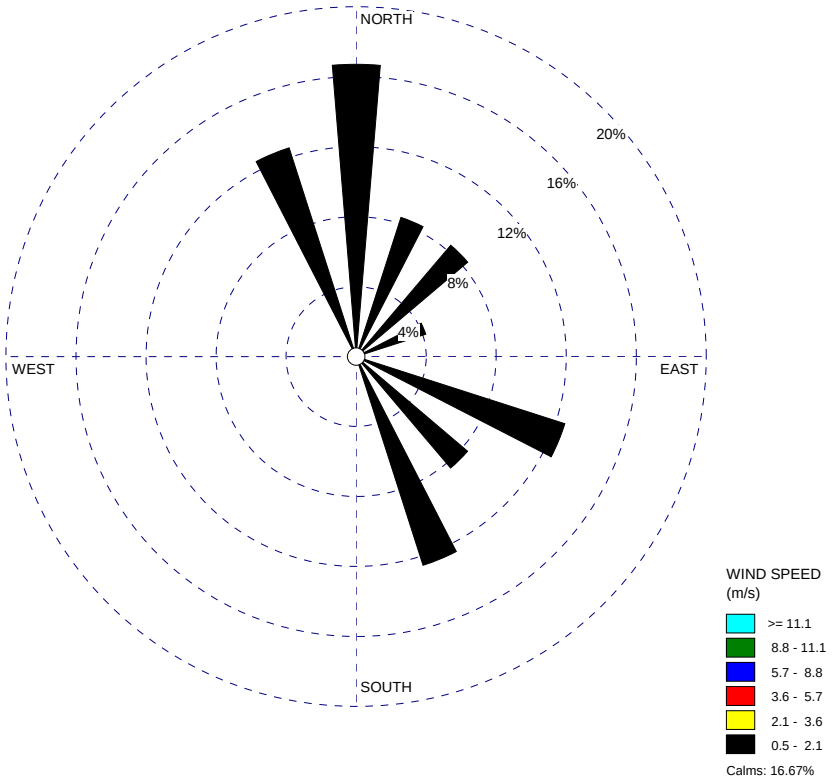
WIND ROSE PLOT:	DISPLAY:
Station # - Maricopa, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Nov 5 - Nov 5** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **20.83%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **0.84 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:	DISPLAY:
Station # - Maricopa, AZ	**Wind Speed** **Flow Vector (blowing to)**



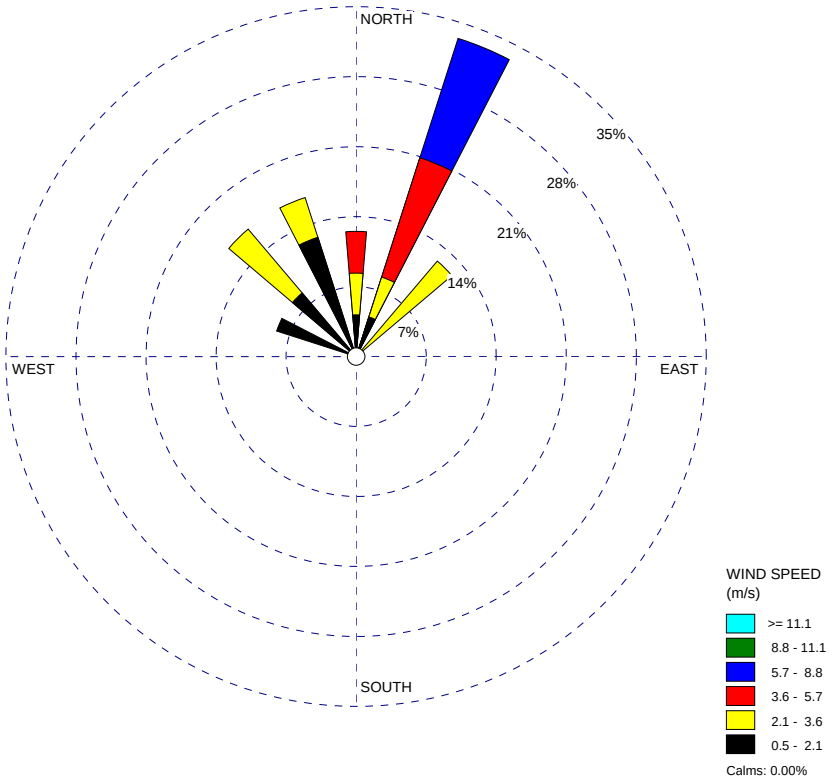
COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Nov 8 - Nov 8** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **16.67%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **0.93 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

Pinal County Housing

Wind Roses

WIND ROSE PLOT:	DISPLAY:
Station # - Pinal County Housing, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 3 - Oct 3** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **3.07 m/s**	DATE: **04/12/2005**	PROJECT NO.:

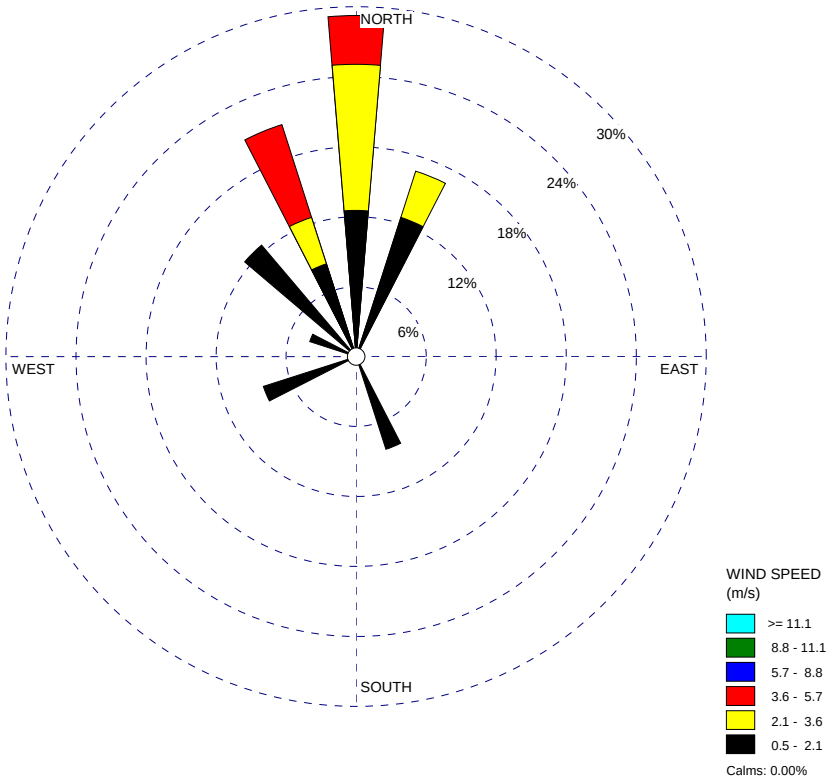
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Station # - Pinal County Housing, AZ

DISPLAY:

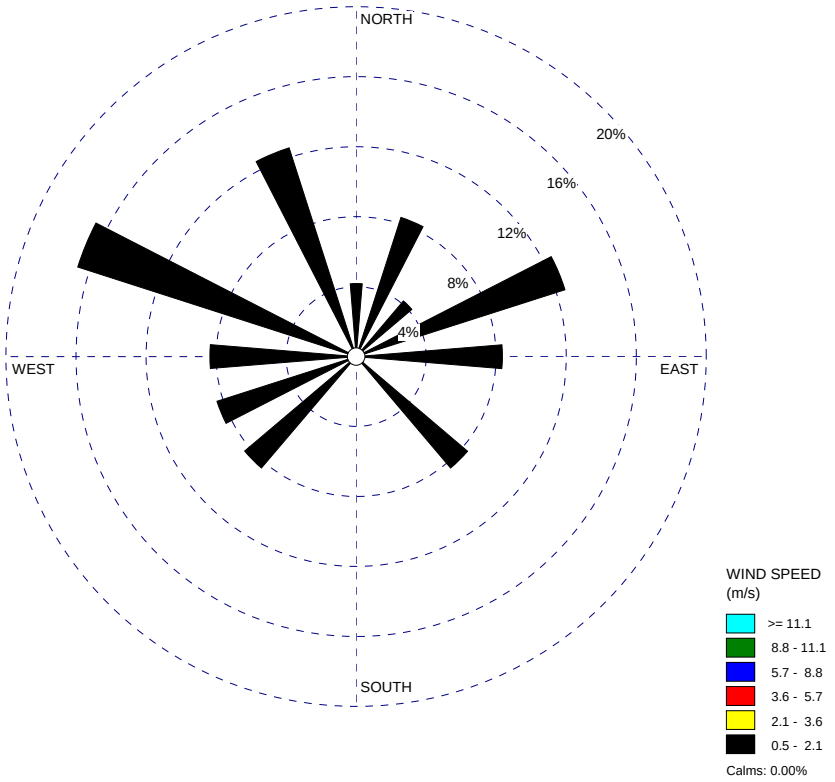
Wind Speed
Flow Vector (blowing to)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 9 - Oct 9** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.85 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

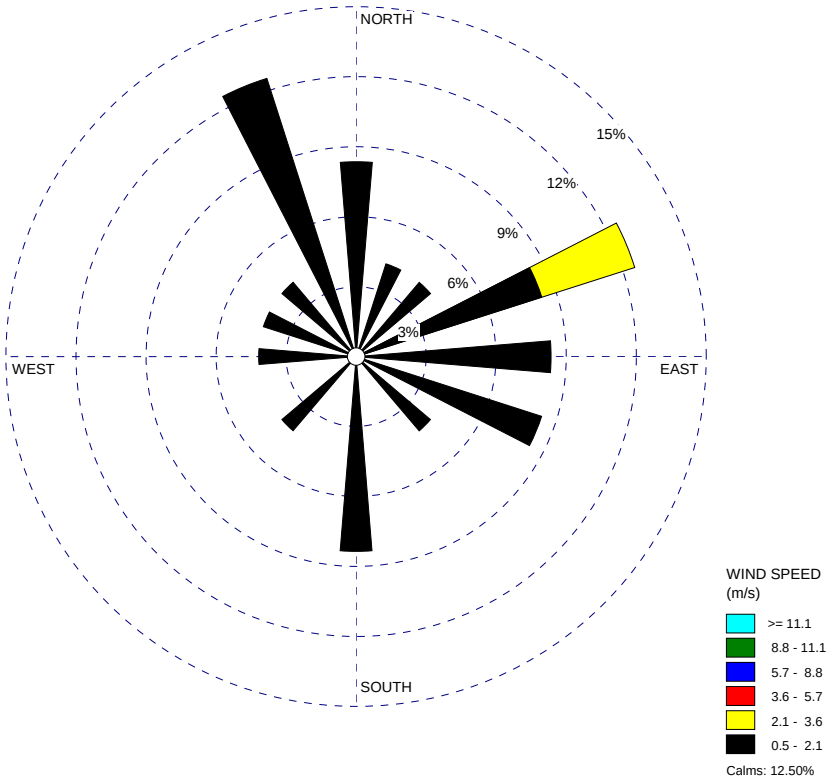
WIND ROSE PLOT:	DISPLAY:
Station # - Pinal County Housing, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 12 - Oct 12** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.19 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

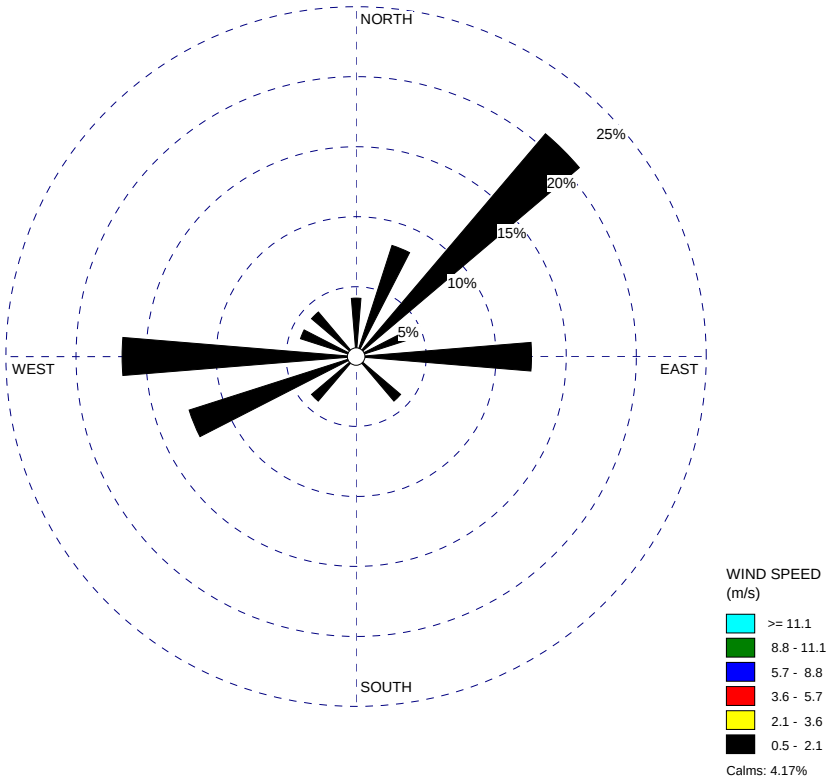
WIND ROSE PLOT:	DISPLAY:
Station # - Pinal County Housing, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 15 - Oct 15** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **12.50%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **0.95 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

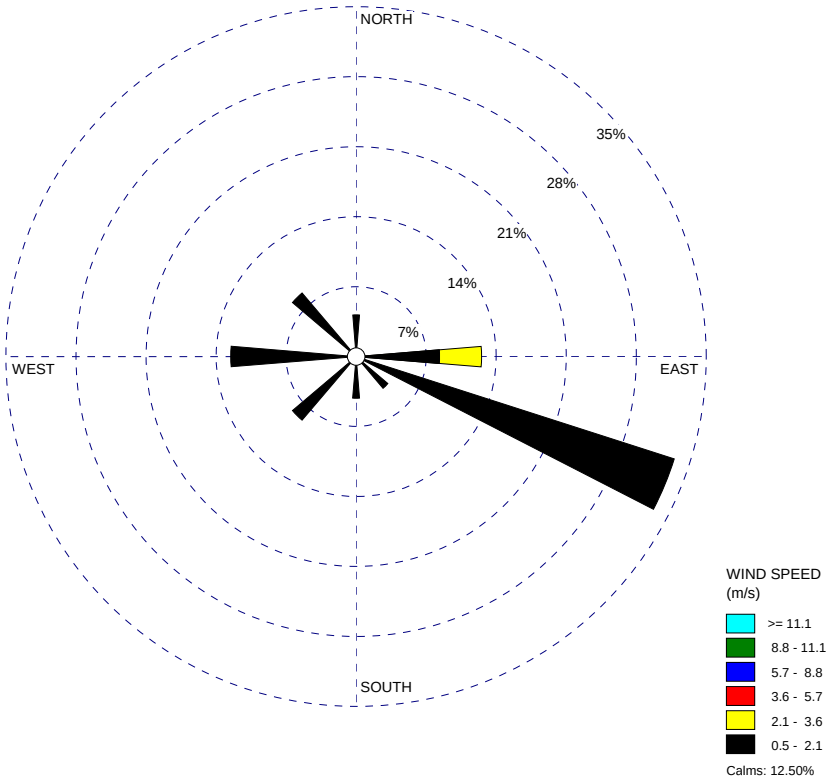
WIND ROSE PLOT:	DISPLAY:
Station # - Pinal County Housing, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 18 - Oct 18** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **4.17%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.02 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

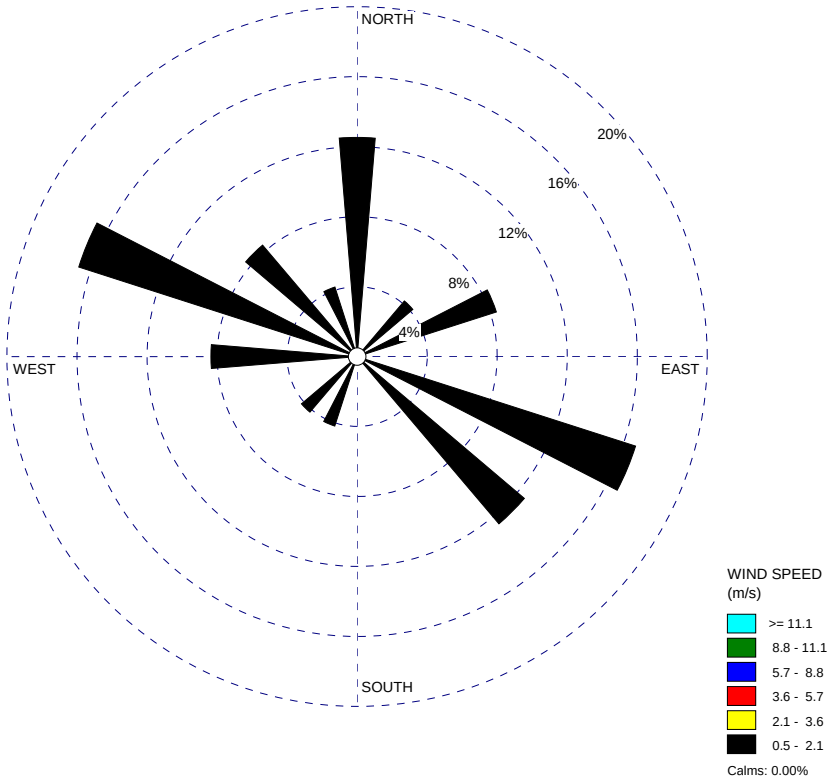
WIND ROSE PLOT:	DISPLAY:
Station # - Pinal County Housing, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 21 - Oct 21** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **12.50%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.17 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

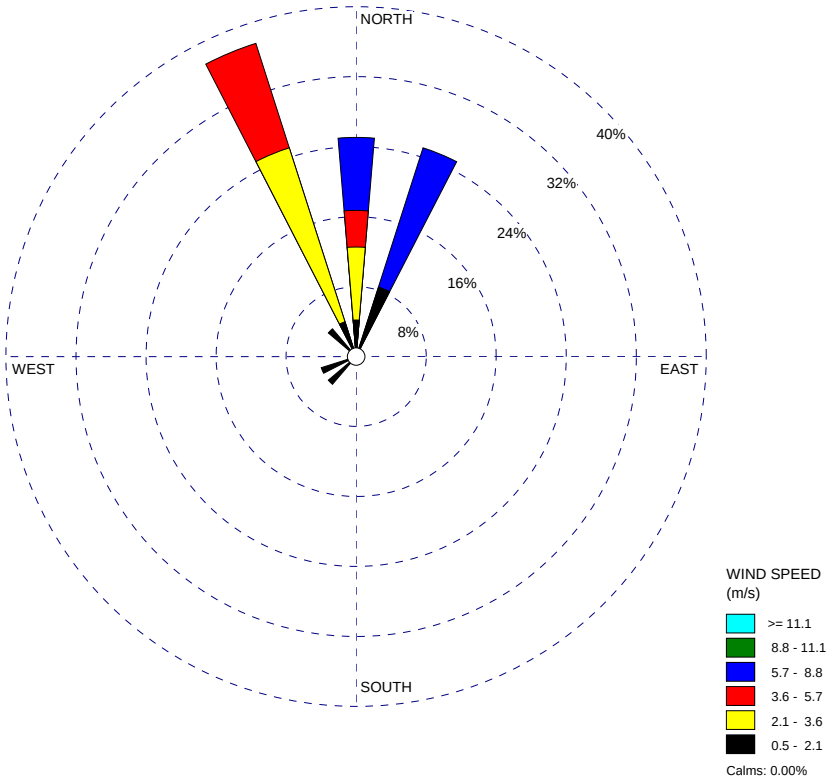
WIND ROSE PLOT:	DISPLAY:
Station # - Pinal County Housing, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 27 - Oct 27** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **1.11 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

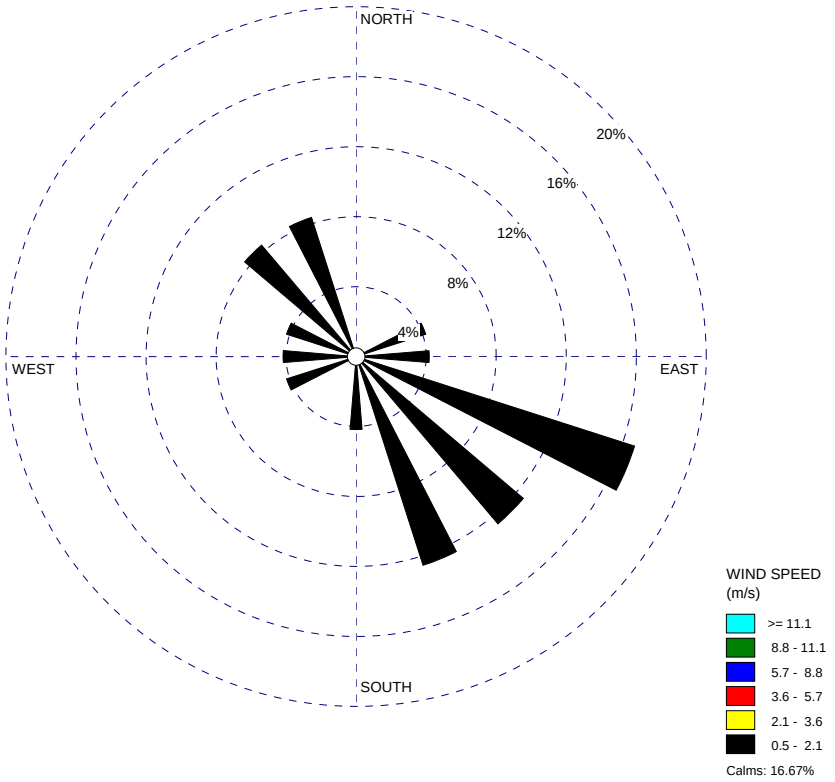
WIND ROSE PLOT:	DISPLAY:
Station # - Pinal County Housing, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Oct 30 - Oct 30** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **0.00%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **3.76 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:	DISPLAY:
Station # - Pinal County Housing, AZ	**Wind Speed** **Flow Vector (blowing to)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Nov 5 - Nov 5** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **16.67%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **0.89 m/s**	DATE: **04/12/2005**	PROJECT NO.:

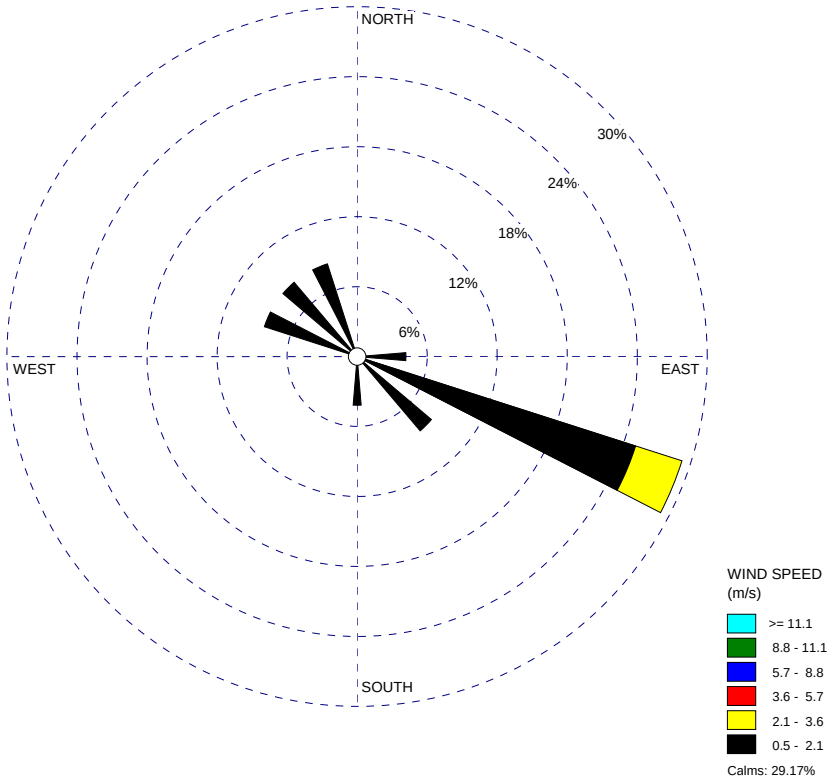
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Station # - Pinal County Housing, AZ

DISPLAY:

Wind Speed
Flow Vector (blowing to)



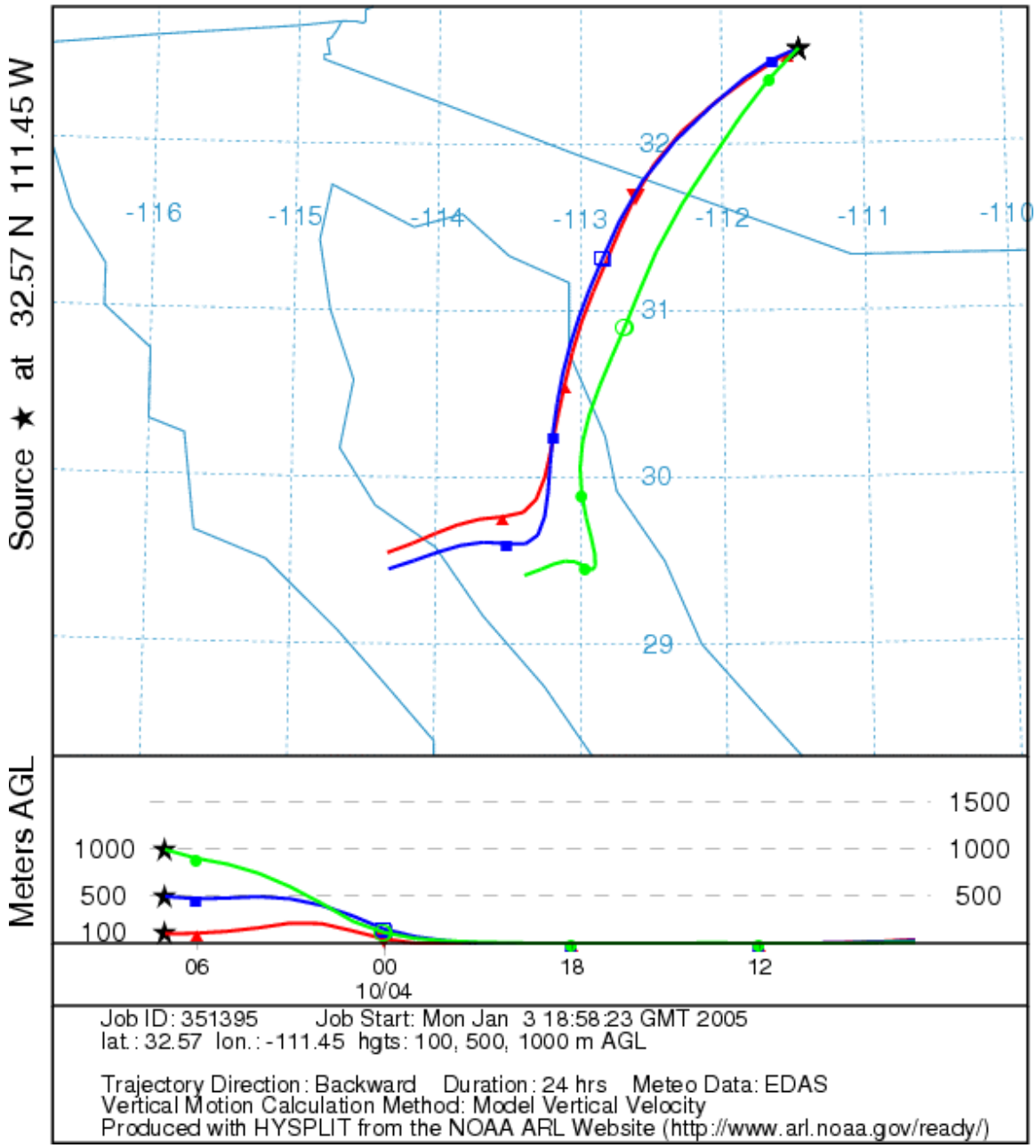
COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2003 **Nov 8 - Nov 8** **00:00 - 23:00**	**Pinal County Air Quality**	
	CALM WINDS: **29.17%**	TOTAL COUNT: **24 hrs.**	
	AVG. WIND SPEED: **0.76 m/s**	DATE: **04/12/2005**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

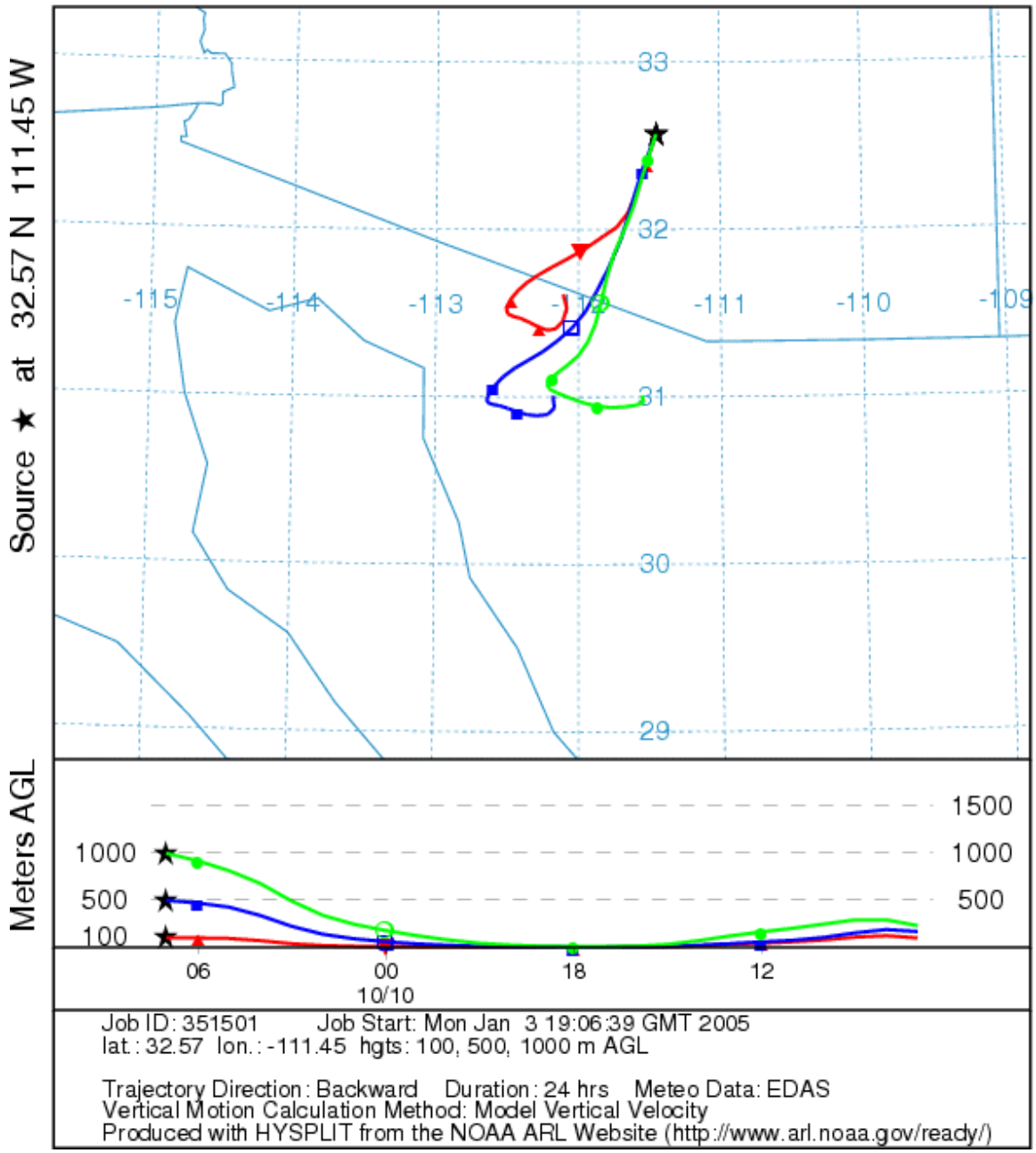
Appendix D-2

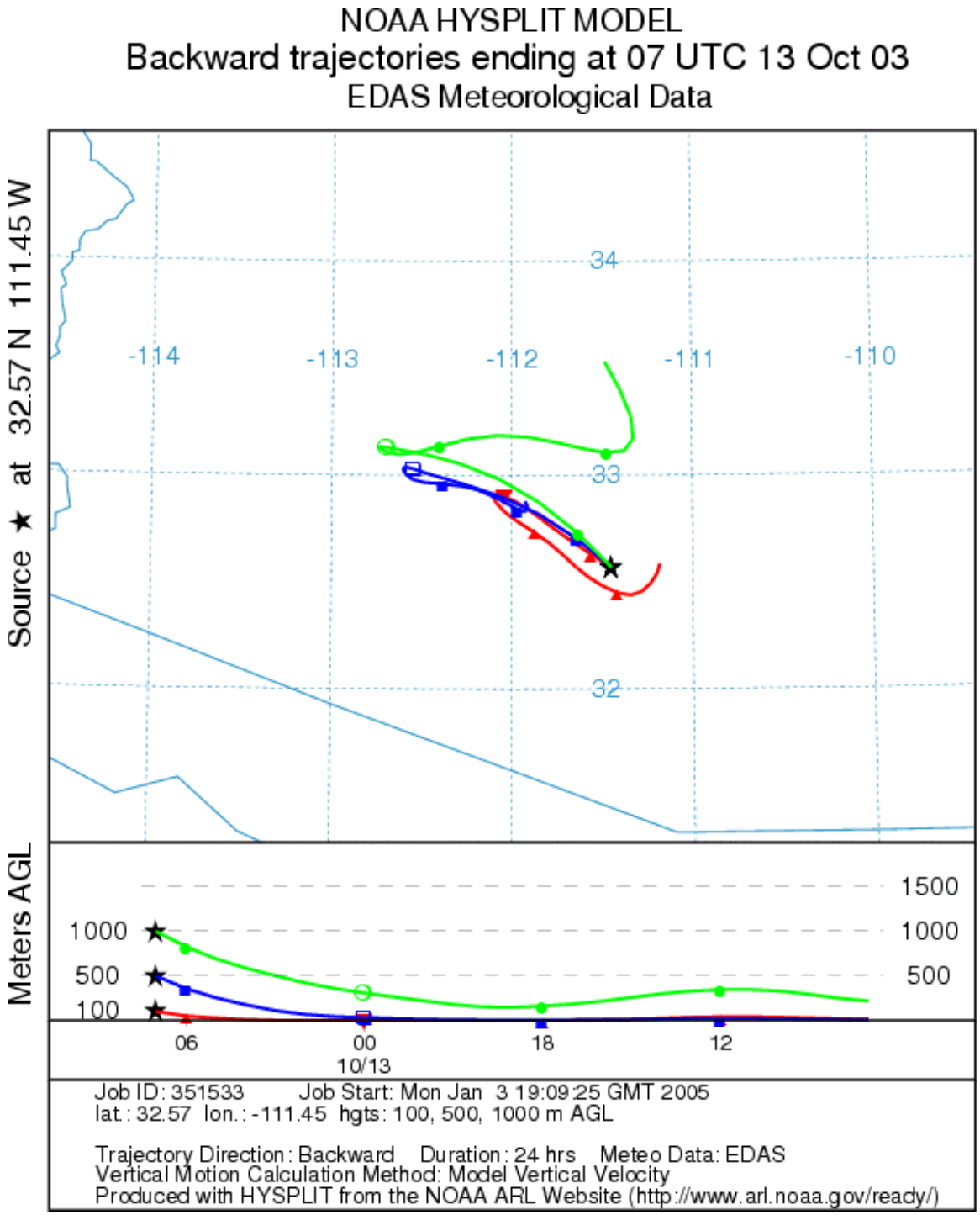
HYSPLIT Analysis

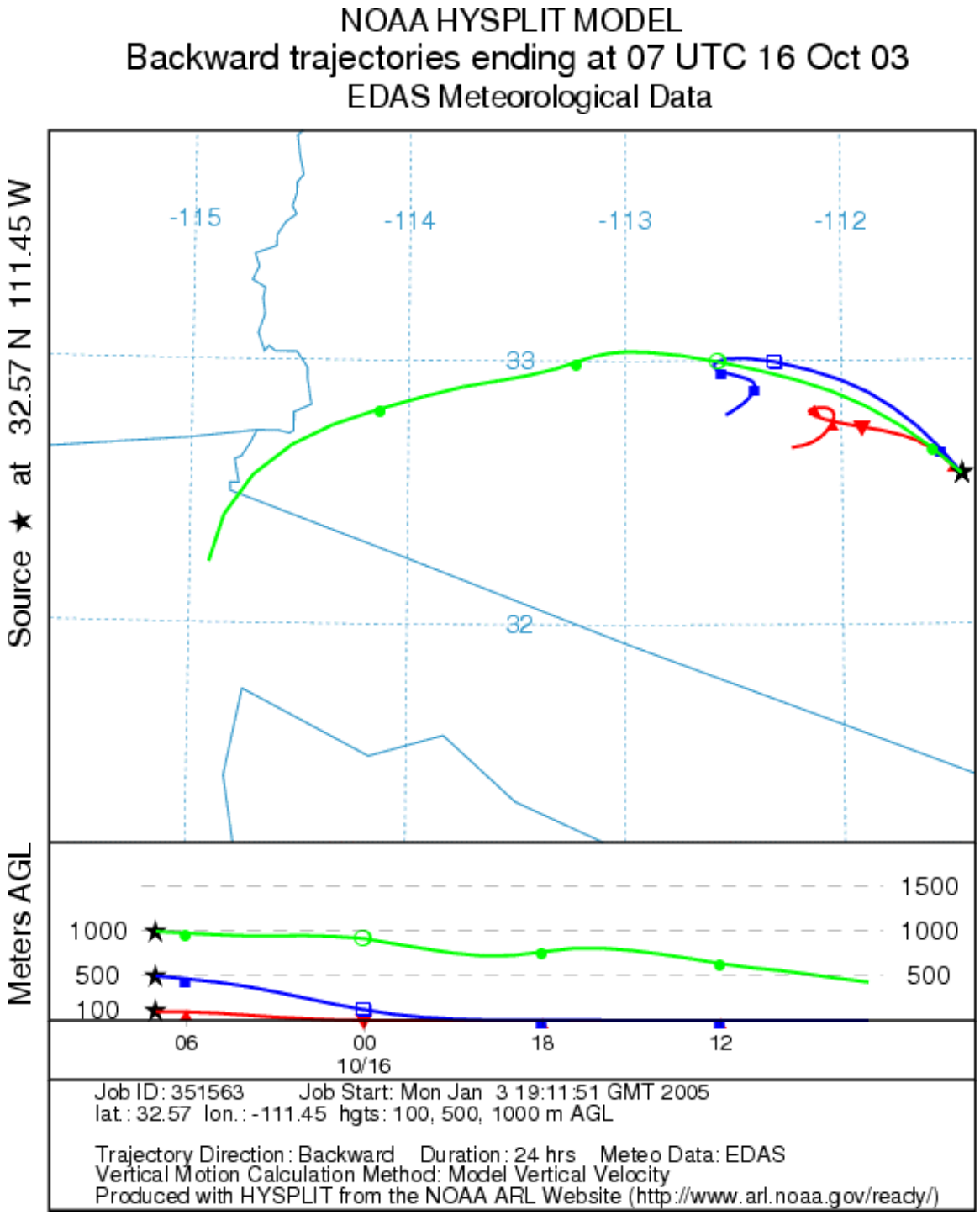
NOAA HYSPLIT MODEL
Backward trajectories ending at 07 UTC 04 Oct 03
EDAS Meteorological Data



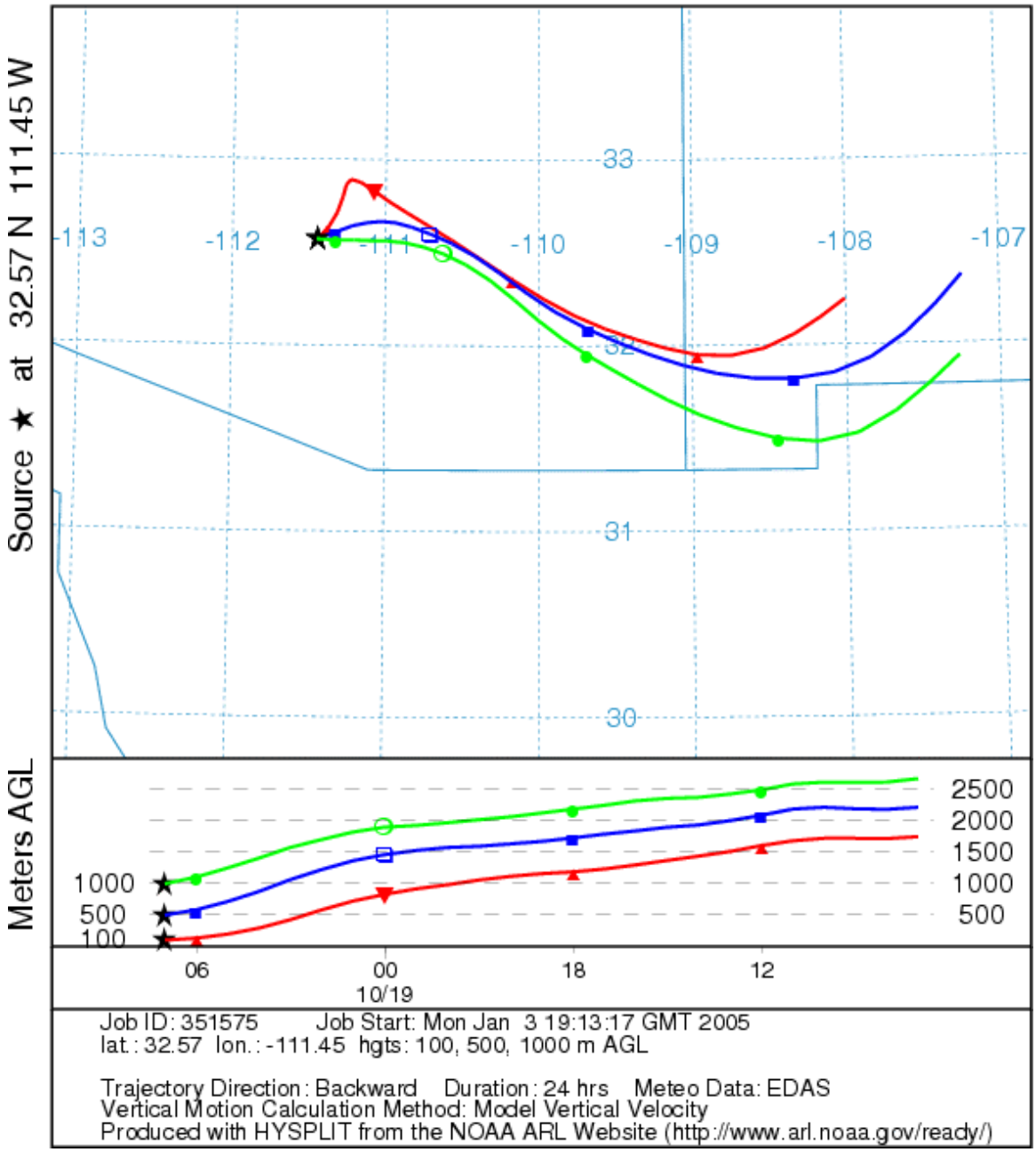
NOAA HYSPLIT MODEL
Backward trajectories ending at 07 UTC 10 Oct 03
EDAS Meteorological Data



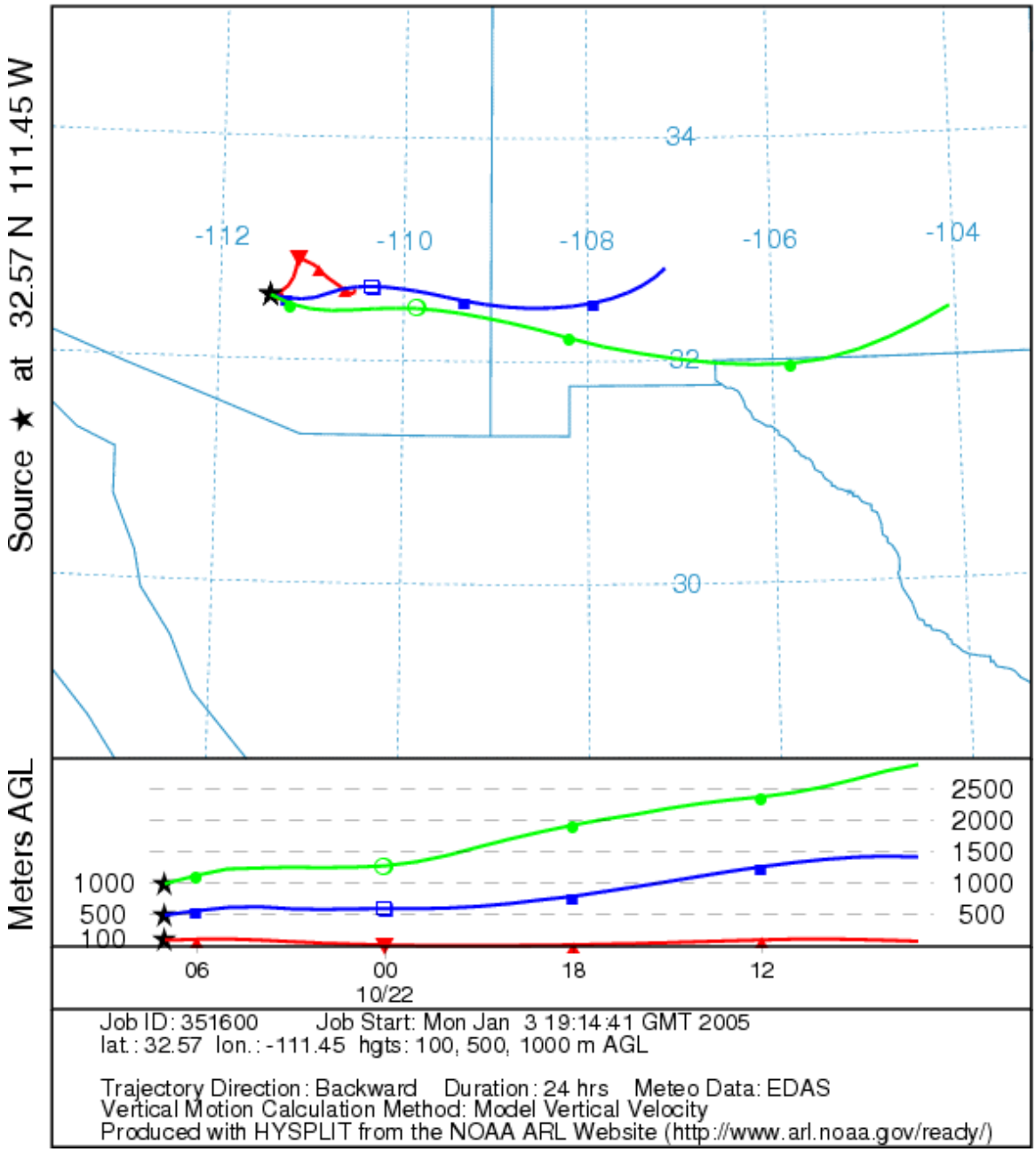

NOAA HYSPLIT MODEL
Backward trajectories ending at 07 UTC 13 Oct 03
EDAS Meteorological Data
Source ★ at 32.57 N 111.45 W
34
33
32
-114
-113
-112
-111
-110
Meters AGL
1500
1000
500
1000
500
100
06
00
10/13
18
12
Job ID: 351533 Job Start: Mon Jan 3 19:09:25 GMT 2005
lat.: 32.57 lon.: -111.45 hgts: 100, 500, 1000 m AGL
Trajectory Direction: Backward Duration: 24 hrs Meteo Data: EDAS
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

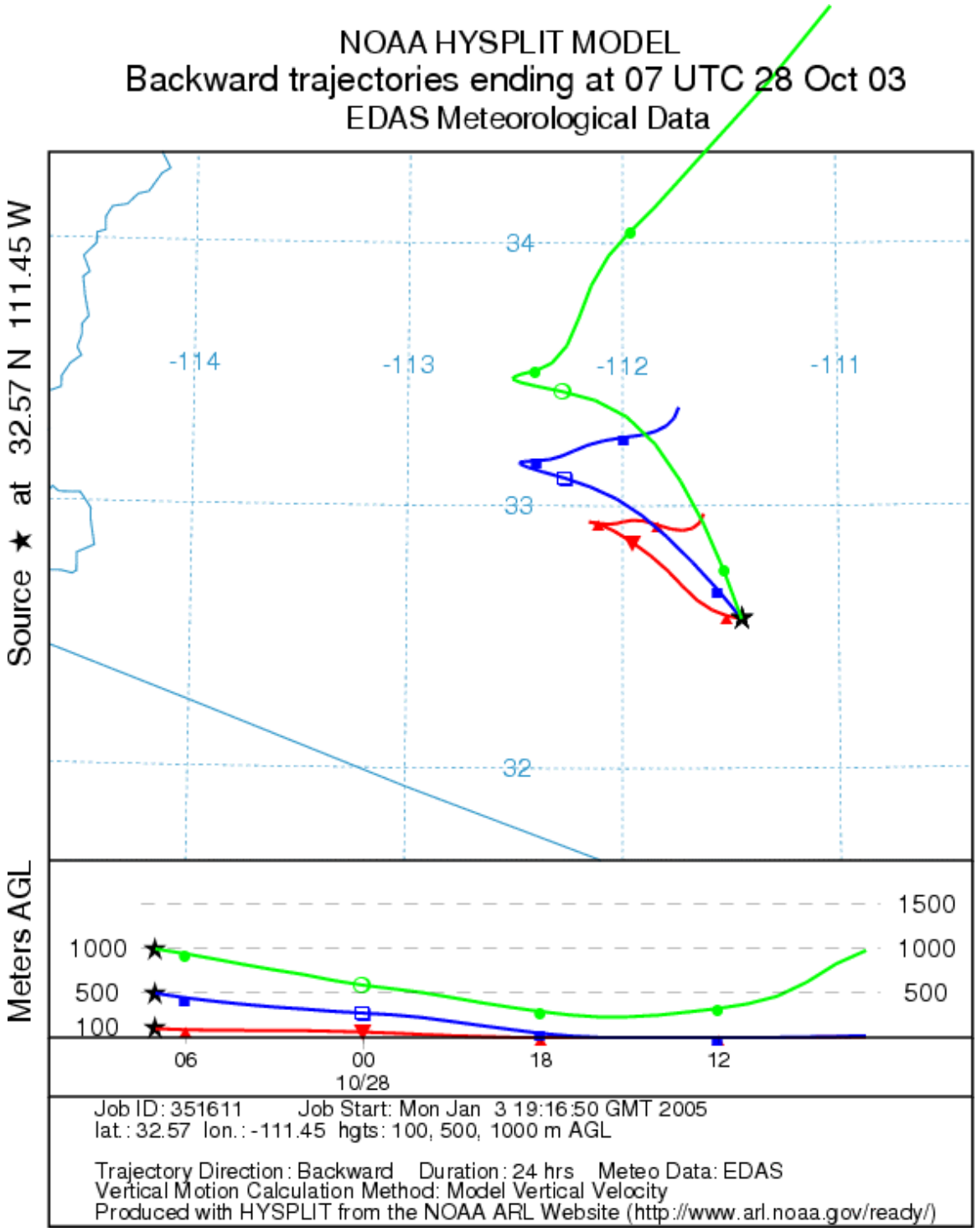

NOAA HYSPLIT MODEL
Backward trajectories ending at 07 UTC 16 Oct 03
EDAS Meteorological Data
Source ★ at 32.57 N 111.45 W
-115
-114
-113
-112
33
32
Meters AGL
1500
1000
500
1000
500
100
06
00
10/16
18
12
Job ID: 351563 Job Start: Mon Jan 3 19:11:51 GMT 2005
lat.: 32.57 lon.: -111.45 hgts: 100, 500, 1000 m AGL
Trajectory Direction: Backward Duration: 24 hrs Meteo Data: EDAS
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

NOAA HYSPLIT MODEL
Backward trajectories ending at 07 UTC 19 Oct 03
EDAS Meteorological Data

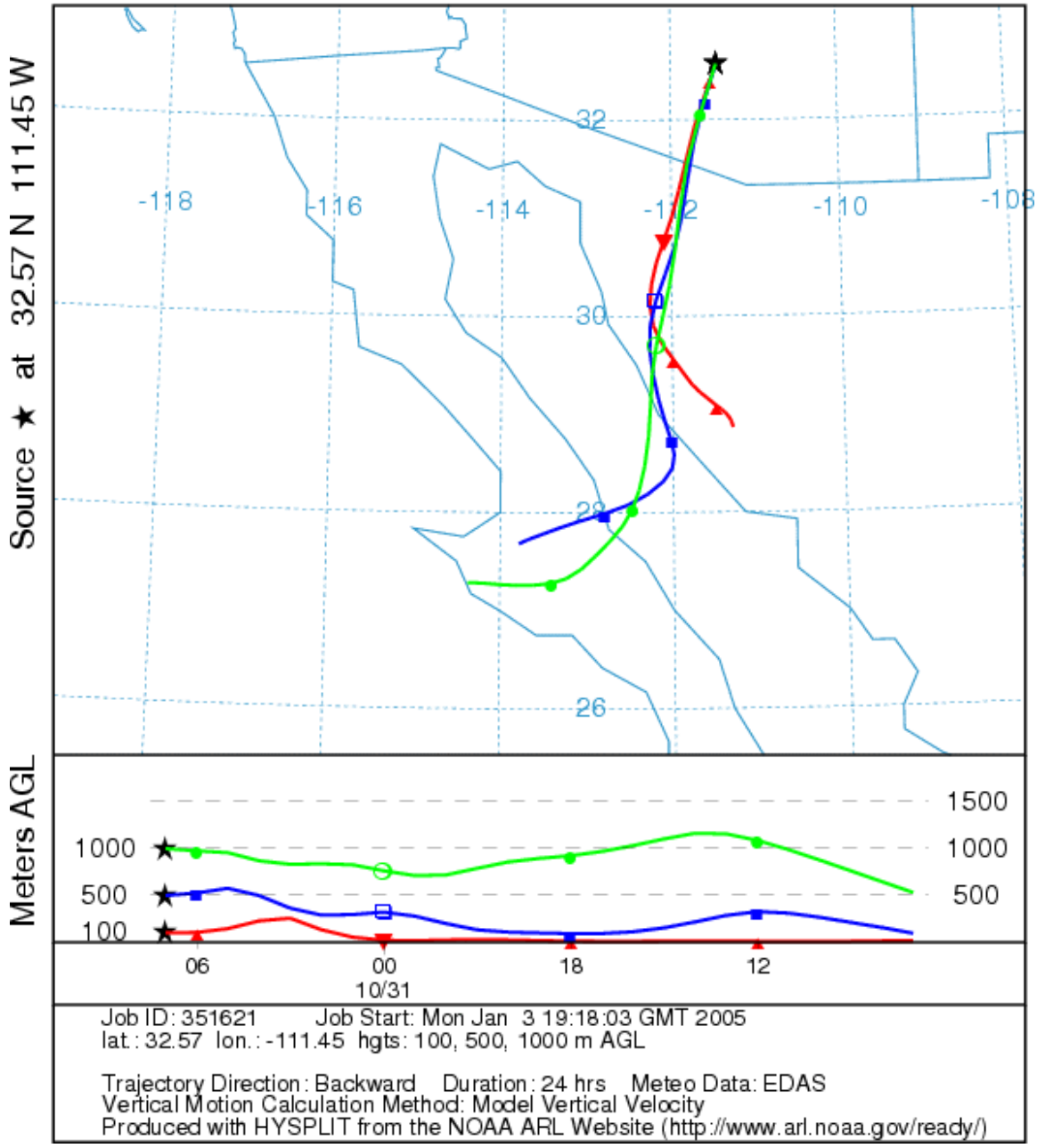


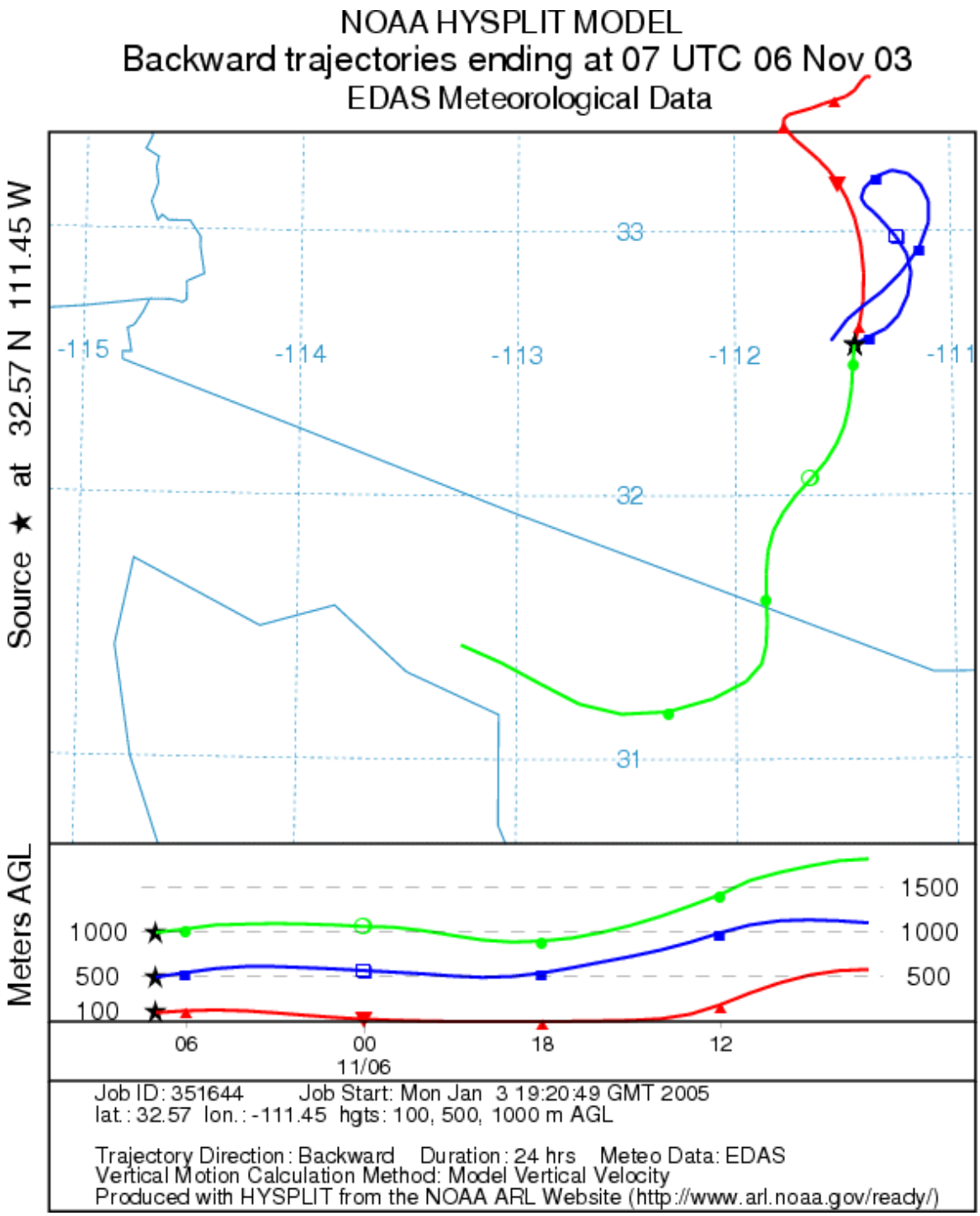
NOAA HYSPLIT MODEL
Backward trajectories ending at 07 UTC 22 Oct 03
EDAS Meteorological Data



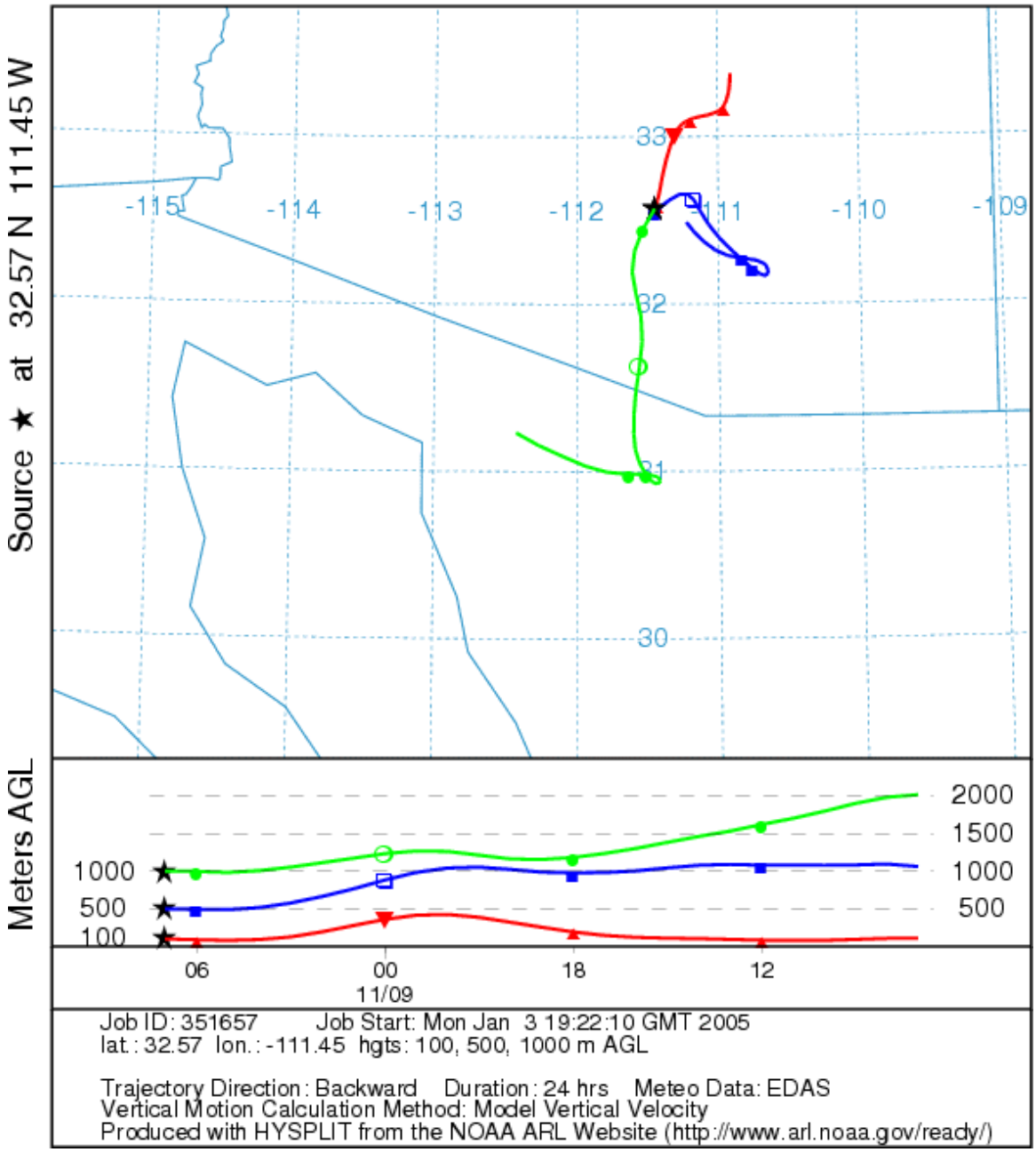

NOAA HYSPLIT MODEL
Backward trajectories ending at 07 UTC 28 Oct 03
EDAS Meteorological Data
Source ★ at 32.57 N 111.45 W
34
33
32
-114
-113
-112
-111
Meters AGL
1500
1000
500
1000
500
100
06
00
10/28
18
12
Job ID: 351611 Job Start: Mon Jan 3 19:16:50 GMT 2005
lat.: 32.57 lon.: -111.45 hgts: 100, 500, 1000 m AGL
Trajectory Direction: Backward Duration: 24 hrs Meteo Data: EDAS
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

NOAA HYSPLIT MODEL
Backward trajectories ending at 07 UTC 31 Oct 03
EDAS Meteorological Data




NOAA HYSPLIT MODEL
Backward trajectories ending at 07 UTC 06 Nov 03
EDAS Meteorological Data
Source ★ at 32.57 N 111.45 W
33
32
31
-115
-114
-113
-112
-111
Meters AGL
1500
1000
500
1000
500
100
06
00
11/06
18
12
Job ID: 351644 Job Start: Mon Jan 3 19:20:49 GMT 2005
lat.: 32.57 lon.: -111.45 hgts: 100, 500, 1000 m AGL
Trajectory Direction: Backward Duration: 24 hrs Meteo Data: EDAS
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

NOAA HYSPLIT MODEL
Backward trajectories ending at 07 UTC 09 Nov 03
EDAS Meteorological Data



Appendix E

Road Counts

Road Count Totals

Table 4-1

Road Name and location of the count	Road Surface Type	Dates on which the count took place	Average number of cars per day
Hartman Road 0.1 mile north of Casa Grande – Maricopa Highway	Dirt	9/26/2003 thru 10/3/03	96
Farrell Road 0.9 mile east of White and Parker Road	Dirt	10/3/2003 thru 10/10/03	134
White and Parker Road 0.1 mile north of Casa Grande – Maricopa Highway	Dirt	10/14/2003 thru 10/21/2003	343
Casa Grande – Maricopa Highway 0.1 mile east of White and Parker Road	Paved	10/28/2003 thru 11/4/2003	2717
Cowtown Road 0.1 mile west of Hartman Road	Dirt	11/7/2003 thru 11/14/2003	146

Appendix F

Acronyms

Acronyms Used in this Document

ADEQ – Arizona Department of Environmental Quality

AZMET - Arizona Meteorological Network (University of Arizona Cooperative Extension)

CFR – Code of Federal Regulations

CMB – Chemical Mass Balance

^{o}C – degrees of temperature in Celsius

DRI – Desert Research Institute

EC – Elemental Carbon

EPA – United States Environmental Protection Agency

FRM – Federal Reference Method

Hi-Vol – High Volume particulate matter sampler

HYSPLIT – Hybrid Single-Particle Lagrangian Integrated Trajectory

L/min – Liters per minute

MCAQD – Maricopa County Air Quality Department

Mini-Vol – Airmetrics low volume particulate matter sampler

mmHg – Millimeters of mercury

NEIP – Natural Events Initiative Plan

NAAQS – National Ambient Air Quality Standards

OC – Organic Carbon

OPT – Optical Pyrolyis by Thermal/Optical Reflectance

NOOA – National Oceanic and Atmospheric Administration

PCAQCD – Pinal County Air Quality Control District

PM_{10} - Particulate Matter less than 10 microns

$PM_{2.5}$ - Particulate Matter less than 2.5 microns

TEOM – Tapered Element Oscillating Microbalance

TC – Total Carbon

μg – Micrograms

$\mu g/m^3$ – Micrograms per cubic meter