APPENDIX A

Inventory Preparation Plan

Report No. SR2013-01-01

Pinal County
PM Inventory Preparation Plan

Prepared for

Arizona Department of Environmental Quality

February 11, 2013

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1. INTRODUCTION

On February 3, 2011, the U.S. Environmental Protection Agency (U.S. EPA) designated the central portion of Pinal County as nonattainment for the 24-hour PM2.5 National Ambient Air Quality Standard (NAAQS), and designated the same area as attainment or unclassified for the annual PM2.5 NAAQS.[1] The rationale for the latter designation was based on the finding that the single monitoring site exceeding the annual standard, Cowtown, was a population-oriented microscale (i.e., localized hot spot) monitor that was not eligible for designation as a nonattainment site for the annual standard. On May 31, 2012, U.S. EPA designated a somewhat larger portion of central Pinal County as nonattainment for the 24-hour PM10 NAAQS.[2] The annual PM10 NAAQS was revoked by U.S. EPA on October 17, 2006. As a result of these decisions, the attainment demonstration for both PM2.5 and PM10 in Pinal County must be based on ambient air quality conditions and contributing emissions on specific design days.

A nonattainment designation reflects monitored airborne pollutant concentrations that exceed the prevailing standard. A nonattainment designation requires a curative amendment to the State Implementation Plan, configured to reduce concentrations below the standard. For purposes of developing that plan, emission inventories define the sources of the offending pollutant. Inventories constitute the practical and regulatory foundation for a plan amendment. Long-term and short-term inventories serve different primary functions. First, an annual inventory defines which sources generate long-term emissions of PM10 across the entire nonattainment area. That general understanding provides the factual basis for discussions regarding long-term emission trends based on changes in underlying activity rates and the impacts of control strategy implementation. In addition, an annual on-road emission inventory is required in order to define an annual emissions budget for transportation planning. Second, attainment demonstrations for the 24-hour PM10 NAAQS require modeling inventories defining the local, short-term emissions that caused specific violations of the 24-hour standard. This document defines a plan for developing those inventories.

Through discussions between U.S. EPA, the Arizona Department of Environmental Quality (ADEQ), and the Pinal County Air Quality Control District (PCAQCD), a base year of 2008 was selected for the preparation of an emission inventory and an attainment demonstration. This is the year of the most recent triennial National Emission Inventory prepared by ADEQ and PCAQCD and approved by U.S. EPA. The EPA implementation rule for preparation of PM2.5 State Implementation Plans (SIP) requires the use of this

[1] Federal Register, Vol. 76, No. 23, Thursday, February 3, 2011
[2] Federal Register, Vol. 77, No. 105, Thursday, May 31, 2012

most recent year for which a complete inventory was required to be submitted to EPA.[3] During 2008, exceedances of the 24-hour PM2.5 NAAQS were recorded at Cowtown; exceedances of the 24-hour PM10 NAAQS were recorded at Maricopa, Cowtown, Stanfield, Casa Grande, Combs School, and Pinal County Housing. At each of these latter sites, continuously recording TEOMs are used to record hourly averaged PM10 ambient concentrations. At the Cowtown site, a filter-based instrument is used to record 24-hour average PM2.5 concentrations.

To support the preparation of PM2.5 and PM10 State Implementation Plans (SIPs), ADEQ commissioned the preparation of an Inventory Preparation Plan (IPP) and an emission inventory based on the IPP. The Plan identifies key requirements, procedures, and data sources to be used in preparing emission inventories for the nonattainment area and for the modeling domains of monitors selected to represent exceedance conditions within the nonattainment area. Standard elements of an IPP include the presentation of EPA guidance and related requirements, a summary of the sources to be addressed and those not to be included, documentation of the procedures to be followed in computing emissions, data sources available to characterize activity and emission factors, local conditions affecting emissions, and quality control procedures to be followed.

To provide a better understanding of the conditions influencing fugitive dust production in the nonattainment area, additional tasks were undertaken (1) to gauge the influence of local versus regional emission sources impacting nonattainment monitors and (2) to select design days and modeling domains of monitors representative of exceedance conditions. Presented below is a summary of EPA guidance on IPP development.

1.1 Emission Inventory Guidance

EPA emission inventory guidance is summarized at the Clearinghouse for Inventories and Emission Factors (CHIEF) website. Guidance for the development of PM10 and PM2.5 emission inventories is available from the documents listed below.

- *PM-10 Emission Inventory Requirements*[4]
- *Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations*[5]
- *1996 Air Quality Criteria for Particulate Matter, Vol. 1*[6]

[3] Federal Register, Vol. 72, No. 79, Wednesday, April 25, 2007
[4] *http://www.epa.gov/ttn/chief/eidocs/PM10eir.pdf*
[5] *http://www.epa.gov/ttn/chief/eiinformation.html*
[6] 1996 Air Quality Criteria for Particulate Matter, Vol. 1, EPA/600/P-95-001aF, (Washington, D.C.: U.S. Environmental Protection Agency, April 1996), Sections 5.2.1, 5.5.1, and 5.5.3

For PM10 nonattainment areas, EPA identifies three basic kinds of inventories that States may need to develop under the CAA: base year inventories, periodic inventories, and modeling inventories. Presented below is EPA's description of the information required for each of the inventory submittals and related IPP requirements.

Base Year Inventory – This is the primary inventory from which all other inventories are derived. All inventories are required to be consistent with data provided in the base year inventory. Section 172(c)(3) of the CAA requires States to ensure that this inventory is comprehensive, accurate, and current for all actual emissions of PM10. The base year inventory must include emissions from all point, area, and mobile sources.

Periodic Emissions Inventory – The CAA states that the emission inventories may be periodically updated as deemed necessary by the Administrator. A periodic inventory may be the consequence of RFP requirements, a maintenance plan for an attainment area, or for other reasons deemed necessary by EPA. The Administrator has determined that states should submit statewide annual and three-year cycle inventories for PM10 and PM2.5.[7]

Modeling Emissions Inventory – The modeling emissions inventory may be used as a tool for a number of purposes, including model performance evaluations, projection to future years, evaluation of the impact of rulemaking, evaluation of control measures and technology, receptor modeling reconciliation, and determination of design concentrations. One of the major roles for modeling inventories is for use in attainment demonstrations. Modeling inventories can be based upon either allowable or actual emissions, depending on the purpose of the modeling. For instance, modeling inventories should be based on the actual daily emissions for model performance evaluation. For control measure evaluations and the attainment demonstration, the modeling emission inventory should consist of allowable emissions for the base year and projected allowable emissions for the attainment year. The phrase "allowable emissions" is a term of art related to permitting and modeling the impacts of stationary sources. The bulk of emissions here are fugitive emissions that are not subject to a stationary source permitting program—for those emissions, base year "allowable emissions" are actual emissions and attainment year "allowable emissions" will reflect base year actual emissions adjusted for the projected control efficiencies of emission reduction measure commitments.

As will be discussed later in this Plan, the emissions inventories to be used in attainment demonstrations will be design-day-specific and specific to the modeling domains computed separately for each design day and monitoring site. None of the modeling domains covers either the entire central Pinal County PM10 or PM2.5 nonattainment areas. At least under stagnation and moderate wind conditions, the spatial and temporal variability in PM10 and PM2.5 exceedances demonstrates that sources within a few miles of each violating monitor are responsible for exceedances, not the totality of sources contained within the boundaries of the nonattainment areas. However, to the extent that land utilization patterns are relatively homogenous across the relevant area, modeling

[7] Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations, EPA-454/R-05-001, August 2005, *http://www.epa.gov/ttn/chief/eidocs/eiguid/eiguidfinal_nov2005.pdf*

inventory analyses are expected to fairly represent similar conditions across the nonattainment area. As a result, emission inventory preparation under this plan will focus on the modeling needs of the various attainment demonstrations, and inventory improvements developed in these domains will be extended to the applicable source categories in the baseline inventories for the two nonattainment areas. However, lower priority will be given under this Plan to improving other emission inventory categories in the nonattainment area baselines that do not benefit the modeling domain inventories.

IPP Requirements – For base year inventories, EPA requires States to prepare a brief IPP that specifies how they intend to develop, document, and submit their inventories. The plans provide States the opportunity to notify EPA how they plan to compile the required inventories and to allow EPA to provide important feedback to prevent the use of approaches that are not consistent with the EPA requirements.

In addition to technical data, the IPPs should contain a schedule showing when the State plans to submit the draft and final inventories to EPA. If the State plans to submit an inventory in component pieces (e.g., point source component, area source component, etc.), the IPP must clearly make this distinction and indicate draft and final submittal dates for each component. The final submittal dates should be consistent with the PM10 emission inventory requirements. A complete draft inventory is required to be submitted to the EPA Regional Offices and the EPA headquarters within 12 months after the date that an area is designated nonattainment. The IPP is also required to detail the year chosen as the base year for the inventory, and explain the basis for the selection.

Source Category Requirements – States are required to define how all pertinent emission sources will be identified and located.

Point Sources – States are required to describe how point source activity levels and associated parameters will be developed, and how these data will be used to calculate emission estimates. States must also discuss how and when statewide point source reporting to the EPA will be conducted and how it will be coordinated with reporting for area and mobile sources. States must indicate whether rule effectiveness was applied and, if it was, the basis for determining control efficiencies. States must describe any source surveys that are planned, and if they intend to use existing data contained in the Emissions Inventory System (EIS), individual State emissions systems, or State permitting files.

Area and Mobile Sources – States must explicitly identify in the IPP which source categories will be addressed and which will not be addressed (with justification for exclusion). For included categories, the plan must indicate what calculation methods will be used to estimate emissions. If a State plans on using EPA's inventory guidance for all categories, the IPP must summarize the EPA guidance and contain reference(s) for the guidance. If the EPA guidance offers alternative methods for a category, the IPP shall clearly indicate which method the State intends to use in its inventory. Particular emphasis shall be given to categories for which the State plans to use an approach other than that recommended in the EPA guidance. Any major assumptions that may affect the development of emission estimates in a category must be clearly stated. The IPP must

also identify the sources of activity data, whether rule effectiveness will be applied (and how it was determined if applied), and the basis for determining control efficiencies.

For on-road mobile sources, the IPP must include a discussion of how the State intends to develop vehicle miles traveled (VMT) estimates, and how PM10 emission factors for mobile sources will be determined. EPA's original guidance required the use of a mobile source particulate model (PART5), which has been superseded by AP-42 guidance for paved and unpaved roads.

The IPP must also clearly describe how the State plans to present, document, and submit the inventory to the EPA. The types of documentation that will be provided and the form of this documentation must be described to the extent that EPA can judge if it would be satisfactory for inventory review purposes. The IPP shall specify the written and computerized methods that the State plans to use to compile and submit its emission data. The State must contact its EPA Regional Office to determine computerized data submittal and format requirements, and must describe in its IPP how its data system (e.g., AIRS, State system) will be used to submit the data to EPA.

States are required to submit Quality Assurance (QA) plans as an initial step in their inventory development work and receive EPA approval on their plans early on in the process. The QA plans must be submitted as part of a State's IPP. The content and general form of QA plans must be consistent with previously issued guidance. This plan shall describe the overall QA program that the State intends to use during the compilation of the inventory.

In summary, PM10 IPPs are required to be concise, and provide only as much detail as is necessary to communicate to the agency how the State intends to develop and present its inventory. However, the document must contain sufficient information to enable the EPA to make a judgment that the State's intended inventory approach is sound and consistent with EPA's guidance and requirements.

For PM2.5 nonattainment areas, the guidance is rather general and stresses the need to begin with a description of inventory objectives (e.g., geographic area covered, base year, pollutants included, temporal resolution, etc.). It states that the IPP should contain the following sections that address portions of the inventory:

- Introduction,
- Point Source Inventory,
- Area Source Inventory,
- Nonroad Mobile Source Inventory,
- Mobile Source Inventory,
- Biogenic Source Inventory,
- Documentation Approach, and
- Quality Assurance Plan.

The primary source of guidance referenced for developing an Inventory Preparation Plan (IPP) and related Quality Assurance Plan (QAP) is EPA's Emissions Inventory Improvement Program (EIIP) documentation. Table 1-1 presents an overview of the IPP and QAP planning activities recommended under EPA's EIIP guidance.

Table 1-1
Inventory Preparation Planning and Quality Assurance Planning Steps

Inventory Preparation	Quality Assurance
1. Preliminary Planning Activities:	
1. Define purpose and scope of inventory 2. Define organization and staffing roles (including agency <u>and</u> contractor roles)	3. Define and document data quality objectives 4. Identify quality assurance (QA) coordinator and assign QA responsibilities to inventory staff
2. Prepare Technical Work Plan:	
5. Identify geographical area 6. Delineate pollutants to inventory 7. Establish point/area source cutoffs 8. Prioritize source categories for inclusion in inventory 9. Prioritize data sources 10. Delineate emissions estimation procedures	11. Prepare QA plan concurrently with or after technical work plan 12. Document data-gathering methods in QA plan 13. Select QA procedures to be used 14. Determine indicators that will be used to measure data quality
3. Prepare Inventory:	
15. Data collection 16. Data handling 17. Estimate emissions 18. Document inventory development activities	19. Follow data handling procedures as documented in QA plan 20. Conduct routine QA activities and independent audits 21. Document QA steps coinciding with inventory development activities
4. Inventory Reporting:	
22. Document methods, data sources, adjustments 23. Discuss sources excluded and explain why 24. Present estimated emissions	25. Prepare QA audit reports 26. Document QA findings and resolution of problems 27. Discuss QA in final inventory report and prepare separate QA report
Source: EPA EIIP Document Series, Volume VI: Chapter 2	

The guidance and "blueprints" for inventory development specified in the EIIP are necessarily broad and comprehensive so that they can be used and adopted by individual States based on prioritized objectives, staffing, and resources. Some of the guidance, however, demands substantial rigor. For example, the QAP guidance in the EIIP provides for an extremely high degree of review, auditing, and relative "scoring" or ranking of the emission estimation, spatial and temporal allocation, and forecasting methodologies and data sources for each individual emission source in an inventory. For agencies with significant budgetary resources and staff that are developing rigorous, Level I-type[8] compliance inventories in industrialized urban areas, the high degree of quality assurance (QA) auditing, ranking, and documentation suggested in the EIIP guidance is appropriate. Since these conditions do not apply throughout the central Pinal County nonattainment area, judgment will be applied in establishing data collection, analysis, and related QA requirements.

Each of the steps outlined in Table 1-1 was considered in the development of this IPP. Presented below is a brief review of the issues considered and addressed within the four main categories of effort.

Preliminary Planning Activities – The work plan for this effort must define the purpose and scope of the inventory. It must address the development of source-specific estimates for PM10 and PM2.5 and precursor emissions. Where options are available for the development of emission inventory estimates for specific source categories, these options are identified and discussed. Since the selection of inventory methodologies will be made subsequent to approval of this IPP, only limited information on the organizational structure and assigned staffing roles relative to inventory preparation is contained in this IPP.

Technical Work Plan Development – While EPA guidance calls for the development of an emissions inventory system that will cover all PM10 and fine particulate pollutants and precursors, ADEQ- and PCAQMD-sponsored CMB studies[9] have shown that PM10 and PM2.5 peaks are dominated by crustal source emissions. For this reason, the inventory will focus on crustal sources and not secondary aerosol precursor emissions.

Prepare Inventory – Activity data will be collected for key emission sources following procedures outlined in this report. The activity data will be combined with emission factors also outlined in this report to prepare representative source specific emission estimates. Tests of alternate high wind emission estimates will be conducted to determine which method provides a more representative estimate of concentrations recorded at selected monitoring sites. QA procedures outlined in Table 1-1 will be followed to ensure that emission estimates are reliable and can be replicated.

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[8]The EIIP guidance categorizes emission inventories into four groups (Levels I through IV) based on uses, requirements, and rigor or accuracy. A Level I inventory refers to that developed for enforcement, compliance, or litigation uses with a high degree of accuracy.

[9] Analysis of PM2.5 Exceedances in Pinal County Arizona: Demonstration that PM2.5 Concentrations are Driven by Local Sources of PM10 Near the Cowtown Monitor. *http://pinalcountyaz.gov/Departments/AirQuality/Documents/Other%20EPA%20Regulatory%20Actions/CowtownTechnicalWhitePaper.pdf*

Inventory Reporting – The final steps in Table 1-1 describe the reporting practices and documentation of the emission inventory. These elements include the following:

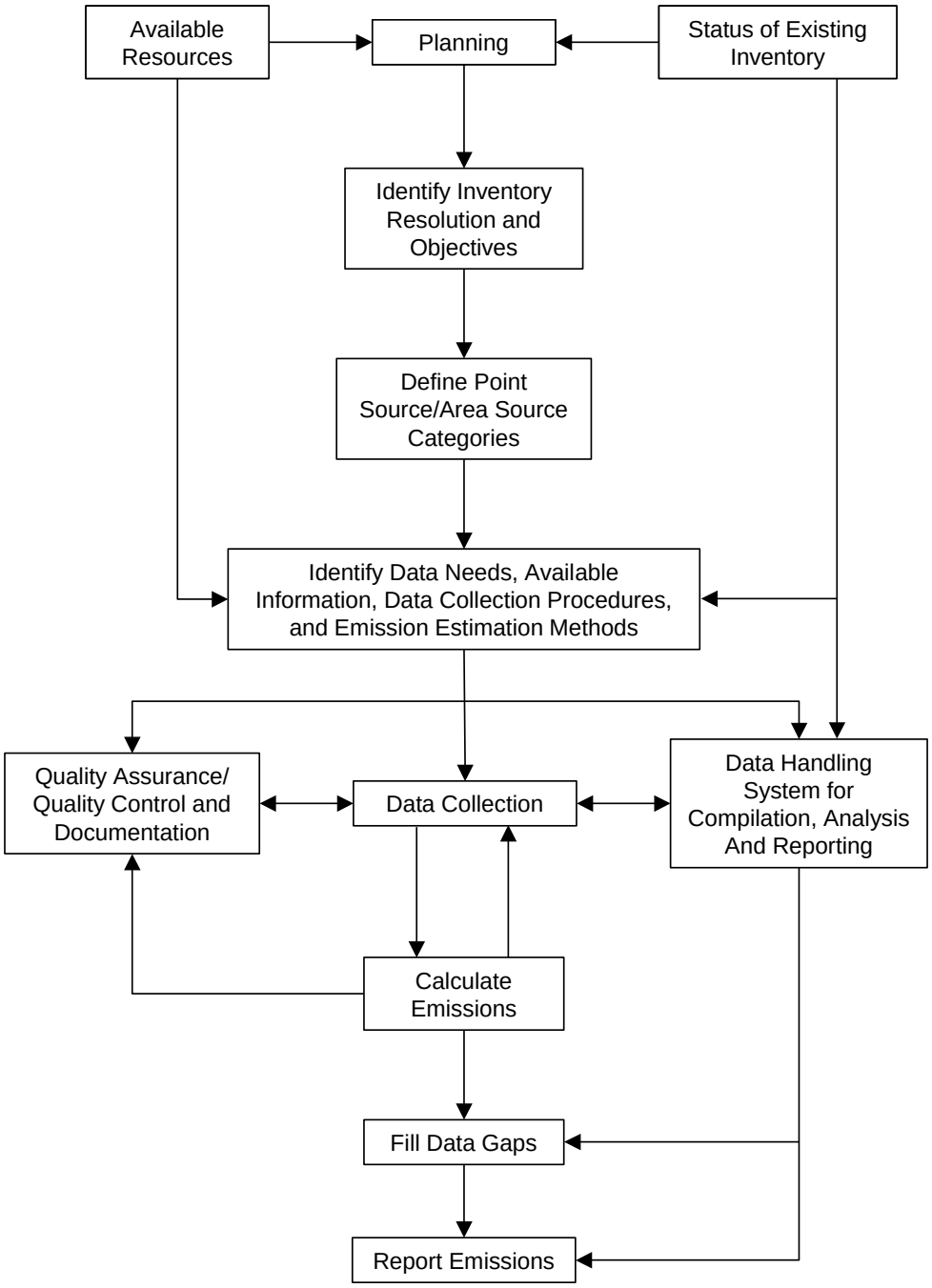
- Documentation of methods and data sources (e.g., MOVES, local travel model outputs, etc.);
- Discussion and explanation of sources excluded from the inventory (e.g., space heating emissions, etc.); and
- Summary reports of the emissions inventory (for both AQ and inventory submittal purposes).

Figure 1-1 illustrates an overview of the processes and issues that were considered in the development of this document. As previously discussed, these processes were largely followed in the development of PM10 SIPs and criteria pollutant inventories elsewhere in Arizona. The challenge is adapting and prioritizing those processes for the central Pinal County nonattainment area and selected modeling domains.

1.2 Report Organization

Following this introduction, Section 2 provides an initial assessment of the diurnal trends and relationships between PM10 hourly averages and meteorological parameters at select Pinal County monitoring stations conducted to gauge the influence of local versus regional sources at these sites. Section 3 presents a summary of design day and modeling domain selections for monitors determined to be representative of exceedance conditions within the nonattainment area. Section 4 presents a review of the emission inventory development procedures for key emission source categories and a summary of data available to characterize activity and conditions within the nonattainment area and selected modeling domains. Section 5 presents a summary of QAPs to be implemented to ensure quality assurance requirements are satisfied.

Figure 1-1
Overview of Inventory Preparation



Source: "Introduction to Stationary Point Source Emission Inventory Development," Emission Inventory Preparation Program, May 2001.

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2. INITIAL ANALYSIS OF BASE YEAR MONITORING DATA

As the first step in developing site-specific, short-term inventories to support attainment analyses, an initial assessment of the diurnal trends and relationships between PM10 hourly averages and meteorological parameters at select Pinal County monitoring stations was conducted to gauge the influence of local versus regional sources at these sites. The monitoring stations at which hourly data were available for this assessment were Cowtown, Stanfield, Casa Grande/Airport, and Pinal County Housing.[10] Prior analysis by both the Arizona Department of Environmental Quality (ADEQ)[11] and the U.S. Environmental Protection Agency (U.S. EPA)[12] demonstrated that windblown dust, generated during high wind events caused by thunderstorm outflows and frontal system passages, was responsible for some of the higher 24-hour average PM10 recordings. This subsequent assessment was designed to determine the prevailing directions from which windblown dust originated and whether higher 24-hour readings were also occurring during low wind conditions and, if so, the relative proximity of sources that might be contributing to these concentrations.[13]

The assessment was conducted in two stages. In the first stage, single-variable analyses were used to rank hourly PM10 averages by wind speed bin and examined diurnal profiles of PM10 hourly averages at each of these four stations. In the second stage, we used two-variable analyses to compute hourly PM10 averages by combinations of wind speed, wind direction, and hour of the day to develop more information about the relative locations and contributions of potential source categories contributing to periods of high, and low, PM10 concentrations at these stations. The data used in these analyses were collected between January 2006 and December 2008 at the Cowtown and Pinal County Housing sites, between March 2007 and December 2008 at the Casa Grande/Airport site, and between July 2007 and December 2008 at the Stanfield site. Because of the influence of very sporadic, but very high, hourly PM10 concentrations, we removed hours during which the average 1-hour PM10 concentration exceeded 10,000 $\mu g/m^3$ from

[10] Although limited hourly data were also available at the Maricopa and Combs School monitoring sites, these data were not included in the initial analyses as the frequencies and magnitudes of PM10 exceedances were lower at these sites, and the control strategy capable of achieving attainment at the initial study sites was believed to be capable of achieving attainment at the Maricopa and Combs Schools sites also.
[11] Boundary Recommendations for the Pinal County 24-hour PM10 Nonattainment Area, Arizona Air Quality Designations Technical Support Document, Arizona Department of Environmental Quality, March 15, 2010
[12] Pinal County, Arizona Area Redesignation for the 1987 24-hour PM10 National Ambient Air Quality Standard, Technical Support Document, U.S. Environmental Protection Agency, Region 9, Sept. 21, 2010
[13] These initial analyses were conducted prior to final selection of design days and monitoring sites.

the analysis to prevent the resulting statistics from being unduly influenced by outlier data.[14]

2.1 Cowtown

Single-Variable Analyses – Table 2-1 summarizes hourly PM10 average and maximum concentrations ranked by wind speed bin. A review of these data suggests several relationships that shed light on source contributions. First, the combination of the relatively uniform magnitude of PM10 average concentrations between 0 and 7 meter-per-second (m/sec) wind speeds—at levels in excess of the federal 24-hour standard of 150 µg/m^3—and the very high maximum concentrations across this range indicates that local sources produce significant and persistent emissions of PM10. The elevated PM10 average of 536 µg/m^3 found in the 8 to 9 m/sec wind speed bin, with an observation count of 105 hours (0.40% of all hours), suggests that high wind conditions are also responsible for a portion of the 24-hour PM10 exceedances at this site. The relatively high average PM10 concentration in this wind speed bin, in comparison to those of other wind speed bins below 8 m/sec, suggests that this is the threshold velocity for a land use category or soil type producing significant emissions upwind of the station.

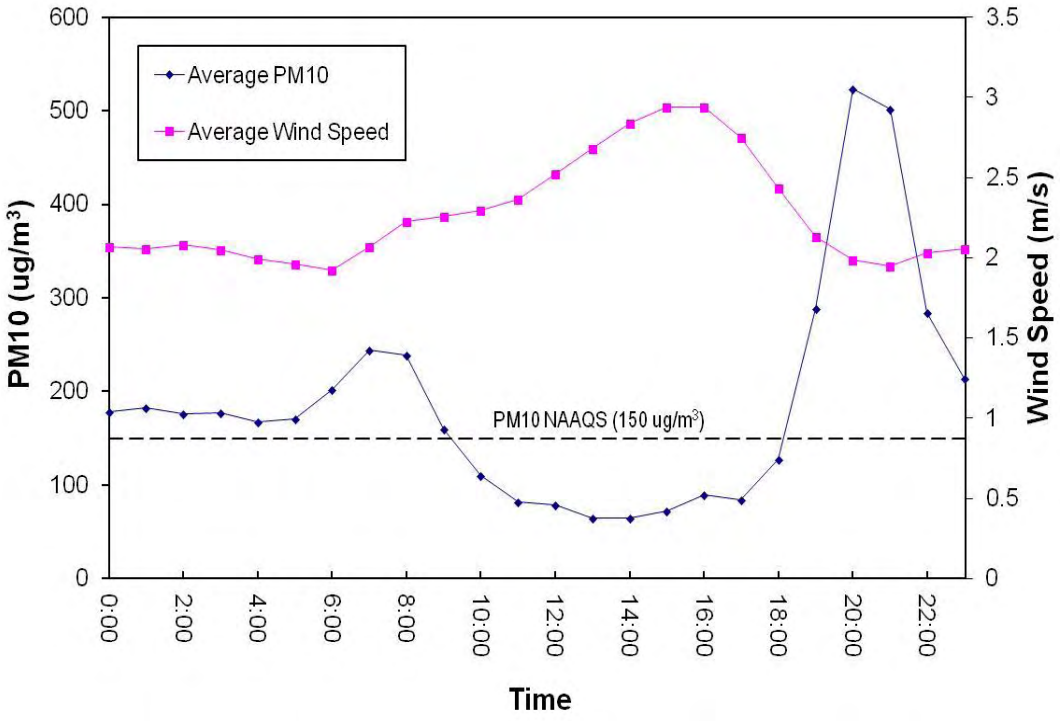
Table 2-1
Cowtown Hourly Average and Maximum PM10 – All Hours
(No Outliers)

Wind Speed Category (m/s)	Observation Count	Average PM10	Max PM10
0~1	3,018	216	6,373
1~2	10,657	196	7,511
2~3	6,655	171	6,175
3~4	2,859	159	7,300
4~5	1,301	146	5,316
5~6	667	146	3,182
6~7	391	195	3,083
7~8	222	292	4,047
8~9	105	536	4,989
9~10	33	403	2,250
10~11	9	446	1,084
11~12	1	2,328	2,328
12~13	1	1,046	1,046
Total Count	25,943	N/A	N/A

[14] At Pinal County Housing, Casa Grande and Stanfield, the hours exceeding 10,000 µg/m^3 were consistently associated with hourly average wind speeds exceeding 12 mph. The Cowtown concentrations exceeding 10,000 µg/m^3 were predominately at night.

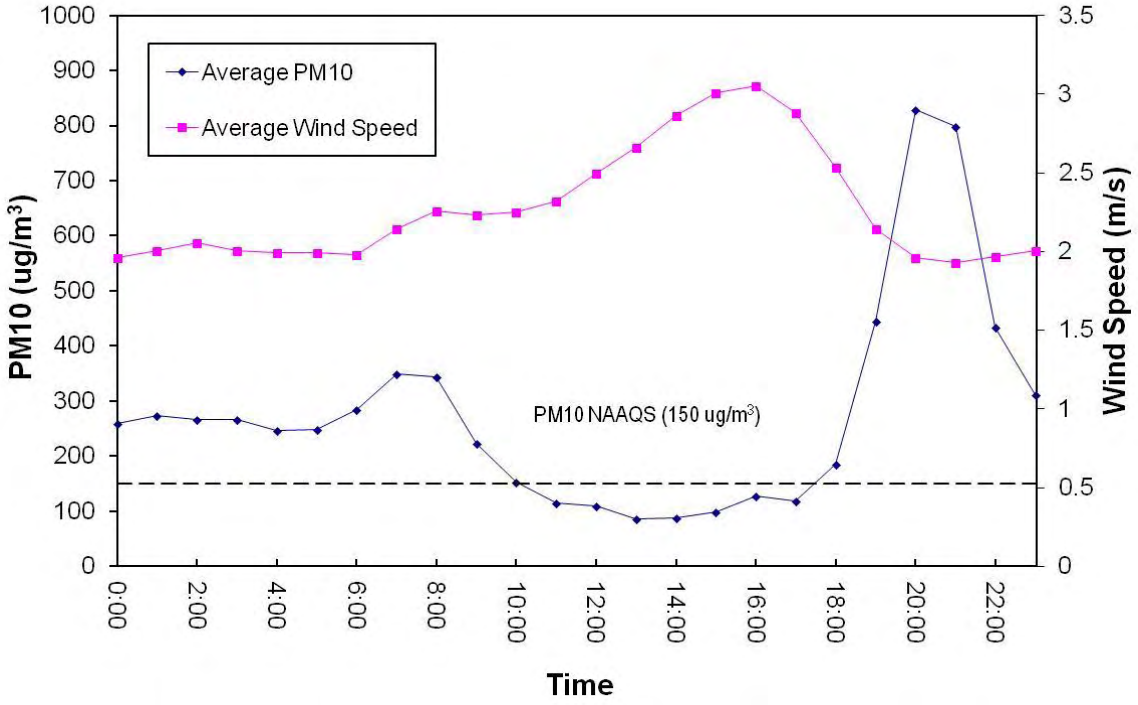
The diurnal distribution of hourly PM10 averages at Cowtown was examined, but did not reveal significant insights with respect to potential source contributions. The diurnal distribution for this site is shown in Figure 2-1. The early-morning smaller peak between 0600 and 0900 hours and much higher peak in PM10 between 1800 and 2400 hours may result from several different phenomena that warrant evaluation in the preparation of the emission inventory. These phenomena include, but are not limited to, the timing and severity of nocturnal inversions at this site (which would concentrate emissions from groundlevel sources in shallow mixing layers) and diurnal variations in mechanical source activity (such as traffic flows on nearby paved and unpaved roads).

Figure 2-1
Cowtown Hourly PM10 Averages by Time of Day, All Hours
(No Outliers)



A refinement of the diurnal distribution pattern at Cowtown, limited to exceedance days, is shown in Figure 2-2. This time plot again shows a low early-morning peak in PM10 and a corresponding evening peak between 1800 and 2400 hours.

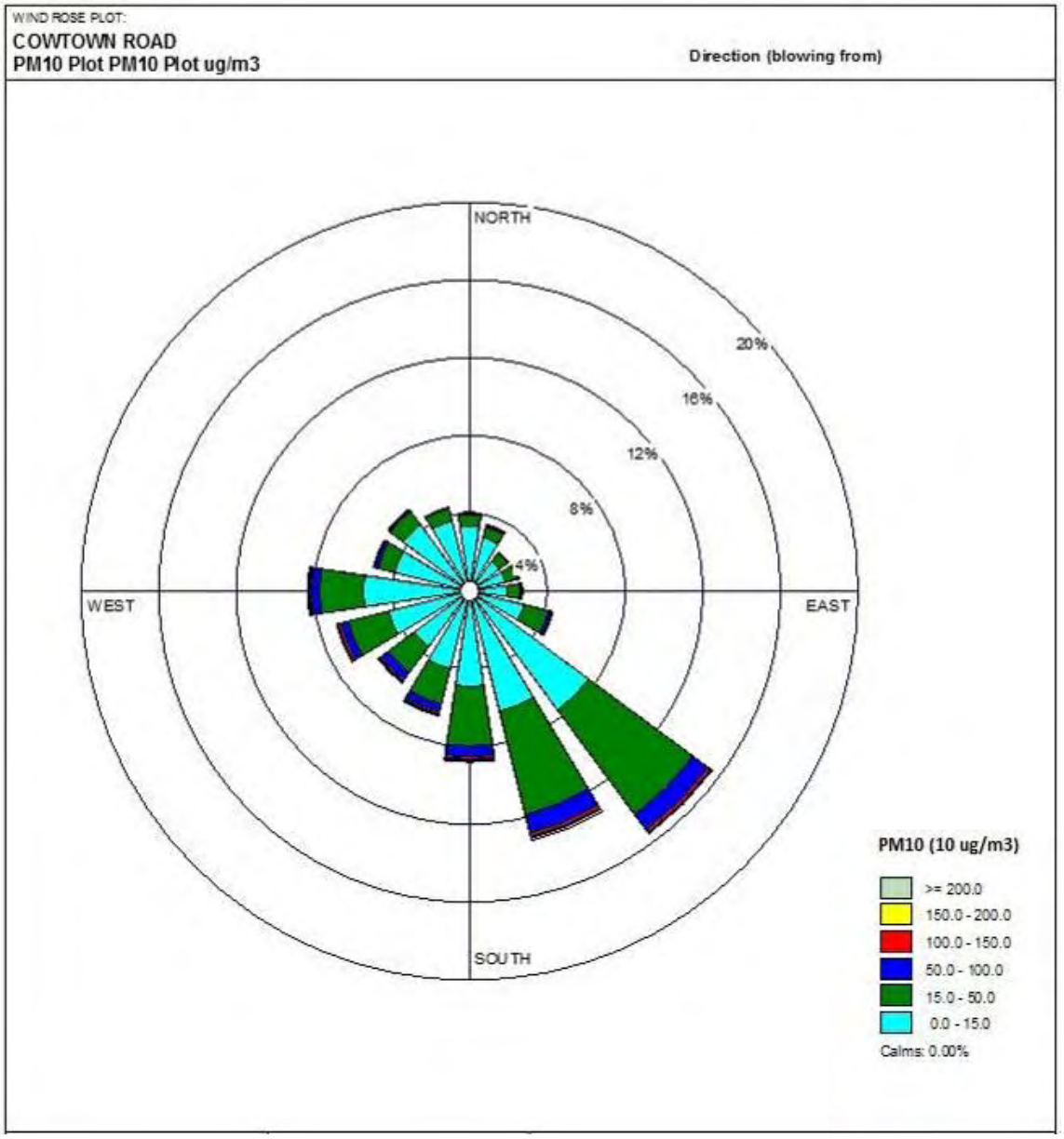
Figure 2-2
Cowtown Exceedance Day Hourly PM10 Averages by Time of Day, All Hours (No Outliers)



A PM10 rose was constructed of the hourly PM10 and wind direction data from the Cowtown monitor using techniques originally developed to generate wind speed and direction roses. This rose is shown in Figure 2-3.[15] The lengths of wind direction radii reflect the fractions of the total number of hours during the monitoring period that the wind blew from the directions to which the wedges point. This plot shows that the prevailing winds at Cowtown are from the southeast, with the southwest quadrant contributing the next highest fraction of wind hours. PM10 roses limited to exceedance days and hours of PM10 exceeding 150 µg/m^3 show very similar patterns (not shown in the figures), suggesting that the sources most significantly impacting this monitor lie in the same arc as the prevailing winds.

[15] Because of limitations of the windrose software used to generate this plot, the values displayed in the legend in the lower right need to be multiplied by 10 to reflect the ranges of PM10 concentrations on which this plot is based. For example, the light green band of PM10 concentrations represents hours exceeding 2,000 µg/m^3, not 200 µg/m^3. Similar multiples should be applied to values displayed in the other PM10 roses, i.e., Figures 2-11, 2-12, 2-17, and 2-21.

Figure 2-3
Cowtown Hourly PM10 Rose



Two-Variable Analyses – The first two-variable analysis of Cowtown data grouped hourly PM10 averages by wind speed and wind azimuth (direction). Wind speed data were grouped in bins spaced 1.0 m/sec apart, and wind azimuth data were grouped in bins spanning 10 degrees of compass arc. The hourly Cowtown PM10 averages by wind speed and azimuth are presented in Figure 2-4. In this figure and the other two-variable tables, data are color-coded to indicate highest (red) through lowest (dark green) values to highlight data clusters. The numerical ranges included in each color band are shown in a legend just below each data table.

In Figure 2-4, the presence of highest PM10 averages at 0-1 m/sec wind speed and multiple wind directions suggests that significant nearby sources impact the monitor during stagnant wind conditions. Wind meander that occurs during these very low wind speeds may be responsible for the multi-directionality of high averages, meaning that significant sources may not lie in these directions, but rather that emissions from any significant nearby sources approach the monitor from a variety of directions as a result of winds meandering between source and monitor. The cluster of moderate PM10 averages at 1-2 m/sec wind speeds between 140 and 260 degrees suggests that the most significant nearby sources lie within this quadrant. This figure also shows a high PM10 cluster at 7 to 10 m/sec wind speeds and 240 to 290 degrees wind direction. This cluster suggests that disturbed soils lying upwind of the monitor within this wind direction arc produce high impacts at the monitor at higher frequencies than disturbed soils in other directions during high wind conditions. This tendency may be due to soils having lower threshold velocities for generating windblown dust in this arc, soils being more continuously disturbed, or greater quantities of deposited dust available for re-entrainment in these upwind directions.

A subsequent analysis examined the relationship of peak hour PM10 concentrations to the same wind speed and direction bins. The resulting table of values is presented in Figure 2-5, showing that high PM10 maxima at 1 to 3 m/sec wind speeds occur in most wind directions, suggesting the presence of multiple high-strength episodic sources surrounding the monitor. Because episodic sources generate high emission rates for short periods of time, initial identification of these sources will depend more on interviews of people who spend time in areas near the monitor than on further statistical analysis of the hourly PM10 and meteorological data. Once potential candidate sources are identified, followup inquiries will be made of any parties responsible for source operation and emission rates will be estimated using reverse dispersion modeling techniques.

Figure 2-4
Cowtown Hourly PM10 Averages by Wind Speed and Azimuth, All Hours (No Outliers)

Cowtown	Hourly PM10 Averages by Wind Azimuth (degrees) and Speed (m/sec), All Data (No Outliers)													
Average of	Column													
Row Lab	0	1	2	3	4	5	6	7	8	9	10	11	12	Count Subt
0	183	109	50	80	320	88		18						493
10	111	138	84	102	85	93	143		25					463
20	84	122	88	54	294	224	191	276						433
30	338	102	99	62	116	107	298	2279	23					381
40	96	134	90	154	84	26	239	33	1307					326
50	455	123	168	217	82	22	25	255						251
60	147	151	104	98	104	99	84	108	550		22			267
70	132	156	157	99	137	122	146	368	136	151	475	365		328
80	432	167	124	80	100	94	133	197	182	330				339
90	142	156	72	149	71	159	127	233	146	98				281
100	136	144	93	99	283	146	83	253	102	403	741			334
110	151	186	127	100	128	100	86	188	95		362			460
120	242	228	168	134	109	74	137	459	186	1214				717
130	494	188	172	200	223	187	246	27	70	158				1580
140	91	253	233	242	176	195	222	25	149		795			1982
150	548	307	235	213	150	148	99	145		131	159			1759
160	166	306	242	188	169	98	190	129	65	2261				1445
170	121	302	200	176	150	199	95	47	1189					1253
180	500	278	190	147	134	141	171	165	31	66				976
190	90	254	225	163	209	146	115	98	58	58	776			822
200	364	261	179	166	181	84	602	127	279	357	716	24	1046	799
210	118	292	184	143	136	95	273	140	174				2328	744
220	171	263	248	161	323	87	113	238	154		440			635
230	135	244	249	229	228	197	360	208	769					679
240	136	314	246	224	177	231	150	261	560	508				736
250	396	254	200	184	134	128	179	96	786					844
260	246	284	179	180	119	130	180	206	685	386	392			1011
270	464	234	134	184	163	130	163	312	528	1558	2055			976
280	163	160	150	145	137	124	137	466	422					784
290	125	180	105	115	88	131	220	323	155	0				596
300	223	144	129	93	79	117	162	599			51	21		564
310	202	144	87	83	149	115	129	130	2803		24			609
320	139	126	70	49	70	119	43	161	217					571
330	297	115	70	73	118	214	42	409	612					547
340	135	101	66	60	78	47	17		255					515
350	126	95	55	96	102	36	37	33	83	53				474
360	124	102	53	77	285	42	374		58	61				233
Count Subt	662	7866	9499	4322	1848	960	510	294	159	60	22	3	2	26207
Color Scale	0	50	100	150	200	300	400							

Figure 2-5
Cowtown Maximum Hourly PM10 Concentration by Wind Speed and Azimuth, All Hours (No Outliers)

Cowtown	Hourly PM10 Maxima by Wind Azimuth (degrees) and Speed (m/sec), All Data (No Outliers)												
Max of PM	Column												
Row Lab	0	1	2	3	4	5	6	7	8	9	10	11	12
0	3703	879	276	287	1468	118		18					
10	481	4262	916	1132	492	173	283		31				
20	493	3639	1364	439	3604	1437	995	1041					
30	1273	625	1903	941	488	497	929	4047	23				
40	448	1436	1825	2535	837	72	887	33	4722				
50	2156	1642	6068	2513	475	80	38	372					
60	310	1921	722	712	631	531	288	234	550		22		
70	516	3264	1650	582	1185	686	818	3083	349	484	718	365	
80	2308	4830	917	550	414	548	707	1017	794	976			
90	335	1682	269	552	632	916	741	666	233	134			
100	242	1629	734	574	2776	847	184	253	102	1336	1296		
110	838	3482	874	766	1132	361	217	188	119		362		
120	1099	3547	1903	833	807	271	346	1020	349	1214			
130	1236	3979	1954	2005	5316	735	1009	39	89	158			
140	253	3648	1851	6175	553	1400	652	65	252		795		
150	4391	3493	4927	2958	825	954	253	264		262	213		
160	467	6373	3921	1414	1155	463	640	346	101	2261			
170	365	3228	3565	864	1217	1309	442	123	4989				
180	2863	4429	2365	1730	822	464	814	732	71	90			
190	548	5066	4223	2319	1789	439	286	301	118	206	2250		
200	1894	5580	2989	1049	1039	451	3182	278	1199	1166	1084	24	1046
210	368	3739	5457	2274	1058	318	1627	396	415				2328
220	819	6137	6439	1587	2462	236	361	352	214		440		
230	355	1789	6140	3307	1511	547	1269	373	1028				
240	323	4607	3095	7300	1285	1090	475	1249	2901	508			
250	1274	4369	1821	3713	932	454	546	346	1513				
260	684	4887	2871	3329	619	485	1014	1130	4102	787	392		
270	2476	3776	1997	2355	2677	643	911	1615	1975	2900	2055		
280	641	1245	7511	2065	875	1306	557	2400	1607				
290	234	3127	3270	1527	938	584	622	1335	155	0			
300	716	1763	3552	2492	693	520	201	599			51	21	
310	752	2591	1053	639	966	350	255	406	4658		31		
320	566	1290	1236	258	433	481	162	369	393				
330	1086	3714	820	404	500	725	42	409	612				
340	419	1649	741	426	510	209	29		255				
350	483	967	676	1590	864	100	195	59	102	53			
360	281	802	418	429	632	63	723		58	83			
Color Scale	0	100	200	400	800	1000	1500	2000					

An analysis that accounts for both PM10 average concentrations and the number of hours contributing to each average was performed by grouping sums of hourly PM10 concentrations by wind speed and direction. The results of this analysis are displayed in Figure 2-6. This plot reflects the wind speeds and azimuths associated with the highest cumulative PM10 impacts at the monitor over the period of the data record. As a rough indicator, high PM10 sums within a single wind speed range can be attributed to sources lying along the upwind direction up to X miles of the monitor, where X = (upper end of wind speed range, m/sec)* (2.24 mph/m/sec). Based on this approach, for example, sources that impact the monitor when wind speeds are between 0.0 and 1.0 m/sec are assumed to lie primarily within 2.2 miles of the monitor (= 1.0 m/sec * 2.24 mph/m/sec). Figure 2-6 shows a hot spot at wind speeds between 2.0 and 3.0 m/sec and within the arc

of 140 to 160 degrees southwest of the monitor. Figure 2-7 shows an aerial photograph from May 2011 of the Cowtown monitor with a radius extending up to 6.7 miles away on an azimuth of 150 degrees. Emission sources anywhere along this line are potentially responsible for the higher PM10 sum shown in Figure 2-6 for this wind speed and direction.

Figure 2-6
Cowtown Sum of Hourly PM10 by Wind Speed and Azimuth, All Hours (No Outliers)

Cowtown	Sum of Hourly PM10 by Wind Azimuth (degrees) and Speed (m/sec), All Data													
Sum of PM	Column													
Row Lab	0	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
0	55007	9243	3770	1599	2561	176		18						72374
10	1548	27522	13203	6306	1872	187	429		74					51141
20	925	22156	13039	2719	5881	2464	1143	1378						49705
30	3040	19158	10398	2249	2210	1178	2978	4559	23					45793
40	1442	19074	8552	5066	1846	155	1913	33	5227					43308
50	3184	14069	12789	5857	1318	110	75	765						38167
60	1616	17954	5420	2745	2400	1979	671	432	550		22			33790
70	926	14678	8792	2667	4920	3176	5706	7735	1496	1204	951	365		52616
80	3022	19519	7051	2410	2191	3006	2918	5135	2736	3635				51621
90	1132	19183	4767	3433	1345	2073	1654	2097	730	195				36609
100	1087	18776	10611	3269	5947	1457	831	253	102	1611	1481			45424
110	1361	30549	18730	6587	5514	1897	687	188	190		362			66064
120	1692	41704	44670	22008	6767	1471	960	2295	371	1214				123151
130	2963	52005	88710	106623	43293	7491	1475	107	211	158				303035
140	732	99430	195506	134749	21174	9157	1998	124	598		795			464263
150	4933	134309	201788	65853	12295	6196	1089	724		262	318			427767
160	1165	144369	157551	40770	8458	2648	2280	775	194	2261				360470
170	1336	140942	108806	22901	7824	4786	1238	375	5943					294150
180	6504	110844	69829	13639	4963	2828	3247	3295	153	133				215433
190	1440	85629	67450	13513	7513	2044	1149	1080	292	351	3103			183563
200	4001	77450	52500	14276	7222	2515	9637	888	2233	2144	2148	24	1046	176082
210	1302	72717	53565	11704	6656	2764	3279	1535	1564				2328	157414
220	1705	57089	65759	11426	10010	1830	1354	715	616		440			150945
230	2027	55864	70839	21096	5476	3738	3240	833	1538					164652
240	1491	65715	64787	29807	8337	4856	3593	4432	5600	508				189125
250	5143	39930	56273	34430	14490	6271	5002	1250	5503					168292
260	1473	37465	48395	42321	19134	14445	8820	4736	9593	3089	392			189863
270	7420	35111	31332	37581	27274	13401	8312	10921	6331	4675	2055			184414
280	1627	20269	25683	26603	17127	10673	6556	10723	4225					123485
290	751	25923	19687	14200	5886	5508	4405	1613	155	0				78127
300	1782	25340	29063	8497	3080	2337	325	599			51	21		71093
310	2015	30488	22085	7784	2836	923	257	652	8410		49			75498
320	1672	25388	17292	3024	1404	1542	304	804	651					52081
330	3863	24959	16820	4294	1175	856	42	409	612					53028
340	1480	22258	14677	2321	1165	285	35		255					42474
350	1389	19317	10534	3460	1425	181	261	99	166	53				36885
360	495	10747	4407	1859	2280	85	1122		116	123				21233
Grand Tota	134690	1687141	1655130	739644	285264	126688	88983	71576	66456	21614	12166	410	3374	4893136
Color Scale	0	40000	80000	120000	160000	200000								

Figure 2-7
Example Cowtown PM10 Hot Spot Source Corridor

Diurnal trends in PM10 concentrations were assessed by tabulating hourly PM10 averages by wind azimuth and hours of the day. The results, presented in Figure 2-8, show a cluster of high PM10 averages during 1900 to 2300 hours in the wind directions of 100 to 300 degrees. As noted above (on page 12), these elevated concentrations could be due to the onset of strong nocturnal inversions as ground heating ceases after sunset or to variations in diurnal activity rates of contributing mechanical sources. The presence of moderate PM10 averages between 0000 and 0600 hours and 120 to 190 degrees from the monitor suggests nocturnal mechanical sources may lie in this arc, which is also the arc occupied by the prevailing winds at this site. These impacts may also be driven by nocturnal high wind events.

Diurnal trends in PM10 concentrations were also assessed by contrasting hours of the day against wind speed bins. The results of this analysis appear in a table in Figure 2-9. High PM10 averages between 2000 and 2300 hours and 0 to 5 m/sec wind speeds again suggest the possibility that strong ground-based inversions are forming during these hours while some mechanical source activity is occurring or that significant local sources with pronounced diurnal variability are causing higher emissions during this period of the day. High PM10 averages between 1500 and 2000 hours at wind speeds between 7 and 12 m/sec suggest the predominance of late-afternoon high wind episodes that transport significant windblown dust to the monitor, possibly from thunderstorm outflows that typically occur in the late afternoon and early evening of the summer months. The cluster of moderate PM10 averages between 0600 and 0900 hours at wind speeds from 0 to 4 m/sec indicate monitor impacts from nearby sources that exhibit significant emissions from early morning activity.

Summary – The Cowtown monitor is impacted primarily by emissions from nearby sources lying between 100 and 300 degrees of the monitor and/or the presence of strong nocturnal inversions. Both of these possibilities should be the focus of emission inventory development for this site. Windblown dust generated during high wind events appears to be the next greatest source impacting the monitor. Thunderstorm outflows are suspected of producing a number of these high wind episodes. As a somewhat repeatable occurrence, these flows may follow wind trajectories that are co-axial, crossing the same source areas in transporting dust to the monitor. If further investigation of outflow back-trajectories demonstrates the dominance of a few wind directions, the emissivity of lands along these trajectories should be a focus of inventory development for this site.

Inventory Focus – The emission sources that this initial analysis points to as significant contributors to high PM10 hours at the Cowtown monitor on low wind days appear to lie within a few miles of the monitor across a fairly wide arc from the southeast to the west. Because of the frequency and magnitude of high hourly PM10 concentrations recorded at this monitor, substantial effort should be directed toward identifying all potentially significant emission sources in the area identified in this analysis and collecting activity and emission characteristic data from these identified sources. For the designated high wind design day, hourly wind back-trajectories ending at the monitor on high wind hours should be identified and the soil attributes related to windblown dust emission rates should be evaluated for each combination of land use and soil type found along these back-trajectories.

Figure 2-8
Cowtown Hourly PM10 Averages by Azimuth and Hours of the Day, All Hours (No Outliers)

Cowtown Hourly PM10 Averages by Wind Azimuth (degrees) and Hour of Day, All Data (No Outliers)

Average of	Column L																							
Row Labe	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0	190	232	191	162	129	169	258	246	167	165	114	50	49	67	53	56	192	57	91	156	287	438	214	163
10	102	305	83	102	47	60	104	301	163	205	88	68	49	42	42	46	64	36	74	154	917	129	128	137
20	51	119	127	73	106	199	123	143	171	273	95	103	73	45	37	37	38	212	77	331	65	267	73	73
30	119	47	49	130	78	102	147	234	370	140	106	54	45	45	33	36	24	44	91	203	478	219	117	205
40	166	72	91	65	136	114	173	160	233	121	130	55	67	29	22	37	31	51	314	289	159	100	375	141
50	81	56	66	165	78	171	117	192	201	201	110	54	67	29	51	15	722	50	66	362	145	686	45	195
60	130	195	148	72	84	110	151	179	346	148	154	86	89	36	32	40	46	31	100	169	173	93	331	138
70	205	130	65	186	100	99	179	281	349	131	115	250	88	58	120	66	45	44	153	133	432	469	213	202
80	107	208	82	73	86	117	177	198	125	176	162	102	79	141	28	80	29	29	127	120	151	804	438	80
90	69	102	69	121	134	153	197	151	225	106	67	95	136	89	107	41	197	71	183	131	229	71	176	111
100	71	117	155	85	135	153	207	100	194	110	87	61	54	67	66	34	25	68	61	233	233	267	330	201
110	161	118	140	157	110	133	164	242	233	97	72	70	61	39	35	93	31	45	95	69	320	370	213	169
120	129	148	199	186	181	123	148	172	221	133	94	76	61	59	55	52	43	173	72	284	452	424	255	132
130	155	209	195	197	167	187	209	260	255	146	96	65	48	38	46	28	136	64	148	328	392	321	202	178
140	232	247	245	231	215	197	246	285	228	166	100	69	66	35	31	54	157	247	316	188	693	340	257	258
150	219	202	195	233	215	200	237	256	256	163	142	57	54	48	37	43	58	28	90	419	683	574	345	208
160	203	228	233	207	199	188	196	285	305	178	105	91	70	39	65	49	63	54	113	482	728	476	285	230
170	183	191	181	154	171	175	206	260	235	162	129	94	53	37	35	174	58	65	96	444	647	480	346	285
180	158	162	169	176	174	175	170	272	222	148	87	70	81	52	52	50	63	74	120	479	673	520	320	195
190	149	154	134	135	212	181	205	250	256	145	103	68	151	62	63	56	54	84	190	521	585	481	357	214
200	139	174	119	124	150	217	206	229	287	182	176	68	63	80	66	111	106	101	166	312	891	664	275	178
210	259	132	156	159	137	119	257	243	187	179	148	76	60	73	84	62	105	198	100	244	751	876	345	158
220	137	109	192	136	146	199	239	190	180	194	81	59	45	62	54	119	71	87	111	649	741	529	318	193
230	221	167	106	146	125	183	284	354	313	169	106	79	63	50	58	63	133	78	195	296	625	709	270	328
240	184	137	153	199	160	188	160	246	247	192	97	107	229	102	73	148	80	103	166	407	679	655	382	407
250	196	153	97	102	120	105	207	310	191	155	146	200	92	90	80	73	153	131	165	256	397	662	211	212
260	160	117	96	163	116	155	208	186	161	226	129	125	171	121	93	90	109	148	128	203	512	386	240	200
270	118	147	73	80	135	182	153	221	259	203	98	75	154	99	144	121	123	75	153	236	420	633	437	218
280	79	128	148	165	108	183	174	202	191	135	97	72	82	88	90	134	117	115	122	354	410	387	138	120
290	243	107	151	145	60	93	91	225	202	151	88	94	71	54	64	67	94	54	103	246	576	553	190	184
300	46	54	68	60	114	106	49	101	270	178	224	80	56	49	56	43	60	56	76	238	440	1066	200	153
310	131	52	117	79	120	70	194	215	271	224	93	66	66	80	61	54	50	73	262	304	226	592	189	135
320	70	106	85	65	61	161	152	180	184	99	93	76	47	61	49	54	45	43	73	206	206	177	311	126
330	82	149	25	118	102	77	154	209	312	90	92	46	39	45	28	33	48	38	70	161	324	287	165	86
340	82	143	64	253	94	125	210	191	166	110	79	59	58	42	39	28	31	48	74	83	273	89	82	126
350	50	141	101	98	83	92	85	185	182	116	91	59	51	38	39	29	36	36	102	119	155	515	54	104
360	24	29	72	52	28	82	106	338	204	158	76	62	70	43	51	62	39	46	120	270	130	259	70	55
Color Scale:	0	50	100	150	200	250	300																	

Figure 2-9
Cowtown Hourly PM10 Averages by Wind Speed and Hours of the Day, All Hours
(No Outliers)

Cowtown	Hourly PM10 Averages by Wind Speed (m/sec) and Hour of Day, All Data (No Outliers)																						
Averag	**Colu**																						
Row	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
0	151	190	173	171	136	123	234	240	275	149	93	68	56	77	78	58	281	83	110	228	366	518	430	146
1	168	162	155	164	169	166	196	238	249	160	107	80	75	44	41	42	46	50	116	381	611	499	322	199
2	200	190	192	183	174	174	200	238	240	157	104	66	57	50	44	45	60	50	96	232	499	542	281	224
3	158	205	196	198	179	187	223	266	208	166	94	71	96	46	55	48	73	74	108	211	359	535	222	260
4	135	119	122	171	113	172	182	252	267	124	123	102	69	82	99	98	72	113	109	222	420	385	236	168
5	108	165	82	39	111	130	149	206	201	151	121	110	106	97	92	113	135	107	138	172	298	121	176	118
6	111	56	36	72	84	15	237	306	240	188	197	145	94	105	160	108	189	178	140	192	587	464	215	121
7	67	99	121	71	208	237	265	182	223	275	153	321	202	238	130	285	219	157	320	407	857	319	146	205
8	212	120	224	108	142		83	143	234	224	198	241	526	401	219	382	343	492	2354	575	1043	950	382	75
9		825	102	283	49	51			271	190	402	117	200	27	193	202	1281	456	833	740	206	90	134	
10	312								72	519	118	31		125		692	2055	329	566	440	2250		105	1296
11											24		21											365
12																	1046	2328						
Color Scale:		0	50	100	150	200	250	300																

2.2 Stanfield

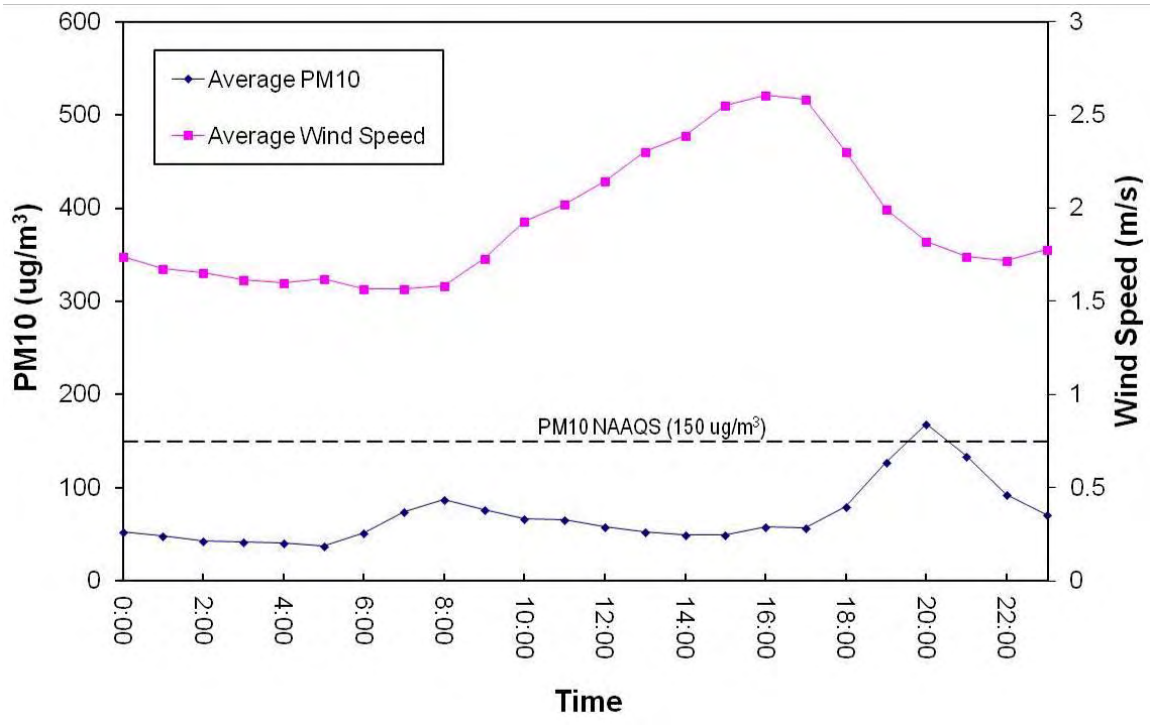
Single-Variable Analysis – Table 2-2 presents hourly PM10 average and maximum concentrations ranked by wind speed bin for the Stanfield site. This table reveals a progression of increasing PM10 average values with increasing wind speed, suggesting that there are no locally significant sources near the monitor. The averages, however, which range from 50 to 85 µg/m^3 at wind speeds between 0 and 5 m/sec, also suggest that a matrix of comparatively low emission sources surrounds the monitor, producing an elevated background level. The high maximum PM10 values at wind speeds in this same range also suggest that episodic sources periodically impact the monitor.

Table 2-2
Stanfield Hourly Average and Maximum PM10, All Hours
(No Outliers)

Wind speed Category (m/s)	Observation Count	Average PM10	Max PM10
0~1	2,225	71	1,284
1~2	6,319	62	1,820
2~3	2,336	50	1,979
3~4	802	52	1,548
4~5	475	85	1,553
5~6	252	195	4,063
6~7	136	277	3,485
7~8	46	453	2,497
8~9	20	664	1,770
9~10	8	1,196	2,528
10~11	1	2,098	2,098
12~13	1	3,384	3,384
Total Count	12,622	N/A	N/A

A plot of hourly PM10 averages by hour of the day is shown in Figure 2-10. This plot shows a low morning PM10 peak that possibly represents an initial increase in anthropogenic emissions from nocturnal levels and, after 0800 hours, a decline in these groundlevel concentrations as inversion heights increase with corresponding increases in morning ground heating from solar insolation. The evening peak in PM10 average at 2000 hours could be due to either an increase in emissions from diurnally varying sources and/or the onset of strong nocturnal inversions, as was also possible at the Cowtown monitor.

Figure 2-10
Stanfield Hourly PM10 Averages by Time of Day, All Hours
(No Outliers)



Examination of PM10 roses for this site provides limited information. An example PM10 rose is presented in Figure 2-11. This plot is limited to hours during which the PM10 concentration at the monitor exceeded 150 µg/m^3, which is the federal 24-hour PM10 standard. This plot shows that prevailing directions of winds transporting high PM10 concentrations are primarily from the west and, to a much lesser extent, from the southeast. A second PM10 rose, limited to hours when wind speeds exceeded 5.0 m/sec, is presented in Figure 2-12. This plot suggests that the highest PM10 impacts at the monitor during high wind conditions are generated by sources to the east and east-northeast.

Figure 2-11
Stanfield PM10 Rose of Hours Exceeding 150 µg/m^3

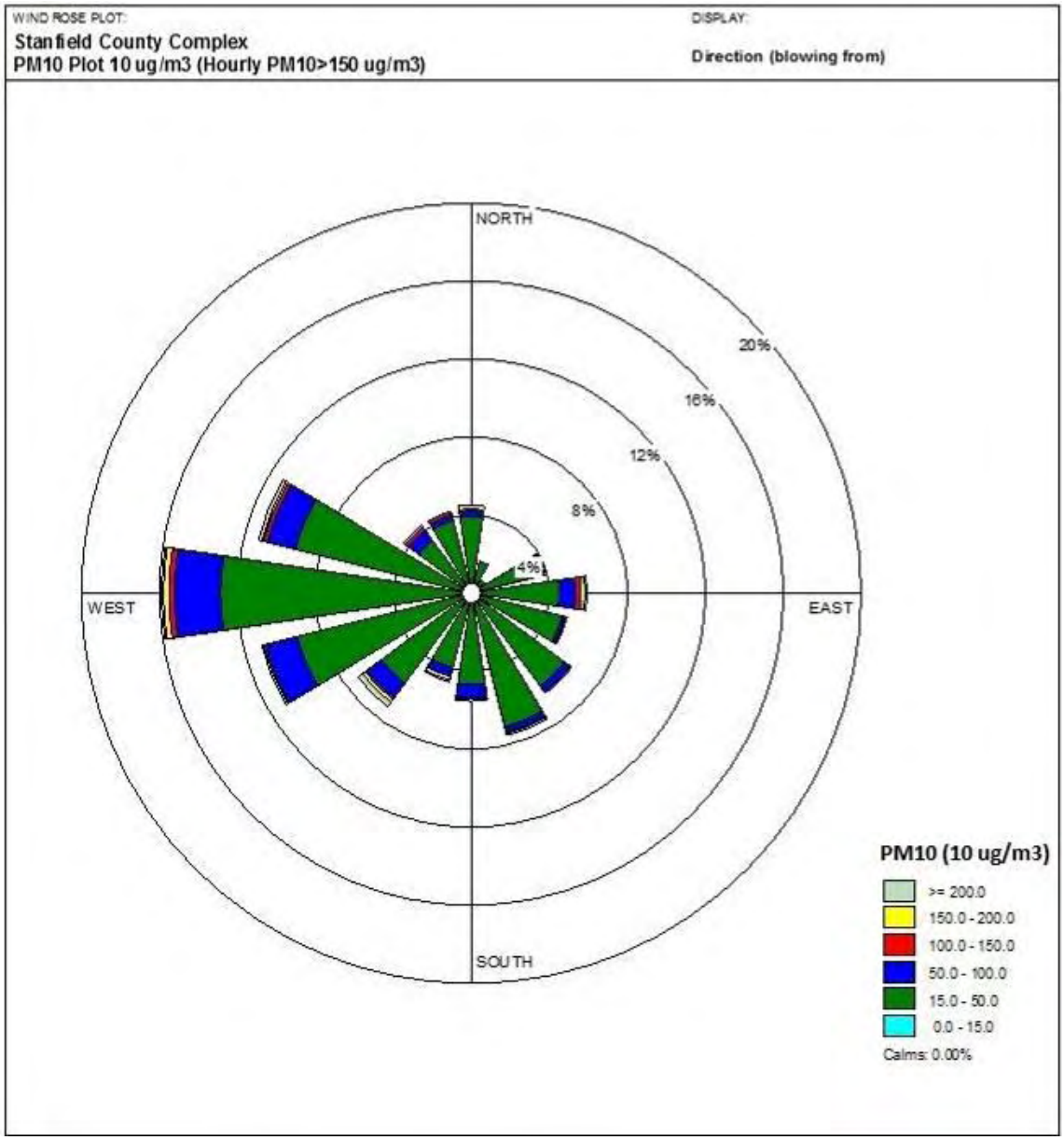
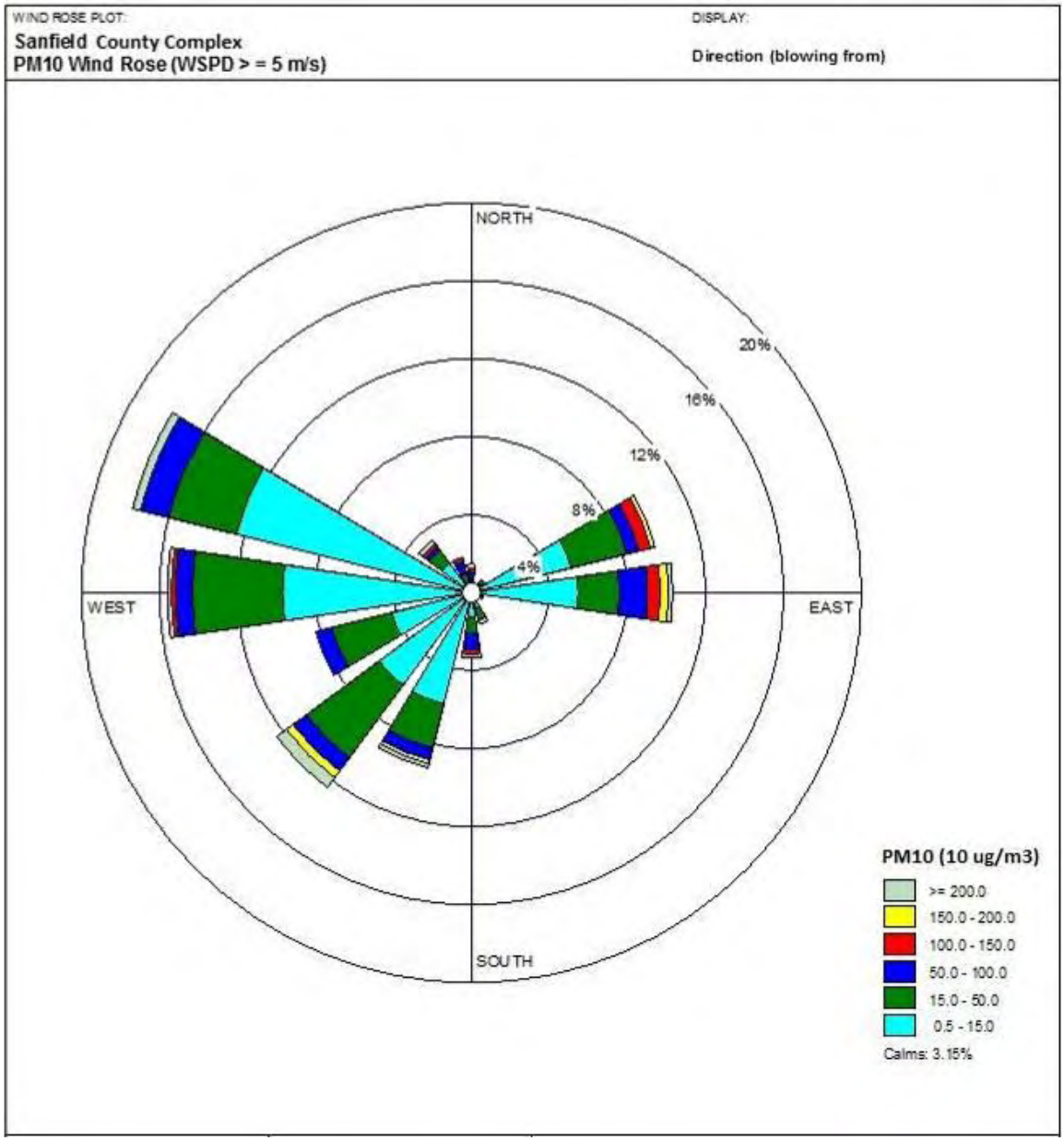


Figure 2-12
Stanfield PM10 Rose of Hours with Wind Speeds > 5.0 m/sec



Two-Variable Analyses – The first two-variable analysis of Stanfield monitoring data sorted hourly PM10 averages by wind speed and wind direction. The table showing this distribution appears in Figure 2-13. High PM10 averages at the highest wind speeds in several directions suggest that episodic windblown dust sources regionally surround the monitoring site. A plot of PM10 hourly counts by wind direction when wind speeds exceed 5.0 m/sec, shown in Figure 2-12 as a PM10 rose, suggest that winds producing high PM10 hour values blow towards the monitor most frequently from the east and east-northeast. Low PM10 averages at low wind speeds in most directions, as shown in Figure 2-13, suggest that few significant PM10 sources are close to the monitor. A review of hourly PM10 maxima by wind speed and azimuth shows that high PM10 concentrations during low wind speeds originate from episodic sources lying in an arc from the south through the northwest of the monitor.

The sums of hourly PM10 concentrations grouped by wind speed and direction are presented in Figure 2-14. This plot suggests that (1) sources within 2.2 miles of the monitor do not significantly contribute to cumulative PM10 concentrations; (2) sources located between 2.2 and 4.5 miles of the monitor and within the arcs of 140-170 degrees and 250-300 degrees produce the highest cumulative impacts at the monitor; and (3) high wind sources in the arcs of 70-90 degrees and 200-240 degrees cumulatively contribute to PM10 measured at the monitor at somewhat higher frequencies or levels than sources lying in other directions. Because the meteorological regimes at Stanfield and Cowtown are somewhat similar, given a separation distance between the two monitors of 8.9 miles over flat terrain, the differences in patterns of PM10 concentrations between the two stations can be attributed almost entirely to the differences in locations, diurnal variabilities, and strengths of the emission sources separately impacting each monitor.

An examination of PM10 averages by hour of day (Figure 2-15) shows that the higher hourly averages of PM10 concentrations occur during the evening hours between 1900 and 2200 hours, with winds from 200 to 330 degrees of the monitor producing higher averages during these hours. Comparison to Figure 2-14 suggests that these higher averages occur more when wind speeds are between 1 and 3 m/sec, suggesting impacts from mechanical sources located within this arc and the possibility of enhancement by the onset of nocturnal inversions. The higher PM10 averages recorded between 0700 and 1000 hours, in comparison with lower averages in hours of 0000 to 0700, suggest that nearby sources related to human activity contribute to daytime background levels at the monitor.

Figure 2-13
Stanfield Hourly PM10 Averages by Wind Speed and Azimuth, All Hours (No Outliers)

Stanfield	Hourly PM10 Average by Wind Azimuth (degrees) and Speed (m/sec), All Data (No Outliers)												
Average of I	**Colum**												
Row Labe	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	Count Sub
0	41	70	53	40	107	89	413	1517					303
10	100	67	44	43	46	35	841						278
20	79	50	44	38	67								237
30	24	51	36	47	38	74							188
40	39	51	41	48	48								194
50	41	41	40	34	30	33	28	85					208
60	47	51	41	46	46	37	184	306					235
70	75	54	51	40	107	108	76	528	422	1070			293
80	90	59	51	75	42	123	417	576	973				302
90	20	56	60	61	62	52	85	294	412	1477			378
100	47	57	50	38	23	181	159		122				339
110	51	60	66	94	43	404	237						327
120	45	64	54	40	85	95							371
130	68	55	54	40	236		1020						473
140	73	61	56	62	79	396							568
150	79	62	55	33	59	224							551
160	54	56	57	39	63	737							683
170	69	55	42	72	80	78	424	141					521
180	66	53	41	27	61	258	1002						347
190	102	55	43	34	85	127	322	52		1099			286
200	35	55	37	33	132	90	720	30	111	1683			224
210	85	80	39	39	52	209	151	123	144	539			296
220	177	68	56	34	56	128	318	1077					323
230	82	71	43	40	63	121	355	64		2528			296
240	95	90	69	36	57	68	287	365		467			311
250	103	89	86	38	52	96	197	110					365
260	86	121	97	95	47	76	172	282	218		2098		410
270	81	117	92	45	74	66	126	135	315	842			434
280	53	97	124	90	41	88	123	288		545			427
290	71	85	71	43	77	46	79	151	396	522			494
300	29	92	69	50	47	50	159	575	2497			3384	382
310	100	70	49	44	48	274	89	131	1374				323
320	106	68	45	34	83	105	274						310
330	30	70	48	33	39	233	340	362					322
340	65	63	51	33	71	1060	373						288
350	65	53	46	45	150	120	943						334
Count Subto	185	5583	4309	1294	570	357	202	80	24	15	1	1	12621
Color Scale:	0	50	100	150	200	300	400						

Figure 2-14
Stanfield Sum of Hourly PM10 by Wind Speed and Azimuth, All Hours (No Outliers)

Stanfield Sum of Hourly PM10 Concentrations by Wind Azimuth (degrees) and Speed (m/sec), All Data

Sum of PM Column													
Row La	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**Grand Total**
0	124	6747	8327	1304	645	267	1238	1517					20169
10	300	7621	5508	1194	232	35	1683						16573
20	787	5013	4710	646	201								11357
30	122	4434	2898	520	113	148							8235
40	78	4735	3122	772	337								9044
50	206	3967	3628	238	179	65	28	85					8396
60	141	5217	3522	731	599	183	1103	1223					12718
70	523	6947	4294	850	1499	1844	760	3696	1267	1070			22749
80	720	8613	4145	1726	464	1722	4167	2303	4867				28727
90	59	10164	7103	1772	986	465	851	2056	1236	2954			27646
100	235	10097	6074	938	46	1088	478		122				19077
110	257	10360	7934	1873	214	1212	474						22323
120	179	11498	8444	969	513	190							21793
130	136	13851	10287	998	707		1020						26999
140	511	17679	12611	2402	158	792							34152
150	394	18915	10620	1223	294	897							32341
160	324	20750	13622	1605	1252	4421							41973
170	689	14743	7685	2897	1037	233	1696	141					29120
180	266	9004	5083	655	797	2067	4010						21882
190	407	6591	3856	1159	1694	1652	1287	104		1099			17850
200	248	4773	1838	1337	2635	719	4323	91	222	1683			17869
210	255	8444	2492	2124	1550	3756	1818	492	288	1078			22295
220	530	8813	3722	1476	2089	2694	6050	4307					29681
230	574	8252	2825	1701	2005	2669	3547	64		2528			24163
240	570	13410	4346	1424	1309	1283	1150	2188		467			26146
250	724	16376	8220	1290	1355	1056	1180	221					30422
260	778	21089	11113	4181	1035	1745	2584	1695	218		2098		46536
270	651	18713	10997	2818	2073	2115	2014	406	629	1683			42098
280	265	17961	15010	4326	942	2123	863	3173		1090			45751
290	282	14560	10530	2626	3010	1623	1738	1058	1187	1044			37656
300	117	12105	8429	3077	1281	891	2064	1725	2497			3384	35570
310	401	7476	5221	2763	1247	3016	268	261	1374				22027
320	423	7655	5487	1754	1327	315	822						17783
330	30	7235	6922	1622	541	1629	1019	362					19359
340	326	6767	5743	1285	1495	1060	746						17422
350	456	5894	6757	2253	1952	481	943						18734
Grand Tot	**13084**	**376470**	**243122**	**60525**	**37809**	**44453**	**49923**	**27165**	**13907**	**14696**	**2098**	**3384**	**886634**
Color Scal	0	4000	8000	12000	16000	20000							

Figure 2-15
Stanfield Hourly PM10 Averages by Azimuth and Hours of the Day, All Hours
(No Outliers)

Stanfield Hourly PM10 Averages by Wind Azimuth (degrees) and Hour of Day, All Data (No Outliers)

Average of I Colum																								
Row Labe	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0	37	11		48	20	14	25	65	64	93	82	52	108	58	34	35	53	42	115	139	136	242	45	53
10	51	32	17	36		31	18	109	73	85	39	101	43	37	57	34	35	44	93	99	104	182	29	57
20	24	37	54	38	27	27	34	56	91	107	43	43	36	34	50	35	31	45	61	82	122	65		75
30		10	10	62	32	12	75	132	54	47	43	41	36	31	30	27	24	34	71	121	88		51	71
40	87	21	89	35	31	49	5	77	127	86	38	37	58	33	34	33	27	35	47	54	65	64		26
50	44	28	19	19	60	20	26	46	21	66	56	40	48	41	33	25	27	34	39	58	77	50	71	45
60	35	76	66	32	38	41	42	137	110	72	70	62	41	35	34	45	32	38	56	55	91	83	124	60
70	58	53	66	58	46	43	47	76	92	103	77	196	47	34	79	47	56	42	64	53	68	99	197	67
80	68	37	62	51	78	32	37	78	80	139	120	135	135	96	60	34	33	45	214	192	237	154	69	72
90	45	43	66	61	28	43	53	86	127	115	96	59	51	164	32	38	54	40	45	83	101	146	60	60
100	54	37	53	30	46	25	71	70	97	73	87	51	50	39	27	30	30	33	68	38	64	39	74	47
110	83	77	52	57	39	41	57	82	105	71	55	41	38	38	26	39	6	135	215	46	88	49	229	88
120	67	37	45	63	37	32	57	81	91	80	47	25	34	34	32	23	22	83	63	122	55	155	70	60
130	64	47	38	33	45	43	54	84	78	65	65	35	29	36	45	73	27	85	27	37	27	118	187	49
140	62	50	57	49	45	41	50	85	88	60	38	29	26	26	29	22	15	71	142	346	269	79	113	75
150	54	50	34	39	50	33	70	94	90	73	49	54	41	36	17	23	11	63	43	79	122	140	75	48
160	41	43	42	30	38	43	63	75	85	71	37	38	38	32	42	38	2068	39	59	414	96	59	69	70
170	61	45	40	27	33	40	61	69	80	62	71	67	28	26	19	81	40	21	37	151	148	80	82	54
180	36	86	29	36	28	30	42	69	75	79	31	111	36	79	69	22	36	67	63	31	69	82	62	164
190	57	35	44	39	20	36	40	81	99	65	30	49	96	19	266	68	28		201	126	95	61	71	49
200	22	46	19	27	39	42	34	36	112	174	329	176	56	52	52	61	32	18	42	69	463	76	47	41
210	75	47	25	38	62	27	43	39	81	79	44	51	37	100	29	156	158	74	143	90	185	71	58	130
220	35	63	23	46	53	38	53	61	74	46	52	43	118	51	167	202	93	121	70	78	322	110	85	58
230	62	40	33	45	28	25	35	97	119	63	34	29	209	64	85	47	42	39	135	47	100	199	91	92
240	35	26	55	40	41	42	61	71	35	39	39	58	28	148	71	82	93	111	39	138	191	133	98	53
250	47	27	32	58	48	45	25	67	41	46	68	45	59	29	34	84	35	60	46	163	202	110	81	66
260	41	54	39	39	44	36	29	42	98	88	156	137	79	45	78	80	46	250	93	167	240	189	133	66
270	58	69	67	58	50	44	46	77	91	70	39	42	116	117	100	36	94	35	61	155	209	153	129	59
280	50	54	63	40	56	69	60	71	88	65	50	61	52	35	43	49	89	58	123	201	228	236	94	84
290	84	63	48	39	34	27	30	51	80	46	77	38	88	32	53	38	74	64	55	147	142	121	145	75
300	64	41	42	47	12	28	68	53	99	62	109	196	40	41	39	76	58	38	104	201	143	241	64	69
310	55	38	41	54	29	53	27	104	30	87	56	64	44	57	36	32	109	82	70	86	115	90	63	52
320	48	66	42	31	18	34	45	59	90	38	38	48	41	86	34	36	34	52	43	99	197	64	109	36
330	66	45	32	28	35	39	43	40	55	147	44	42	35	31	37	60	39	38	81	96	103	136	72	27
340	32	59	60	48	80	25	15	15	36	71	142	40	38	65	52	34	35	52	65	105	117	120	84	74
350	68	36	32	30	39	15	18	25	138	52	43	35	36	41	40	66	35	52	65	86	83	356	81	15

Color Scale:	0	50	100	150	200

Summary – A cluster of sources lying within 4.5 miles to the south through northwest of the monitor appears to produce the highest impacts at the monitor during low wind conditions. No sources within 2.2 miles of the monitor appear to produce high impacts. Windblown dust sources producing the highest impacts at the monitor appear to lie to the east and east-northeast of the monitor. Mechanical source activity occurring in the late evening should be investigated to determine the sources of high PM10 impacts during these hours.

Inventory Focus – Mechanical sources lying within 4.5 miles and 200 to 330 degrees of the monitor should be identified through field inspection and interviews of people living or working near the monitoring station. Activity rates and emission characteristics of these sources should be estimated from available records or field observation. Land uses and soil characteristics lying along the back-trajectories of high wind hours on the selected high wind design day should be identified from record data or evaluated from sample collection and analysis.

2.3 Casa Grande

The hourly PM10 data were collected at an urban site within the city of Casa Grande, while the meteorological data were collected at the city's airport, approximately 4 miles to the north. For this analysis, we assumed that the wind patterns at the downtown site were very similar to those recorded at the airport. Because of this separation distance, however, the relative locations of some sources, especially those close to the monitor producing impacts during low wind "meander" conditions, cannot be estimated with the same accuracy as those near other monitors where meteorological monitors are co-located with PM10 instruments.

Single-Variable Analyses – A table of hourly PM10 averages and maxima grouped by wind speed is shown in Table 2-3. This table suggests that there are no significant sources operating in a continuous fashion within a few kilometers of the monitor. An elevated maxima PM10 hour when wind speeds are between 3 and 4 m/sec, however, suggests that an occasional episodic emission event may occur within the urbanized area of Casa Grande. Higher hourly PM10 averages and maxima at wind speeds above 9 m/sec indicate that this monitor is impacted by windblown dust sources within the surrounding region.

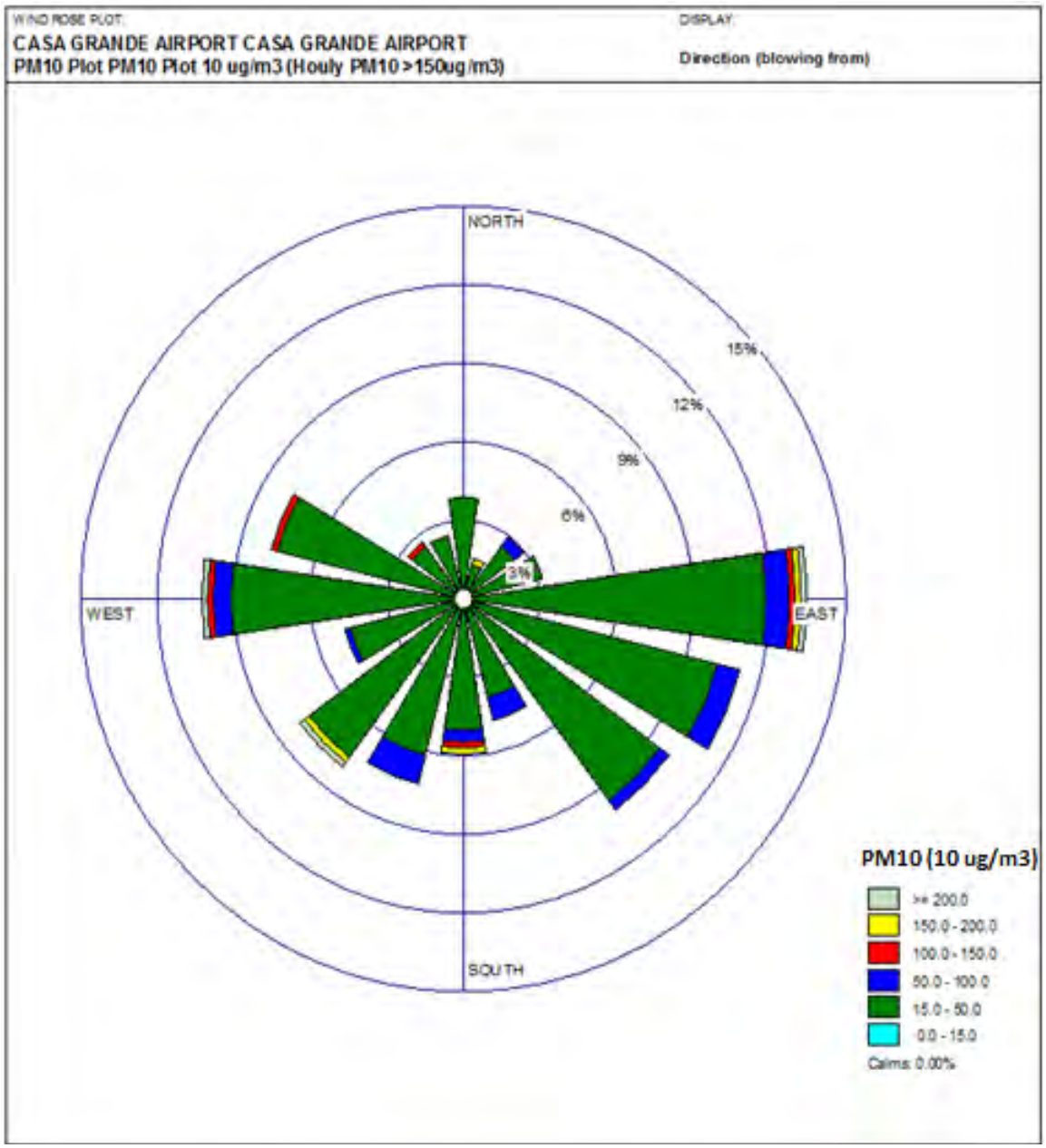
Confirmation of the absence of significant sources, and the presence of episodic emission events, in the urbanized area is shown in Table 2-4. This table represents hourly PM10 averages and maxima for all hours during which hourly PM10 concentrations at the monitor exceeded 150 $\mu g/m^3$. The relatively low numbers of hours shown in the Observation Count column for wind speeds less than 5 m/sec suggests that high PM10 hours at the monitor at low and moderate wind speeds are relatively infrequent and that local and nearby sources are not continuously significant in emission strength, but rather may be significant on an episodic basis.

Table 2-3 Casa Grande Hourly Average and Maximum PM10, All Hours (No Outliers)			
Wind Speed Category (m/s)	Observation Count	Average PM10	Max PM10
0~1	1,771	52	417
1~2	5,101	48	400
2~3	3,419	42	561
3~4	2,109	42	2,172
4~5	1,309	44	757
5~6	736	57	1,972
6~7	458	73	1,698
7~8	254	76	693
8~9	151	101	902
9~10	85	202	3,565
10~11	44	290	1,603
11~12	11	562	4,173
12~13	6	463	1,453
13~14	1	38	38
Total Count	15,455	N/A	N/A

Table 2-4 Casa Grande Hourly Average and Maximum PM10, Hours > 150 µg/m^3 (No Outliers)			
Wind Speed Category (m/s)	Observation Count	Average PM10	Max PM10
0~1	43	188	417
1~2	96	196	400
2~3	47	206	561
3~4	34	316	2,172
4~5	32	233	757
5~6	36	327	1,972
6~7	27	470	1,698
7~8	27	275	693
8~9	27	275	902
9~10	30	444	3,565
10~11	29	409	1,603
11~12	8	760	4,173
12~13	5	527	1,453
Total Count	442	N/A	N/A

The count of PM10 hours during which concentrations at the Casa Grande monitor exceed 150 µg/m^3 is presented in a PM10-rose format in Figure 2-16. This figure shows that during hours of elevated PM10, winds typically blow from the east through southeast and the west through west-northwest quadrants.

Figure 2-16
Casa Grande PM10 Rose of Hours Exceeding 150 µg/m^3
(No Outliers)



Two-Variable Analyses – The distribution of hourly PM10 averages by wind direction and wind speed at the Casa Grande monitor is shown in Figure 2-17. Relatively uniform and low PM10 averages at wind speeds of less than 5 m/sec suggest the absence of continuously significant sources within a few miles of the monitor. Scattered high PM10 averages at wind speeds above 7 m/sec suggest variability in emissions rates from windblown dust sources in the region surrounding the urbanized portion of Casa Grande. This variability could be due to emission seasonality resulting from high wind seasonality driven by monsoon conditions.

Emission variability is also borne out by the distribution of hourly PM10 maxima by wind direction and speed, as presented in Figure 2-18. Scattered hot spots in this figure suggest the episodic nature of PM10 emissions from sources impacting the monitor. This pattern suggests that controls implemented to bring the Cowtown and Stanfield monitors into attainment will probably reduce high episodic emission rates in the area surrounding the Casa Grande monitor and obviate the need to conduct inventory research focused on sources near this monitor.

The sum of hourly PM10 distributed by wind direction and wind speed is displayed in Figure 2-19. This plot shows that emission sources lying in an arc between 60 and 140 degrees and within 6.7 miles of the monitor are responsible for the highest cumulative impacts at the monitor.

Summary – No significant sources within the urbanized portion of Casa Grande were found to impact the monitor. Periodic high impacts from surrounding rural areas suggest the generation of significant emissions during high events entraining dust from disturbed lands.

Inventory Focus – As the Casa Grande monitoring site was not selected for a design day attainment demonstration, no modeling domains that included this site were developed, and no focused emission inventory will be researched and compiled at this site. Although the Maricopa monitoring site was selected for an attainment demonstration, no meteorological data have been collected at this site and, as a result, this site was not included in initial study analyses.

Figure 2-17
Casa Grande Hourly PM10 Averages by Wind Azimuth (degrees) and Wind Speed (m/sec)

Casa Grande	Hourly PM10 Average by Wind Azimuth (degrees) and Speed (m/sec), All Data													
Average Colun														
Row L	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
0	58	61	43	38	48	19	48							
10	71	42	40	40	33	55	27	537		48				
20	51	53	49	44	27	41	11	29						
30	45	49	49	34	25	65	23	27	40					
40	32	48	42	34	24	22	41	23	34	17				
50	55	54	50	36	40	31	116	380	76	47				
60	63	56	49	31	37	22	74	68	20	78	25			
70	46	49	44	46	35	34	45	39	83	68	40	28		
80	68	51	38	34	40	37	47	142	58	292	1603			
90	57	53	44	44	40	49	37	46	82	163	452	422		
100	35	53	48	37	46	50	47	100	62	66	212		21	
110	92	57	51	48	47	49	64	206	247	547	849			
120	51	58	55	42	68	41	35	57	126		64			
130	39	59	58	51	37	175	23	98	156					
140	46	57	58	47	43	69	64	273						
150	46	54	51	47	35	42	113	294						
160	49	52	47	47	24	117	92	92	302	151				
170	50	52	48	41	44	77	58	33	28		533			
180	33	54	43	43	51	41	307	42	340					
190	49	51	47	35	23	45	100	88	395	281	152		56	
200	44	46	42	37	41	41	56	43	42	67	228	594		
210	68	52	39	40	32	71	84	82	109	407	287			
220	67	52	41	36	80	63	244	138	68	37				
230	40	42	39	47	64	69	97	124						
240	39	41	45	40	38	80	98	67	131					
250	44	46	38	38	47	85	51	81	103	105				
260	35	47	41	48	43	49	43	67	52	84	71	126		301
270	207	38	41	42	42	51	57	111	67	128	116	313	142	420
280	95	47	36	42	51	42	57	52	81	74	112	215	1247	38
290	44	40	37	41	47	47	46	55	83	66	95	103	673	
300	33	41	40	35	39	39	43	49	77	85	277	264		
310	89	50	37	35	32	56	36	60	116	71	252	687		
320	74	54	38	35	36	48	50	37	38		191			
330	59	48	31	34	38	22	96	30	36	158				
340	52	48	38	34	34	28	44	19			56	263		
350	34	50	37	38	42	27	29	45	255	118	242			
360	21	47	43	42	41	17	29		178	171	105			
Color Sca	0	50	100	150	200	250	300							

Figure 2-18
Casa Grande Hourly PM10 Maxima by Wind Azimuth (degrees) and Wind Speed (m/sec)

Casa Grande	Hourly PM10 Maxima by Wind Azimuth (degrees) and Speed (m/sec), All Data														
Max of P Colun															
Row L	0	1	2	3	4	5	6	7	8	9	10	11	12	13	(blank)
0	67	236	170	147	161	28	120								
10	182	180	154	109	62	276	27	1556		48					
20	75	173	156	111	41	109	12	29							
30	45	208	197	94	45	109	34	42	40						
40	62	261	124	97	73	44	67	27	34	17					
50	81	292	178	153	170	87	583	693	103	47					
60	133	230	167	95	187	44	120	87	20	124	25				
70	61	203	159	163	138	118	99	68	83	74	40	28			
80	217	165	196	105	99	96	121	635	129	292	1603				
90	122	188	152	515	159	161	93	112	348	384	3565	704			
100	90	157	166	120	328	152	209	750	153	142	330		21		
110	158	384	377	561	339	236	199	411	247	547	849				
120	119	263	382	164	486	100	67	61	200		64				
130	55	400	223	234	137	892	31	98	287						
140	102	244	329	195	308	205	152	550							
150	73	246	513	179	108	122	343	548							
160	81	176	183	139	43	757	310	148	721	187					
170	114	164	248	186	125	281	98	60	44		533				
180	65	235	236	267	148	84	1972	119	340						
190	126	203	322	88	93	242	1461	409	902	281	152		56		
200	133	143	286	148	266	120	385	106	192	140	284	954			
210	118	170	120	339	89	934	262	240	281	801	552				
220	167	376	176	259	2172	312	1698	205	68	37					
230	64	192	176	331	325	283	284	166							
240	43	204	291	199	124	204	167	159	259						
250	116	152	172	200	174	251	166	107	185	146					
260	92	264	197	847	136	103	92	196	56	84	71	126		301	
270	207	121	164	150	344	512	326	1031	175	335	239	733	142	420	
280	145	137	203	215	264	168	700	152	241	175	291	301	4173	38	
290	123	146	116	178	323	185	127	203	220	123	143	186	1453		
300	44	157	210	183	135	169	112	130	180	152	277	449			
310	157	141	122	132	91	285	64	89	116	73	272	1140			
320	117	202	148	135	139	187	130	37	38		191				
330	70	207	108	164	131	46	226	53	36	179					
340	99	417	142	112	131	59	56	19			56	263			
350	61	241	122	116	151	58	34	70	397	118	242				
360	39	138	164	132	109	31	43		259	182	105				
(blank)															
Color Sca	0	200	400	600	800										

Figure 2-19
Casa Grande Sum of PM10 by Wind Azimuth (degrees) and Wind Speed (m/sec), All Hours (No Outliers)

Casa Grande — Sum of Hourly PM10 by Wind Azimuth (degrees) and Wind Speed (m/sec)

Sum of PM Column	0	1	2	3	4	5	6	7	8	9	10	11	12	13	Grand Total
Row Label															
0	115	2581	2212	2071	1348	116	193								8636
10	284	3182	2963	2091	685	549	27	1612		48					11443
20	303	4183	2931	1051	216	204	21	29							8939
30	45	4406	2989	615	150	196	69	82	40						8590
40	192	4515	2650	509	341	223	82	46	34	17					8608
50	218	7608	3002	572	802	307	926	761	153	47					14394
60	252	9387	3884	645	675	130	444	137	20	156	25				15754
70	185	9146	4931	1459	700	372	627	117	83	137	40	28			17826
80	613	9811	5527	1545	1555	1227	793	1418	174	292	1603				24556
90	687	12353	8850	2929	2748	2639	1850	1904	3831	3106	7235	1687			49817
100	176	12968	14015	2610	2381	1643	1083	1296	868	856	1061		21		38979
110	461	13683	15045	4344	932	728	514	617	247	547	849				37969
120	717	10920	12783	4088	2248	497	69	114	253		64				31752
130	195	7798	12582	4850	1205	1403	68	98	312						28509
140	229	8441	9839	3717	904	625	192	819							24765
150	138	5756	6737	2270	451	250	563	588							16754
160	438	5165	4654	1424	291	1055	462	184	907	302					14881
170	198	5635	4593	1452	614	919	231	99	55		533				14328
180	134	5865	4465	2065	1019	493	2457	167	340						17003
190	388	6005	5454	1356	551	675	2507	791	1581	281	152		56		19796
200	309	5790	4763	2210	1738	1176	1340	639	466	269	456	1188			20344
210	408	6406	5204	3285	1938	3314	2521	1639	1307	814	575				27410
220	606	7910	7048	2486	4620	2384	4395	691	68	37					30243
230	359	5156	5082	3041	2869	1652	773	495							19427
240	77	5548	5361	2590	1531	1202	294	734	523						17860
250	266	4774	4597	2928	1545	1105	560	243	517	210					16744
260	176	4555	5065	5500	2637	1481	894	535	313	84	71	126		301	21738
270	207	2829	4815	5589	5410	3058	2577	2101	1473	1156	696	1251	142	420	31724
280	285	2333	3590	6667	8609	5048	4808	2387	2023	1327	1121	858	4987	38	44078
290	218	1660	3180	5041	8429	7558	3284	2825	1571	461	851	206	2019		37303
300	201	2371	3157	3370	4042	3043	1899	976	692	510	277	792			21328
310	178	2379	2513	2751	1396	1841	287	480	116	141	503	1374			13961
320	221	2483	3792	3114	1860	913	351	37	38		191				13000
330	235	2761	2715	3169	1604	200	288	91	36	475					11574
340	156	3045	4182	3616	1488	389	133	19			56	263			13347
350	68	3131	3465	5881	2319	384	117	90	1020	118	242				16834
360	62	1075	2052	2794	1424	100	115		356	342	105				8424
Grand Total	10001	213612	200684	105692	73271	49097	37813	24860	19416	11732	16704	7773	7225	758	778638
Color Scale	0	2500	5000	7500	10000										

2.4 Pinal County Housing

Single-Variable Analyses – An analysis of PM10 impacts grouped by wind speed is presented in Table 2-5. The low averages for wind speeds less than 5 m/sec indicate the absence of continuously significant mechanical sources within a few miles of the monitor. The moderately high maximum hourly PM10 values, up to 5,000 µg/m^3, at wind speeds of 0 to 2 m/sec suggest, however, the presence of significant episodic sources near to the monitor that periodically contribute to elevated 24-hour average PM10 concentrations.

Table 2-5
Pinal County Housing Average and Maximum PM10, All Hours
(No Outliers)

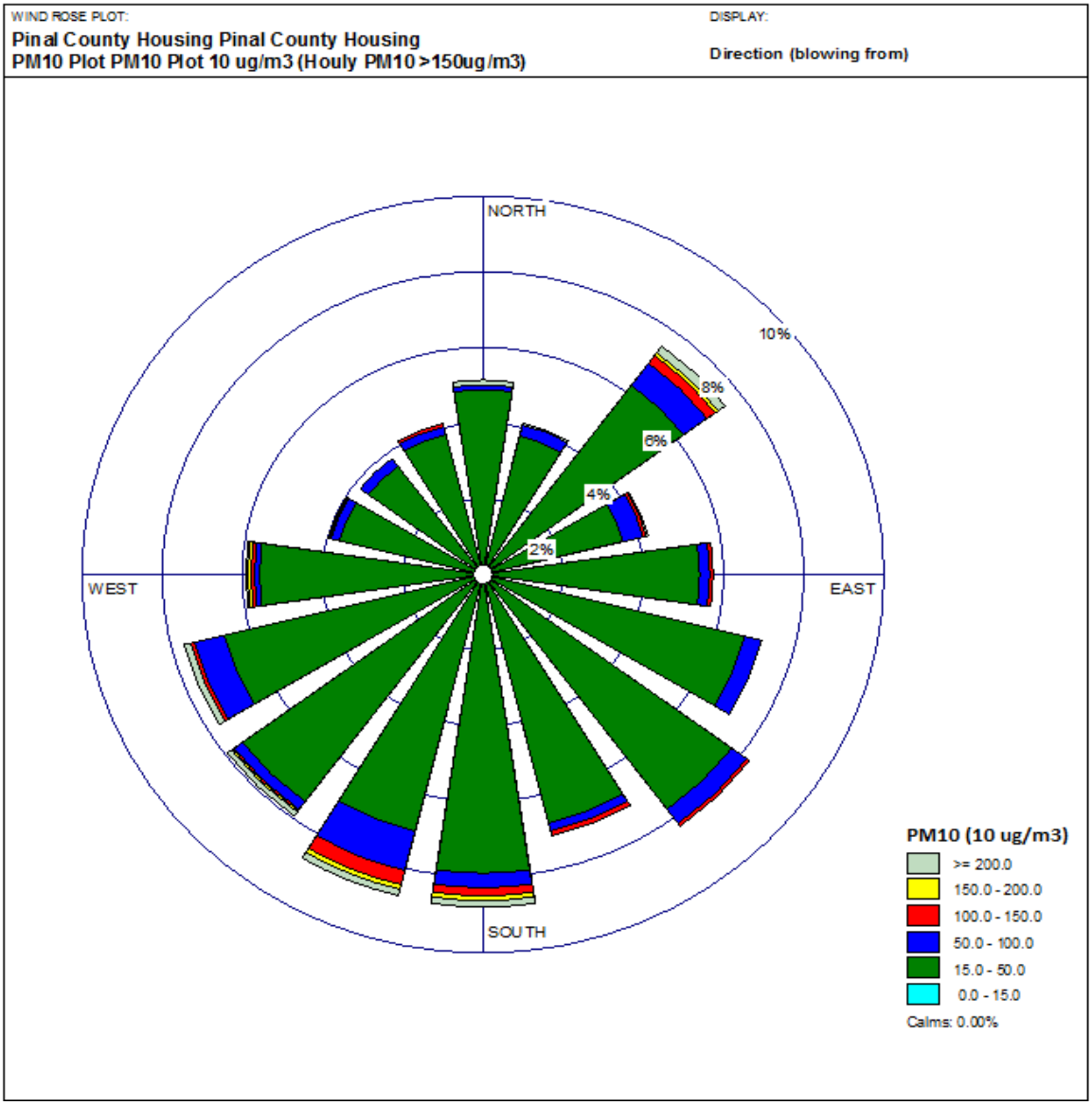
Wind Speed Category (m/s)	Observation Count	Average PM10	Max PM10
0~1	10808	74	2292
1~2	8564	56	5004
2~3	3486	47	937
3~4	1593	63	2914
4~5	869	105	8608
5~6	481	213	5591
6~7	212	408	8449
7~8	81	475	2311
8~9	24	954	5774
9~10	8	1098	4281
10~11	4	1302	3141
Total Count	26130	N/A	N/A

The relationships of hourly PM10 impacts and wind speeds were further studied by limiting the above analysis to those hours during which the monitor recorded hourly PM10 concentrations greater than 150 µg/m^3. The results of this analysis are shown in Table 2-6. The relationship between increasing wind speed and increasing fraction of hours when PM10 is greater than 150 µg/m^3 suggests that soils in the region of Pinal County Housing are frequently disturbed and available to contribute entrained PM10 emissions during high wind events. The higher fraction of elevated PM10 hours when wind speeds are less than 1 m/sec, compared to hourly fractions when wind speeds are between 1 and 4 m/sec, suggests the presence of PM10 sources close to the monitor that produce impacts when wind meander and limited dispersion occur at these low wind speeds.

Table 2-6 **Pinal County Housing Average and Maximum PM10, Hours Exceeding 150 µg/m^3** **(No Outliers)**			
Wind Speed Category (m/s)	Observation Count (Hours > 150 µg/m^3)	Fraction of Total Hours	Average PM10 (Hours > 150 µg/m^3)
0~1	1202	51%	241
1~2	475	20%	240
2~3	104	4%	259
3~4	103	4%	351
4~5	119	5%	446
5~6	152	7%	541
6~7	106	5%	748
7~8	52	2%	707
8~9	15	1%	1498
9~10	6	<1%	1442
10~11	3	<1%	1736
Total Count	2337	100%	N/A

A PM10 rose based on hours when PM10 concentrations exceed 150 µg/m^3 is presented in Figure 2-20. This rose shows that sources producing hourly PM10 concentrations above 150 µg/m^3 appear to surround the monitor. Sources producing the highest hourly concentrations appear to lie to the northeast, south, and south-southwest of the monitor.

Figure 2-20
Pinal County Housing PM10 Rose of Hours Exceeding 150 µg/m^3
(No Outliers)



Two-Variable Analyses – Hourly PM10 averages grouped by wind speed (m/sec) and direction (degrees) at Pinal County Housing are displayed in Figure 2-21. Uniform and moderate hourly PM10 averages at wind speeds less than 5 m/sec suggest that continuously emitting sources surround the monitor. These sources appear to produce an elevated background concentration of PM10 at the monitor, but not at levels that exceed the 24-hour standard. The uniformity of hourly averages within this range of wind speeds and in all directions also suggests the presence of mechanical dust sources of uniform emission strength. High hourly PM10 averages at wind speeds greater than 6 m/sec in many directions also suggests that disturbed soil surfaces surround the monitor, with sources centered on 50, 200, and 250 degrees from the monitor producing the highest impacts primarily because of the prevailing directions of highest wind speeds.

A corresponding table of hourly PM10 maxima by wind speed (m/sec) and direction (degrees) is presented in Figure 2-22. The occasional elevated PM10 maxima at wind speeds of less 6 m/sec indicate that sources relatively close and within arcs spanning 0 to 80 degrees and 180 to 270 degrees of the monitor periodically generate high levels of emissions.

The combinations of wind speeds and wind directions responsible for the greatest cumulative PM10 impacts are shown in Figure 2-23, which presents the sums of hourly PM10 concentrations grouped by wind speeds and directions. The highest cumulative subtotals at wind speeds of 1 to 2 m/sec suggest that sources within 4.5 miles, and in almost all directions, of the monitor are responsible for a majority of PM10 measured. At these wind speeds, mechanical generation will be the primary mechanism for emission generation.

Figure 2-21
Pinal County Housing Hourly PM10 Averages by Wind Azimuth (degrees) and Wind Speed (m/sec), All Data (No Outliers)

Pinal County Housing	Hourly PM10 Averages by Wind Azimuth (degrees) and Speed (m/sec), All Data (No Outliers)												
Average	**Colum**												
Row L	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Average**
0	108	65	45	60	29	77							77
10	76	62	51	60	182	71	1002						77
20	81	61	61	54	60	92	2065	57					78
30	65	58	51	103	72	115	348	300					69
40	77	54	50	50	80	215	406	1839					83
50	61	57	53	61	60	280	187	780	1016	919			106
60	68	69	60	56	55	71	288	223	302				79
70	73	55	46	55	137	168	179	464					69
80	72	61	47	56	250	1237	406						87
90	82	71	60	87	25	156	95						74
100	84	69	47	75	213	140		8449					88
110	86	71	60	70	198	304	250						76
120	75	73	48	58	267	64							73
130	72	72	45	49	42	112							67
140	73	64	45	77	81	167	108	410	90				65
150	65	61	48	43	78	184	413	655					62
160	76	64	46	41	87	392	257				108		63
170	79	60	55	36	81	48	176	100					61
180	73	66	56	44	79	47	218	727	744	800			80
190	80	74	54	74	70	116	194	235	239	510			82
200	87	69	55	53	55	77	213	281	320	1484	2235		91
210	68	71	53	48	62	84	208	495	525	413		370	84
220	84	67	49	48	62	99	364	122					73
230	84	74	48	53	61	59	496	409					71
240	73	68	49	56	53	290	174	1040	118				76
250	96	70	45	47	78	107	161	721	2198	661	570		79
260	95	66	41	47	66	102	277	576	234	5774			74
270	99	61	43	53	84	152	265	264					67
280	87	59	44	46	62	121	318	690					61
290	72	64	40	48	224	86	653	700					63
300	93	59	44	59	118	41							60
310	78	53	39	48	45	157							55
320	91	56	37	36	75	358							58
330	84	59	82	42	170	197	412						71
340	78	70	58	33	125	182							68
350	73	61	41	40	96	169							60
360	73	60	58	39	74	137							63
Average	**79**	**65**	**49**	**52**	**77**	**144**	**278**	**521**	**631**	**1229**	**1287**	**370**	**72**
Color Scale:		0	50	100	150	200	300	400					

Figure 2-22
Pinal County Housing Hourly PM10 Maxima by Wind Azimuth (degrees) and Wind Speed (m/sec), All Data (No Outliers)

Pinal County Housing	Hourly PM10 Maxima by Wind Azimuth (degrees) and Speed (m/sec), All Data (No Outliers)												
Max of P Colum													
Row L	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Max**
0	2052	554	237	344	69	146							2052
10	578	355	374	376	2234	359	3619						3619
20	633	455	417	171	444	219	5591	82					5591
30	498	697	379	2914	425	432	696	300					2914
40	976	463	224	357	597	1208	2922	1839					2922
50	369	450	288	235	321	2518	479	3731	2316	919			3731
60	588	505	1444	296	322	381	3883	1285	460				3883
70	503	336	301	198	543	730	382	622					730
80	490	431	180	184	1279	8608	1069						8608
90	454	531	371	636	42	217	95						636
100	522	442	188	511	629	259		8449					8449
110	565	667	837	192	449	558	250						837
120	395	622	168	410	1421	92							1421
130	436	540	159	203	248	396							540
140	387	557	583	1074	386	869	187	443	90				1074
150	310	441	524	417	711	850	1467	655					1467
160	457	386	376	255	617	1436	363				108		1436
170	341	568	422	163	1269	443	1402	190					1402
180	290	400	400	320	997	349	2265	3771	1880	800			3771
190	389	1049	379	2193	437	1134	2471	997	964	856			2471
200	587	721	670	317	552	765	2806	1439	814	4281	3141		4281
210	308	475	658	322	251	412	1108	2400	1579	826		740	2400
220	562	320	444	192	444	457	2033	250					2033
230	490	490	191	323	223	120	1737	781					1737
240	298	478	706	1139	216	3714	541	2311	118				3714
250	790	626	261	288	1104	722	732	3555	3875	661	570		3875
260	474	526	408	169	328	538	1589	718	252	5774			5774
270	2292	433	277	314	776	808	1088	264					2292
280	478	294	343	151	310	403	457	1568					1568
290	620	675	292	142	1289	86	2863	700					2863
300	648	421	619	506	215	41							648
310	435	949	313	163	104	296							949
320	484	341	133	118	127	498							498
330	613	549	5004	209	352	487	412						5004
340	457	1133	937	172	265	182							1133
350	452	1145	252	135	169	203							1145
360	319	479	372	187	206	202							479
Max	**2292**	**1145**	**5004**	**2914**	**2234**	**8608**	**5591**	**8449**	**3875**	**5774**	**3141**	**740**	**8608**
Color Scale:		0	100	200	400	800	1000	1500	2000				

Figure 2-23
Pinal County Housing Sum of Hourly PM10 by Wind Azimuth (degrees) and Wind Speed (m/sec), All Data
(No Outliers)

Pinal County Housing			Sum of Hourly Average PM10 by Wind Azimuth (degrees) and Speed (m/sec), All Data										
Sum of PI	**Colum**												
Row La	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Sum**
0	11853	7454	2113	1324	116	385							23245
10	11996	12886	4791	1750	4188	498	4006						40114
20	8964	11448	5741	2381	1797	1008	6195	114					37647
30	7647	11314	6312	6208	2367	2177	1739	300					38064
40	10431	10321	5752	4116	3857	7542	8518	1839					52376
50	6739	11466	4754	2078	2693	12037	5801	7802	6094	919			60384
60	8285	15428	3963	2031	1430	2066	5751	2895	603				42452
70	10225	11967	3024	1315	2459	1179	1076	1857					33102
80	11205	13933	3120	1070	2002	9893	1217						42439
90	12781	20054	3083	1040	76	312	95						37441
100	14204	23042	2503	1346	1276	700		8449					51520
110	17234	28992	3947	1048	988	609	250						53069
120	19553	39826	3867	1339	2402	128							67115
130	19455	40666	6283	1435	883	670							69392
140	14088	35070	7247	2678	2267	1499	216	820	90				63975
150	11192	31643	10415	2631	2956	1104	2480	655					63075
160	14686	31841	14009	4917	3137	3924	771				108		73393
170	13466	28077	16701	4498	3624	1104	2819	200					70488
180	9653	22096	12614	3995	4169	932	4584	7265	5209	800			71316
190	10005	22903	10572	8034	3877	3833	5614	3989	1194	2040			72060
200	9106	17006	9479	6983	5702	4993	8962	5900	2241	7419	4469		82260
210	9040	20432	11316	4326	5321	4791	6446	8905	5777	826		740	77920
220	10615	21524	9644	4429	4602	4929	7998	611					64353
230	9317	21636	9037	5517	1880	892	3473	1638					53389
240	7996	17191	10755	6582	2472	5800	2614	6242	118				59770
250	9613	15910	11680	8193	7161	4267	3210	5045	6593	661	570		72902
260	7490	15436	9878	7497	5804	4194	5822	1727	467	5774			64088
270	9105	14833	10070	5928	4044	4110	2918	264					51271
280	7739	15803	10367	3894	1799	1692	955	2071					44319
290	7483	16923	9145	1967	1795	86	3265	700					41363
300	9353	18480	7907	1818	355	41							37954
310	9650	14583	5842	869	136	315							31394
320	10170	15702	5577	1229	226	716							33620
330	8702	16278	10748	1093	681	590	412						38502
340	7672	16886	6731	756	627	182							32854
350	8698	14902	3292	889	383	338							28501
360	4642	5997	2211	815	517	410							14591
Sum	**390051**	**709945**	**274486**	**118017**	**90068**	**89946**	**97205**	**69284**	**28388**	**18439**	**5147**	**740**	**1891716**
Color Scale:		0	5000	10000	15000	20000							

Diurnal variations in PM10 impacts were analyzed by grouping hourly PM10 concentrations by hour of the day and wind speed or wind direction. The table showing hourly PM10 averages by wind direction and hour of the day is presented in Figure 2-24. Increasing hourly PM10 averages between 0700 and 1000 hours suggest that mechanical activities produce higher emissions from sources near the monitor than occur between 0100 and 0700 hours. Decreasing hourly PM10 averages between 1000 and 1500 hours, compared with averages between 0700 and 1000 hours, suggest either lower emission rates or, more probably, increasing mixing height overcoming higher morning emissions. Scattered elevated PM10 averages between 1600 and 2100 hours suggest episodic source impacts, possibly resulting from high wind events.

Figure 2-25 shows the hourly PM10 averages by wind speed and hour of the day. The cluster of highest averages between 0900 and 2300 hours and between 6 and 11 m/sec wind speeds suggests that high wind events produce the highest consistent concentrations at the monitor, and that high wind events tend to occur during these hours and not during nocturnal hours after 2300 hours.

Figure 2-25 also shows the increase in PM10 averages from 0700 to 1000 hours at all wind speeds, possibly due to increases in mechanical source emissions near the monitor. Correspondingly, averages are seen to rise between 1900 and 2200 hours, especially at very low wind speeds, but these increases occur after the evening traffic peak. Looking back at Figure 2-24, evening increases in PM10 appear when winds are blowing from some, but not all, directions toward the monitor. Emission investigations at this site should include an assessment of mechanical activities occurring during these hours of the day within one or two miles and within the arc of 60 to 200 degrees of the monitor.

Finally, fairly low PM10 averages are seen at wind speeds between 6 and 8 m/sec during the nocturnal hours of 0400 to 0800. The lack of windblown dust at these wind speeds and during these hours suggests the presence of a mitigation factor unique to this time period. The source of this mitigating influence should also be included in emission investigations at this site.

Figure 2-24
Pinal County Housing Hourly PM10 Averages by Wind Azimuth (degrees) and Hour of Day, All Data (No Outliers)

Pinal County Housing Hourly PM10 Averages by Wind Azimuth (degrees) and Hour of Day, All Data (No Outliers)

Averag Colu Row	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Averag
0	43	24	70	37	37	47	71	89	130	116	97	60	37	38	37	51	22	71	174	98	110	79	88	40	77
10	55	36	27	43	31	49	65	97	123	121	66	52	57	41	27	27	40	63	55	124	135	101	160	262	77
20	42	41	55	40	34	32	52	79	112	105	86	57	55	41	69	34	35	36	266	116	147	62	41	58	78
30	47	50	34	33	35	39	56	72	128	87	59	65	95	84	45	217	65	53	48	103	78	82	38	83	69
40	46	40	43	52	28	34	44	86	104	127	260	199	94	85	170	105	63	61	118	71	90	68	62	54	83
50	47	42	39	35	34	42	38	74	75	81	165	224	315	146	179	76	81	113	299	97	117	84	78	50	106
60	96	64	40	35	44	37	39	90	110	81	54	74	57	53	23	32	55	416	100	160	159	83	58	28	79
70	59	66	45	50	40	39	51	72	98	63	88	96	43	42	59	58	19	24	80	146	97	77	109	87	69
80	58	56	99	47	44	38	58	77	70	45	36	47	53	31	24	37	34	857	222	106	115	128	85	48	87
90	72	80	69	36	34	44	36	75	91	113	52	27	16	31	29		38	55	132	158	123	140	80	59	74
100	285	48	48	50	47	38	54	81	81	110	39	63	16	15	4	35	42	69	136	161	139	105	66	74	88
110	79	56	53	43	51	43	49	96	102	47	55	62	49	31	11	10	119	166	48	165	149	110	75	76	76
120	60	69	56	48	36	40	56	70	105	91	75	28	127	34	115	32	23	410	62	175	132	103	91	75	73
130	75	76	52	47	37	31	48	69	111	58	45	39	20	30	25	7	57	103	124	113	121	91	86	80	67
140	65	63	50	40	43	36	45	63	106	59	46	33	28	35	38	32	54	83	98	203	103	110	88	78	65
150	68	54	41	36	32	32	49	58	82	73	62	26	55	23	24	16	188	66	36	175	108	129	77	90	62
160	73	55	48	35	35	35	36	64	92	84	52	35	44	20	38	57	17	125	141	85	146	113	100	68	63
170	56	52	41	37	36	32	39	66	86	69	60	38	51	20	56	25	25	48	127	140	108	118	89	71	61
180	60	50	36	33	36	38	36	63	66	110	72	52	85	66	141	181	46	47	83	192	147	210	102	78	80
190	62	53	44	61	48	45	54	70	102	77	50	53	30	62	32	143	297	205	122	144	101	162	80	86	82
200	58	58	45	36	40	39	44	66	79	75	54	71	48	86	106	160	129	180	363	164	133	80	103	80	91
210	64	47	40	38	41	44	55	69	97	80	57	64	105	66	116	115	124	92	87	83	124	98	75	99	84
220	68	49	43	43	31	44	40	54	91	66	54	43	29	54	48	80	164	76	77	82	91	124	118	92	73
230	56	34	54	59	42	35	30	87	77	90	67	58	51	41	45	107	51	94	73	92	120	106	100	66	71
240	71	27	27	41	56	56	39	63	109	75	57	45	36	49	48	52	94	91	72	107	120	138	217	70	76
250	93	74	20	40	52	34	47	127	72	107	62	52	49	40	49	64	80	47	84	150	180	154	109	73	79
260	40	40	39	43	28	20	45	90	83	119	80	55	49	63	64	67	52	52	75	270	98	102	109	15	74
270	69	22	32	32	40	27	49	67	93	115	76	87	50	39	40	52	60	53	66	88	213	88	79	74	67
280	86	43	27	58	53	45	78	95	105	120	83	83	46	35	37	34	44	53	69	122	106	76	62	55	61
290	27	59	30	41	20	45	54	84	151	80	68	69	63	84	33	34	37	53	71	95	232	68	29	42	63
300	59	37	32	44	31	32	59	67	97	85	101	61	53	41	32	33	39	59	91	127	94	116		61	60
310	46	44	40	47	23	64	44	48	99	81	71	54	39	37	41	34	32	79	80	62	149	56	64	55	55
320	28	24	30	36	37	37	41	88	62	111	87	58	43	34	28	44	32	41	112	155	93	127	43	75	58
330	31	55	14	17	38	32	43	75	106	92	80	43	53	27	48	38	43	57	91	124	328	128	30	24	71
340	65	69	27	40	32	36	48	97	126	135	88	46	61	39	28	30	35	46	120	110	110	61	35	42	68
350	25	39	53	40	52	47	43	65	109	86	117	55	43	46	29	26	23	37	66	134	109	76	40	23	60
360	37	30	50	30	28	41	54	110	109	178	113	44	56	31	40	36	33	53	54	77	106	63	51	56	63
Averag	**71**	**57**	**47**	**41**	**38**	**38**	**47**	**74**	**96**	**89**	**74**	**63**	**60**	**52**	**53**	**61**	**62**	**79**	**103**	**127**	**129**	**111**	**90**	**76**	**72**

Color Scale:	0	50	100	150	200	250	300

Figure 2-25
Pinal County Housing Hourly PM10 Averages by Wind Speed (m/sec) and Hour of Day, All Data (No Outliers)

Pinal County Housing Hourly PM10 Averages by Wind Speed (m/sec) and Hour of Day, All Data

Averag	Colu																								
Row	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**Averag**
0	68	57	45	43	38	39	50	82	110	106	81	73	60	37	47	44	46	75	134	141	132	118	96	77	79
1	65	61	48	42	40	40	48	76	102	92	71	52	42	35	30	28	30	45	78	107	118	103	84	73	65
2	54	42	38	32	33	31	41	63	80	71	52	42	40	34	30	29	32	42	55	71	122	79	63	61	49
3	46	60	34	22	27	25	30	49	68	54	48	45	39	35	37	55	53	51	54	69	96	86	65	71	52
4	55	45	171	33	38	33	49	53	83	79	50	57	64	41	50	65	64	73	86	134	152	180	191	86	77
5	170	42	25	94	58	34	38	64	82	77	142	85	65	109	111	106	119	344	324	203	289	144	406	121	144
6	91	79	83	50	56	28	17	98	42	141	271	285	185	257	263	253	336	295	834	679	225	508	140	1228	278
7	8449	301	23	96			25		137	325	309	372	931	294	269	565	412	598	208	716	1308	1190	335	181	521
8	95		40							289	450	784	593	395	794	586	822		543	3875	946		39	87	631
9									749			447		1398	412	1660		456	2471	3300	14				1229
10																	1328	3141		570		108			1287
11										740	0														370
Averag	**71**	**57**	**47**	**41**	**38**	**38**	**47**	**74**	**96**	**89**	**74**	**63**	**60**	**52**	**53**	**61**	**62**	**79**	**103**	**127**	**129**	**111**	**90**	**76**	**72**
Color Scale:		0	50	100	150	200	250	300																	

Summary – Mechanical dust sources within one mile of and surrounding the Pinal County Housing monitor appear to daily produce moderate PM10 concentrations, between 45 and 100 $\mu g/m^3$ at the monitor. Information on candidate sources fitting this profile should be collected at this site, possibly through interviews of residents or employees typically situated at or near the housing complex during daylight hours. Hours of maximum PM10 concentrations in excess of 1000 $\mu g/m^3$ should be investigated with respect to wind speed and direction to determine which of these continuous sources has the potential to generate high PM10 hourly values during episodic events. High wind events also appear to be responsible for high PM10 hours at the monitor. Back-trajectories of high wind hours on design days should be computed and the disturbance status of lands along these back-trajectories should be determined on these days through interviews of property owners or leasees. Land uses within 4 miles of the monitor in an arc from 90 to 230 degrees should be compared to those in the complementary arc to identify any differences that may contribute to the cumulatively higher impacts being generated in the former range of directions. Finally, the cause of nocturnal mitigation of emissions during wind speeds of 6 to 8 m/sec should be probed.

Inventory Focus – Mechanical source activity in areas immediately surrounding the Pinal County Housing monitor should be the focus of inventory data collection and analysis for the low wind day modeling inventory. On the high wind design day of January 1, 2008, the disturbance status of lands along the high wind hour back-trajectories should be assessed through interviews of property owners or lessees.

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3. DESIGN DAY SELECTION

3.1 Introduction

On February 3, 2011, the U.S. Environmental Protection Agency (U.S. EPA) designated the central portion of Pinal County as nonattainment for the 24-hour PM2.5 National Ambient Air Quality Standard (NAAQS), and designated the same area as attainment or unclassified for the annual PM2.5 NAAQS.[16] The rationale for the latter designation was based on the finding that the single monitoring site exceeding the annual standard, Cowtown, was a population-oriented microscale (i.e., localized hot spot) monitor that was not eligible for designation as a nonattainment site for the annual standard. On May 31, 2012, U.S. EPA designated a somewhat larger portion of central Pinal County as nonattainment for the 24-hour PM10 NAAQS.[17] The annual PM10 NAAQS was revoked by U.S. EPA on October 17, 2006. As a result of these decisions, the attainment demonstration for both PM2.5 and PM10 in Pinal County must be based on ambient air quality conditions and contributing emissions on specific design days.

Through discussions between U.S. EPA, ADEQ, and PCAQCD, a base year of 2008 was selected for the preparation of an emission inventory and an attainment demonstration. This is the year of the most recent triennial National Emission Inventory prepared by ADEQ and PCAQCD and approved by U.S. EPA. During 2008, exceedances of the 24-hour PM2.5 NAAQS were recorded at Cowtown, and exceedances of the 24-hour PM10 NAAQS were recorded at Maricopa, Cowtown, Stanfield, Casa Grande, Combs School, and Pinal County Housing. At each of these latter sites, continuously recording TEOMs are used to record hourly averaged PM10 ambient concentrations. At the Cowtown site, a filter-based instrument is used to record 24-hour average PM2.5 concentrations.

In an analysis of the relationship between PM2.5 and PM10 concentrations at Cowtown, ADEQ concluded that any control measures that will achieve attainment of the PM10 NAAQS will also yield attainment of the PM2.5 NAAQS.[18] This conclusion was based on the predominance of local source emissions, primarily from four nearby feedlots and disturbed soil surfaces, on elevated concentrations of both PM2.5 and PM10 measured at the Cowtown monitor. The monitoring data upon which this analysis was based were collected at the Cowtown station between 2006 and 2008.

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[16] Federal Register, Vol. 76, No. 23, Thursday, February 3, 2011
[17] Federal Register, Vol. 77, No. 105, Thursday
[18] Analysis of PM2.5 Exceedances in Pinal County Arizona: Demonstration that PM2.5 Concentrations are Driven by Local Sources of PM10 Near the Cowtown Monitor, Arizona Department of Environmental Quality, March 15, 2010

3.2 PM10 Exceedance Days

Each of the six monitoring sites deemed to be nonattainment for the 24-hour PM10 NAAQS recorded several exceedances of the 150 µg/m^3 standard. The numbers of exceedances recorded at each site in 2008 are presented in Table 3-1. The 24-hour average PM10 concentrations measured at each site on each monitoring day in 2008 are tabulated in Appendix A.

Table 3-1
Exceedances of 24-Hour Average PM10 and PM2.5 NAAQS at Pinal County Monitoring Sites in 2008

Monitoring Site	Number of Exceedances	
	PM10	PM2.5
Casa Grande	3	0
Combs School	4	N/A
Cowtown	173	7
Maricopa	6	N/A
Pinal County Housing	10	N/A
Stanfield	14	N/A

Initial evaluation of the relationships of hourly wind speed and PM10 concentration at the four sites with longer PM10 monitoring records indicated the presence of two primary meteorological scenarios that produced hourly PM10 concentrations in excess of the 24-hour NAAQS of 150 µg/m^3: high wind conditions, and stagnation conditions. The sources responsible for high PM10 concentrations are fundamentally different under these two scenarios. During high wind conditions, disturbed soil surfaces typically dominate the emission inventory and, because of the tendency of wind trajectories to remain somewhat constant during these periods, sources within a narrow band along the upwind trajectory and within one hour's transport distance of a monitor tend to significantly contribute to recorded PM10 concentrations. Conversely, during stagnation conditions, when wind speeds are typically below 3 mph, wind entrainment of loose soil particles is virtually nonexistent, and mechanical sources that lift particles into the air through combustion, vehicle movement, and other anthropogenic activities are primarily responsible for recorded PM10 concentrations. Additionally, because transport distances are relatively short under low wind conditions, only those sources within one mile in any direction of a monitor contribute to high hourly PM10 concentrations during stagnation conditions. Because of these differences in source mix and the need to demonstrate attainment under the range of meteorological conditions found at Pinal County monitors, a committee providing technical assistance to the development of the Pinal County PM2.5/PM10 State Implementation Plan (SIP) advised that at least one stagnation and

one high wind design day be selected for each nonattainment monitor ultimately selected for emission inventory and attainment demonstration development.

3.3 Stagnation Design Days

Table 3-1 shows that Cowtown is unique among the Pinal County monitoring stations with respect to PM10 exceedances. The proximity of stationary sources under permit to PCAQCD and transportation corridors to the Cowtown monitor in 2008 caused or significantly contributed to the very high number of PM10 exceedances recorded there in that year. While high wind conditions occurred on some of these exceedance days, a substantial number of exceedances occurred on stagnation days with little to no wind entrainment of loose soil particles nor wind transport of suspended PM10 over extended distances. Instead, mechanical sources caused the elevated PM10 impacts at the Cowtown monitor on stagnation days.

Some of these mechanical sources are common to most of the nonattainment PM10 monitoring sites. A control program that reduces emissions from these sources sufficient to attain the PM10 24-hour NAAQS at the stations other than Cowtown will provide air quality benefits to Cowtown and help define the reductions needed from sources that uniquely impact the Cowtown site. When this approach was endorsed by the SIP advisory committee, a list of PM10 exceedances occurring on stagnation days for stations other than Cowtown was assembled. This list is provided in Table 3-2.

Table 3-2 indicates that two monitoring sites—Pinal County Housing and Stanfield—exceeded the 24-hour PM10 NAAQS on one of the stagnation days, October 29, 2008. Table A3 in Appendix A shows that the Cowtown site also exceeded the 24-hour PM10 NAAQS on this date, and analysis of the meteorological data shows that October 29, 2008, was also a stagnation day at this site. Plots of hourly PM10 concentration, wind speed, wind direction, and mixing height recorded or modeled at each of these three monitoring sites on October 29, 2008, are presented in Appendix B. As each of the PM10 vs. Wind Speed plots show, wind speeds were low (typically less than 4 mph) and fluctuations in PM10 concentration did not correlate well with fluctuations in wind speed.

Table 3-2
PM10 Exceedances on Stagnation Days in 2008 at Monitoring Sites Other Than Cowtown

Date	Site	24-Hour Average PM10 Concentration ($\mu g/m^3$)
4/26/08	Stanfield	207.5
5/10/08	Stanfield	161.7
10/29/08	PCH	178.0
	Stanfield	162.1

These conditions are representative of stagnation conditions. Additionally, there were no high wind speed hours recorded at any of the three sites on this day. Because of these factors, October 29, 2008, was selected by the SIP advisory committee as the design day for the attainment demonstration under stagnation conditions at each of these three monitoring sites. Because no PM10 exceedances occurred on stagnation days at the Maricopa, Casa Grande, or Combs School monitoring sites, these sites were not included in the list of low wind speed attainment demonstrations to be addressed in the SIP.

3.4 High Wind Design Days

The control strategies needed to reduce emissions from high wind sources are different from those applicable to stagnation sources. High wind sources typically consist of disturbed soil surfaces that require shielding from the wind, covering of soil surfaces, or the consolidation of wind-entrainable surface particles into wind-resistant matrices in order to reduce PM10 emissions. High wind source emission strength is directly related to the magnitudes of wind velocity and disturbed surface area, and the soil texture. Stagnation sources typically involve mechanical or combustion processes from which PM10 emissions can be controlled through either pre-treatment of emission-generating materials or the capture of PM10 released by these processes. In sum, PM10 concentrations from wind events are primarily proportional to the areas of wind-affected soils, while concentrations from stagnation events are proportional to activity rates of mechanical sources.

Control strategies for high wind sources are best developed from the analysis and modeling of design days during which only these sources are contributing to ambient PM10 concentrations. To identify days on which these conditions existed, the PM10 exceedance days recorded at each of the six nonattainment monitoring sites were screened for hourly average wind speeds during hours of high PM10 concentrations. From limited analysis of the relationships between hourly wind speeds and PM10 concentrations over the 2008 baseline year at the monitoring stations continuously sampling these parameters, an average wind speed of 12 mph was estimated to be the threshold velocity for the generation of significant PM10 emissions from disturbed soil surfaces and was chosen as the definitional cut point for the identification of high wind hours in the 2008 meteorological record.

3.5 Cowtown

Several criteria were used to select the high wind day at the Cowtown monitoring site. These included the 24-hour average PM10 concentration for the day, the number of hours during which the hourly average wind speed exceeded 12 mph, the number of hours during which the high winds blew from areas other than the directions of the nearby stationary and transportation sources, and the correlation between hourly wind speeds and PM10 concentrations. These statistics are tabulated for the candidate high wind days at Cowtown in 2008 in Table C1 in Appendix C. The initial list of high wind days shown in the table represents those days on which the hourly wind speed exceeded 12 mph for at least one hour during the day.

The high wind PM10 exceedance days in the Appendix C table are ranked by 24-hour PM10 concentration. The screening criteria enumerated above were used sequentially to eliminate days from consideration, starting at the top of the table and working down. The average number of high wind hours per day was calculated to be 4.03 on PM10 exceedances days. Days reporting 4 or fewer high wind hours were removed from consideration as these days either included hourly PM10 concentrations in excess of 150 $\mu g/m^3$ during low wind hours (suggesting the influence of stagnation day sources), or resulted from very high PM10 concentrations for four or fewer hours in a day, such as result from passage of monsoon winds, which would normally qualify as an exceptional event because of the overpowering of emission controls qualifying as best available control measures. This screen reduced the number of candidate days from 36 to 11, but retained the top two highest PM10 days: May 21 and November 9, 2008.

Emission reductions at the stationary sources and transportation corridors south and west of the Cowtown monitor are expected to be critical to the attainment of the 24-hour PM10 NAAQS on stagnation days. The controls developed to achieve these reductions are also expected to significantly reduce windblown PM10 emissions from these facilities. In order to develop a control strategy that will be effective on all high wind days, a high wind design day during which high winds blow from sources other than those to the south and west is desirable. In the second screening of candidate days, the number of high wind hours during which the wind blew from sources other than those to the south and west—i.e., when the wind was blowing from a direction greater than 303 degrees or less than 134 degrees—were tabulated and days with 0 high wind hours meeting this condition were eliminated from consideration. As the table in Appendix C shows, this condition reduced the candidate days from 11 to 4: October 27, September 29, April 27, and November 21, 2008.

Review of hourly plots of wind speed and PM10 concentration for stagnation days in Appendix B demonstrated that a final criterion for screening high wind days should be the correlation of hourly PM10 concentration to wind speed. This was deemed to be useful since, in view of the many elevated PM10 concentrations recorded during low wind conditions at Cowtown, the recording of a high PM10 concentration during a low wind hour could be due to emissions from mechanical sources observed frequently by PCAQCD inspectors at Cowtown that would adversely skew the analysis of high wind source impacts at the monitoring site. The correlation between hourly wind speed and PM10 concentration was computed for each day at Cowtown in 2008, and the resulting values were included in Table C1 in Appendix C. Review of these values shows negative correlations on October 27 and September 29, and positive correlations on April 27 and November 21, 2008. Of these latter two days, April 27 has the higher correlation value and the higher 24-hour PM10 concentration. On this basis, April 27, 2008 was selected by the SIP advisory committee as the high wind design day for the Cowtown monitoring site. The hourly profiles of PM10 concentrations, wind speed, wind direction, and mixing height for this date are shown in the plots contained in Appendix C.

3.6 Stanfield

During 2008, exceedances of the PM10 24-hour standard were recorded at Stanfield on 11 days on which the hourly wind speeds exceeded 12 mph for at least one hour. These dates, together with PM10 and wind speed statistics, are presented in Table D1 in Appendix D. The dates are ranked by highest-to-lowest 24-hour average PM10 concentration measured at the Stanfield monitor.

In the first screening of these data, days with fewer than the average number of high wind hours for the days listed were eliminated from consideration as the design day should include a greater-than-average number of high wind hours. The average number of high wind hours calculated for these exceedances is 6.2 hours per day. This initial screen reduced the candidate exceedances days from 11 to 6. The remaining candidate days, having at least 7 high wind hours each, were November 9, May 21, January 1, November 15, November 21, and December 13, 2008.

These remaining days were further screened by the correlation of hourly PM10 concentration to wind speed. The date with the highest correlation, May 21, 2008, was further evaluated by reviewing the hourly plots of PM10 concentration, wind speed, wind direction, and mixing height. These plots are also presented in Appendix D. The plot of PM10 concentration and wind speed, Figure D1, shows a significant drop in PM10 concentration at 1400 hours and then a return to previous hourly values without any corresponding drop in wind speed. It is unclear what might have caused this anomalous fluctuation in PM10 concentration, but the lack of a change in wind speed causes this day to be questionable as a high wind design day candidate.

The day with the next-highest correlation between PM10 concentration and wind speed was November 9, 2008. Plots of hourly PM concentrations, wind speeds, wind directions, and mixing heights for this day appear in Figures D4 through D6. Like May 21, this candidate design day also shows a significant decline in PM10 concentration at 1200 hours and a slow return while wind speeds steadily increase. This precipitous drop in hourly PM10 concentration and later return similarly cannot be explained. The use of these data to calculate and model windblown dust emission rates, however, would lead to both errors in the emission rates and the lack of good correlation between modeled and monitored PM10 concentrations at the Stanfield monitor. For this reason, November 9, 2008, was questioned as a design day candidate.

The day with the third-highest correlation between hourly PM10 concentrations and wind speeds was December 13, 2008. Plots of hourly PM10 concentrations, wind speeds, wind directions, and mixing heights for this day are presented in Figures D7 through D9. Figured D7 shows a short-term drop and return in PM10 concentration commencing at 1200 hours without any decline, and in fact an increase, in hourly wind speed, which raises the same questions of modeling accuracy discussed above for May 21 and November 9, 2008. Like these two latter candidate days, December 13, 2008, was questioned as a candidate for the high wind design day for the Stanfield site.

The day with the fourth-highest correlation between hourly PM10 concentrations and wind speeds was November 21, 2008. Plots of hourly PM10 concentrations, wind

speeds, wind directions, and mixing heights for this day are presented in Figures D10 through D12. Although this day shows a small decline in PM10 concentration at 0800 hours, the drop is far less dramatic than is evidenced in the three candidate days with higher PM10 concentration-to-wind speed correlations. As a result of this smoother hourly PM10 profile and the relatively good statistics in the categories evaluated, November 21, 2008 was chosen as the high wind design for the Stanfield site.

3.7 Pinal County Housing

The monitoring station at Pinal County Housing recorded seven exceedances of the PM10 24-hour standard on high wind days in 2008. These dates, together with PM10 and wind speed statistics, are presented in Table E1 in Appendix E.

The process of choosing a high wind design day for the Pinal County Housing site followed a process similar to that used at the Cowtown site. First, high wind days were sorted into those that recorded more than 4 hours of hourly average wind speeds greater than 12 mph. This had the effect of excluding short duration, monsoonal-related, high wind days from the analysis, and reduced the list from seven candidate days to three: June 21, January 1, and October 27, 2008. The correlation values of hourly wind speed to PM10 concentration were then compared for these three days. Although October 27, 2008, recorded the highest correlation, this date had the lowest 24-hour average PM10 concentration and the lowest number of high wind hours of the three candidate days. January 1, 2008, recorded the second-highest correlation between hourly wind speeds and PM10 concentrations, and had the second-highest 24-hour average PM10 concentration. The 24-hour average PM10 concentration on June 21, 2008, was only 4% higher than that of January 1 (271 vs. 260 $\mu g/m^3$), but the wind speed/PM10 concentration correlation for June 21 was 27% lower than that of January 1. Based on these considerations for the two top candidate days, January 1, 2008, was selected as the high wind design day for Pinal County Housing. Plots of hourly PM10 concentration, wind speed, wind direction, and mixing height for January 1 are also presented in Appendix E.

3.8 Maricopa

In 2008, six exceedances of the PM10 24-hour standard were recorded at the Maricopa monitor. All of these exceedances occurred on high wind days. Wind and PM10 statistics for each of these days are presented in Table F1 in Appendix F.

Until the modeling domains for low wind and high wind days at the Cowtown monitoring site were established, the working assumption of the SIP steering committee was that the emission control strategies demonstrating attainment at this site would simultaneously demonstrate attainment at the Maricopa site. When the Cowtown modeling domains were selected, the committee realized that the Maricopa site was sufficiently distant from these study areas as to invalidate this working assumption. Upon that realization, the committee agreed to develop a separate emission inventory focus and attainment demonstration based on a modeling domain specific to the Maricopa site.

The selection of a high wind design day for the Maricopa site was based primarily on the number of high PM10 hours recorded on each candidate day. On May 21, 2008, hourly PM10 concentrations spiked at 1300 hours at an hourly average value of 1704 $\mu g/m^3$, but levels in both the preceding and succeeding hours were below 920 $\mu g/m^3$. During the same hours, hourly average wind speeds remained fairly constant, suggesting a poor correlation between wind speed and PM10 concentration during 1200 to 1400 hours. Because of this lack of good correlation, this date was not considered to be a good candidate for a design day.

On August 7, 2008, hourly PM10 concentrations also spiked for a three-hour period in the late evening. Hourly wind speeds followed a similar trend, suggesting the presence of a thunderstorm outflow on this day. Because hourly PM10 concentrations exceeded the 24-hour standard for only three hours, this day was also deemed not to be a good candidate for a design day.

Another three-hour PM10 spike was recorded on September 11, 2008. Although this spike corresponded to a similar rise and fall in hourly average wind speed, the very limited number of hours of high PM10 concentrations also eliminated this day from consideration as a design day.

Hourly PM10 concentrations exceeded the 24-hour standard for a period of seven non-contiguous hours on October 11, 2008. Although hourly wind speeds were close to or exceeded 12 mph during these hours, there is little correlation between wind speed and PM10 concentration during the high PM10 hours. As a result, this day was also not considered to be a good candidate for a design day.

The 24-hour PM10 standard was exceeded on six successive hours on October 27, 2008. The rise of hourly PM10 concentrations between 0700 and 0900 hours on that day closely followed the rise in hourly wind speeds. Although hourly average wind speeds remained elevated through 1600 hours, hourly PM10 concentrations fell between 0900 and 1200 hours back to the level of the 24-hour standard and continued to decline slowly through the remainder of the day. This relationship suggests that contributing windblown dust sources contained limited reservoirs of abradable material, and that these reservoirs were exhausted by hourly wind speeds peaking at 18 mph at 0900 hours. The good correlation between hourly wind speed and PM10 concentration during the rise in PM10 and the continuing decline in hourly PM10 concentration after the daily peak make this day a reasonable candidate for a high wind design day.

On the last PM10 exceedance day in 2008 at the Maricopa monitor, which occurred on November 9, 2008, hourly PM10 concentrations rose and fell in two spikes of two hours duration each, while hourly wind speeds gradually rose from the beginning of the first spike at 1,000 hours to the peak for the second hourly PM10 spike at 1600 hours. The poor correlation between hourly wind speed and PM10 concentrations during this interval makes this day a poor candidate for a design day.

Based on the analyses of each PM10 exceedance day recorded in 2008 at the Maricopa monitor, the advisory committee selected October 27, 2008, as the high wind design for

this monitoring site. Hourly plots of wind speed, wind direction, mixing height, and PM10 concentration for this day are shown in Figures F-1 through F-3 in Appendix F.

3.9 Combs School and Casa Grande

All of the PM10 exceedances recorded at the Combs School and Casa Grande sites in 2008 occurred on high wind days. Like the Maricopa site, the SIP steering committee assumed that a high wind day attainment demonstration developed for the Casa Grande site would also demonstrate PM10 attainment at the Combs School site due to proximity and a similar set of disturbed soil land uses impacting each site. The Casa Grande site was subsequently determined to be impacted not by local emission sources, but only by regional windblown dust sources that would be subject to control under the attainment strategies developed for the Cowtown, Stanfield, Maricopa, and Pinal County Housing sites. At this point, the committee conducted a limited analysis of hourly PM10 and wind relationships on exceedance days, and concluded that the high wind control strategies that would bring the Casa Grande site into attainment would also provide the same benefit at the Combs School site. As a result, these sites were not chosen for development of modeling domain emission inventories or attainment demonstrations.

3.10 PM2.5 Exceedance Days

The national 24-hour ambient air quality standard for PM2.5 of 35 $\mu g/m^3$ was exceeded at only the Cowtown monitoring station during 2008. A tabulation of the 24-hour average PM2.5 concentrations, PM10 concentrations, and wind speed statistics for these days is shown in Table G1 in Appendix G. The exceedance days are ranked in the table from highest to lowest 24-hour average PM2.5 concentration for each day.

PM2.5 is collected by a filter-based sampler that produces only 24-hour average concentrations at the Cowtown station. Hourly average values of PM2.5 are not available from this type of monitoring. As a result, fluctuations in hourly PM10 concentrations were evaluated as a surrogate for hourly PM2.5 values, based on the close correlation between PM10 and PM2.5 concentrations reported in an analysis conducted by ADEQ.

At the Cowtown monitoring site, PM10 concentrations are dominated by emissions from south and west of the monitor. Because of the close correlation between 24-hour average PM10 and PM2.5 concentrations recorded at this site, it is logical that PM2.5 concentrations are also heavily influenced by emissions from the stationary sources and transportation corridors in these directions. As a result, the PM2.5 design day should not be a high wind day, but rather a day in which wind directions are from the south or west to the monitor at wind speeds less than 12 mph. The hourly PM10 concentrations, wind speeds, wind directions, and mixing heights of the days listed in Table G1 were plotted and reviewed using these criteria in selecting a PM2.5 design day. These plots are presented in Figures G1 through G21 in Appendix G.

The day with the highest PM2.5 concentration—March 25, 2008—has a single hour with a very high PM10 concentration that represents approximately 40% of the 24-hour

average for that day. Because of the very small number of high PM10 concentration hours, this date was not considered to be a good candidate for the PM2.5 design day.

The day with the second-highest PM2.5 concentration—April 12, 2008—contains a similar evening PM10 spike spanning three hours. This spike represents approximately 79% of the 24-hour average for this day. Again, because of the small number of high PM10 hours, this date was not considered to be a good candidate for the PM2.5 design day.

The day with the third-highest PM2.5 concentration—May 6, 2008—includes two hours with the highest PM10 concentrations when wind speeds exceeded 12 mph. Because of the desire to avoid days when high winds caused high PM10 concentrations that dominated the 24-hour average, this day was not considered to be a good candidate for the PM2.5 design day.

The day with the fourth-highest PM2.5 concentration—April 30, 2008—also contains a single high PM10 hour during which the wind speed exceeded 12 mph. Because of this high wind contribution, and the significant contribution made by this single hour to the 24-hour average concentration, this day was also not considered to be a good candidate for the PM2.5 design day.

The day with the fifth-highest PM2.5 concentration—November 20, 2008—includes a major PM10 peak spanning four hours in the evening and a minor PM10 peak in the early morning spanning two hours. None of the hours spanned by these peaks exceeded the assumed high wind speed threshold of 12 mph. In the absence of concerns raised in the days with higher PM2.5 24-hour concentrations, this day was considered to be a reasonable candidate for the PM2.5 design day.

The day with the sixth-highest PM2.5 concentration—June 23, 2008—contains several PM10 peaks spread throughout the day. The most significant of these peaks, spanning two hours in the late evening, occurs when hourly average wind speeds are between 10 and 12 mph, approaching the high wind threshold. Because of the presence of these two hours with elevated wind speeds, this day was considered to be a marginal candidate for the PM2.5 design day.

The day with the seventh-highest PM2.5 concentration—April 18, 2008, has an evening PM10 spike spanning three hours and a missing hour of PM10 data at 0900 hours. The evening PM10 spike represents approximately 40% of the 24-hour average PM10 concentration for this day. Because of the missing PM10 hour and the significant contribution of the evening PM10 spike, this day was not considered to be a good candidate for the PM2.5 design day.

As a result of the screening analysis summarized above, November 20, 2008 was selected as the PM2.5 design day for the Cowtown site.

<u>Summary</u> – For the purpose of demonstrating attainment with the national 24-hour PM10 ambient air quality in central Pinal County, emission inventories will be prepared for modeling use in the source areas surrounding each of the Cowtown, Maricopa, Pinal

County Housing, and Stanfield air quality monitoring stations. Separate modeling domains for stagnant design days and high wind design days will serve as the basis for modeling inventory preparation at each of the Cowtown, Pinal County Housing, and Stanfield monitoring sites. For the Maricopa site, only a high wind design day modeling domain will be developed. Finally, a PM2.5 design day modeling domain will be prescribed for the Cowtown site. Table 3-3 lists the design days for which inventory preparation will also focus at each attainment demonstration site.

Table 3-3
Summary of Selected Design Days

Design Day Character	Site	Date	24-Hour Average PM10 Concentration ($\mu g/m^3$)
High Wind Days	Cowtown	April 27, 2008	168.3
	Pinal County Housing	January 1, 2008	264.9
	Stanfield	November 21, 2008	178.6
	Maricopa	October 27, 2008	159.4
Stagnant Days	Cowtown	October 29, 2008	188.8
	Pinal County Housing	October 29, 2008	178.0
	Stanfield	October 29, 2008	162.1
$PM_{2.5}$ Day	Cowtown	November 20, 2008	345.0

3.11 Modeling Domains

Emission inventory preparation will focus on emissions generated within the attainment demonstration modeling domain surrounding each PM10 monitor for which a design day was selected. For the central Pinal County PM10 nonattainment area, these monitoring sites include Cowtown, Maricopa, Pinal County Housing, and Stanfield. Because separate stagnation, high wind, and PM2.5 design days were selected for each affected site, separate modeling domains were also developed to correspond to each design day.

Different modeling domains were developed for stagnation and high wind design days because the source categories significantly impacting monitors under each of these of meteorological conditions are quite different. On stagnation days, PM10 is entrained into the air only through the action of mechanical sources—such as motor vehicles, farm equipment, and industrial machinery—either releasing quantities of fine particulate matter through production processes or dislodging fine particulate lying on soil surfaces, with sufficient force to discharge the particulate into the air. Once suspended in the air, these particles travel limited distances—because of the lack of lateral air movement during stagnation conditions—before settling out the air again within an hour or so. This

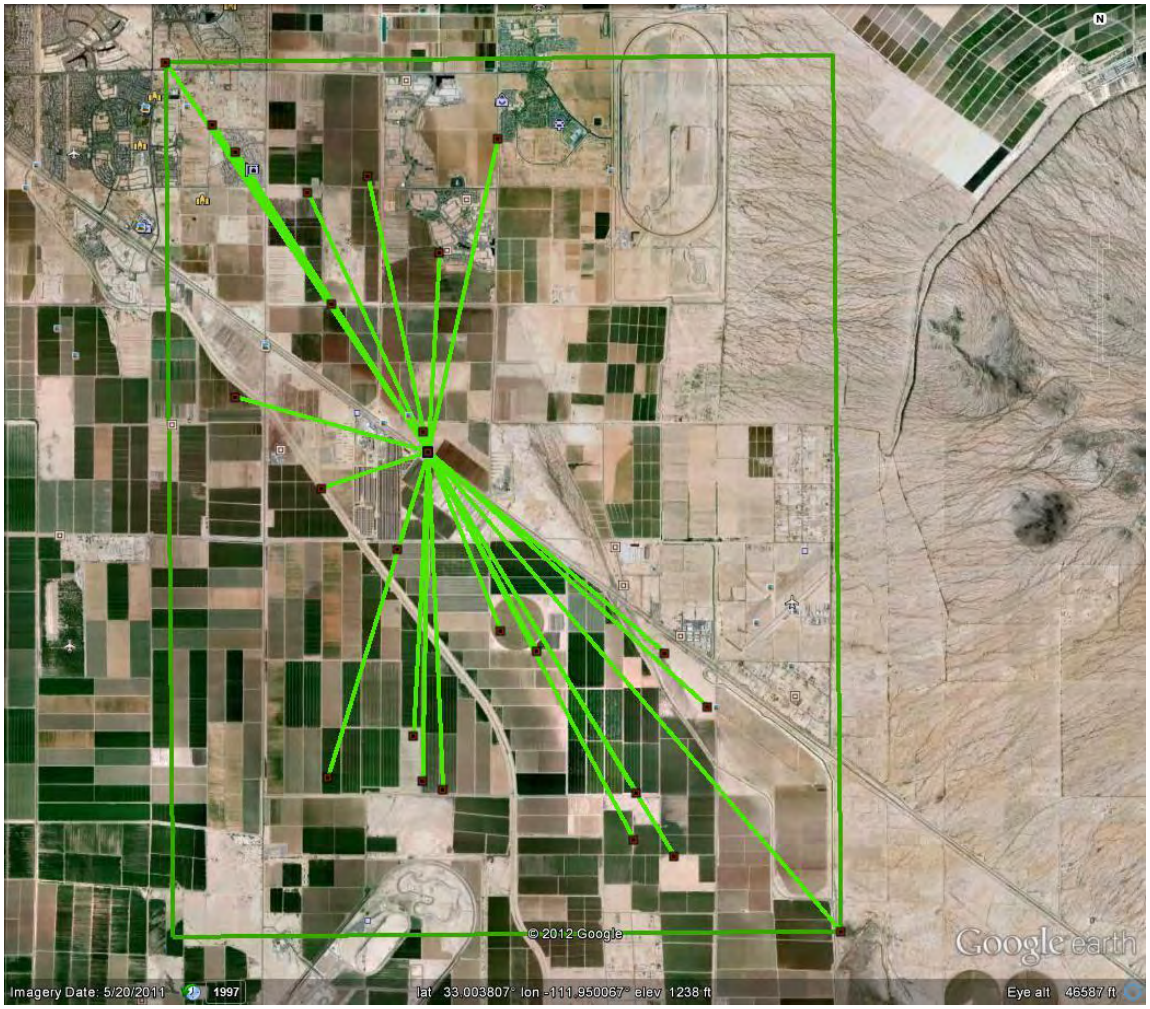
condition of limited travel means that sources whose emissions impact a monitoring site on such a day are typically located quite close to the monitor.

The types and locations of sources whose emissions significantly impact PM10 monitors on high wind days are considerably different from significant stagnation day sources. During high wind hours, when hourly average wind speeds nominally exceed 12 mph, windblown dust sources—most of which are disturbed soil surfaces—produce high concentrations of ambient PM10 that significantly exceed concentrations produced by mechanical sources in the same area. Research has demonstrated that the flux of PM10 in the vertical direction above disturbed soil surfaces is proportional to the speed of the wind, above a certain threshold velocity, blowing horizontally over the soil. This research has also demonstrated that below this threshold wind speed, windblown dust emissions from disturbed soil surfaces are much lower.[19] This condition is explained by the fact that the saltation (bouncing) of sand particles over soil surfaces is the primary cause of fine particles being dislodged from surface matrices and lifted into the air by turbulent eddies to produce airborne PM10 concentrations. Below the threshold wind speed, sand particles remain at rest on soil surfaces and no significant PM10 emissions are generated. Once entrained in the air, PM10 particles can be blown considerable distances depending on the velocity of the wind during transport. With time, however, suspended PM10 particles settle out of the moving air mass and are also widely dispersed laterally and, to a less extent, vertically due to increased groundlevel turbulence at higher wind speeds. As a result, windblown dust sources located a number of miles upwind can contribute to measured concentrations at a monitor, but those that significantly impact a PM10 monitor during a high wind hour are more typically within a few miles upwind of the monitor.

The settling velocities of PM10 particles cause a majority of particles entrained from soil surfaces to settle out of the air within an hour after initial entrainment. This characteristic of PM10 facilitated the process by which modeling domains for stagnation and high wind days were selected. On stagnation days, when wind velocities were typically less than 4 mph throughout the day, particles arriving at the monitor were assumed to have traveled no more than one hour at the average wind velocity recorded at the monitoring station for that hour. The starting point for each hourly trajectory of emissions from windblown dust sources to the monitor was determined by plotting the back-trajectory of the hourly wind parcel from the monitor to the emission source on the basis of that hour's wind speed and direction. The starting points of each hourly wind trajectory ending at the monitor were plotted on an aerial photograph of the area surrounding each stagnation design day, and rectangles with sides aligned with the cardinal compass directions were drawn to bound all of the trajectory origin points. A diagram showing each hourly wind trajectories and the rectangular boundary enclosing all of the origin points for the Cowtown monitor on the stagnation design day of October 29, 2008, is presented in Figure 3-1.

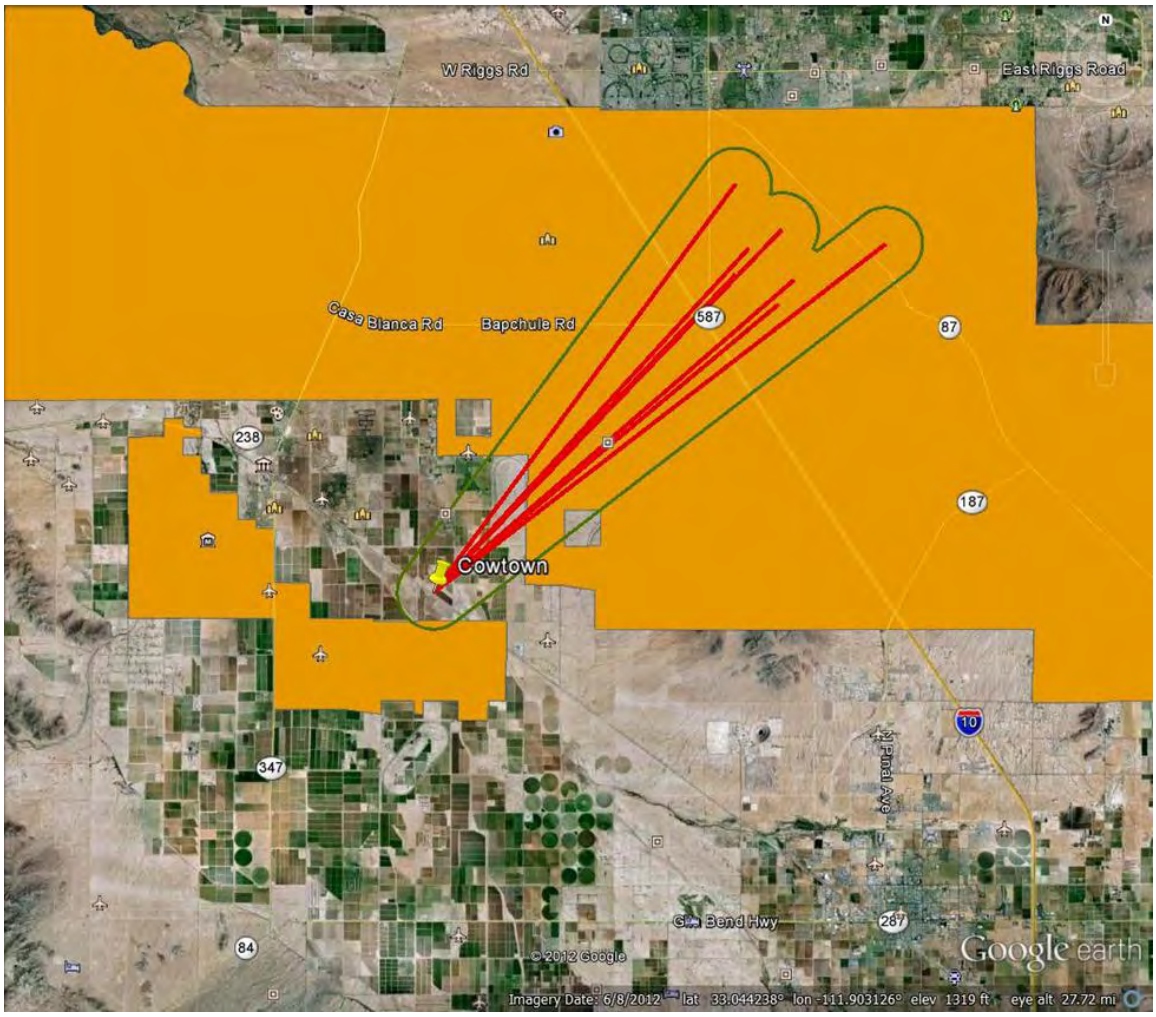
[19] The Physics of Blown Sand and Sand Dunes, Bagnold, Ralph A., Dover Publications, Mineola, New York, 2005

Figure 3-1
Cowtown Stagnant Design Day Modeling Domain



During high wind hours, wind directions tend to be less variable than those recorded hourly on stagnation days. Analyses of area source plume behavior contained in technical support documents of earlier PM10 attainment planning in Arizona, indicated that windblown dust sources lying more than one mile laterally from the centerline of the one hour wind back-trajectory centerline contributed less than 1% to the PM10 concentrations measured at a monitor, assuming that windblown dust emission factors were uniform across all upwind disturbed soil surfaces. This finding guided the design of high wind hour modeling domains that were centered over one-hour wind back-trajectories and extended one mile laterally from each centerline. An example of this type of modeling domain for high wind hours on April 27, 2008, at the Cowtown monitor is shown in Figure 3-2.

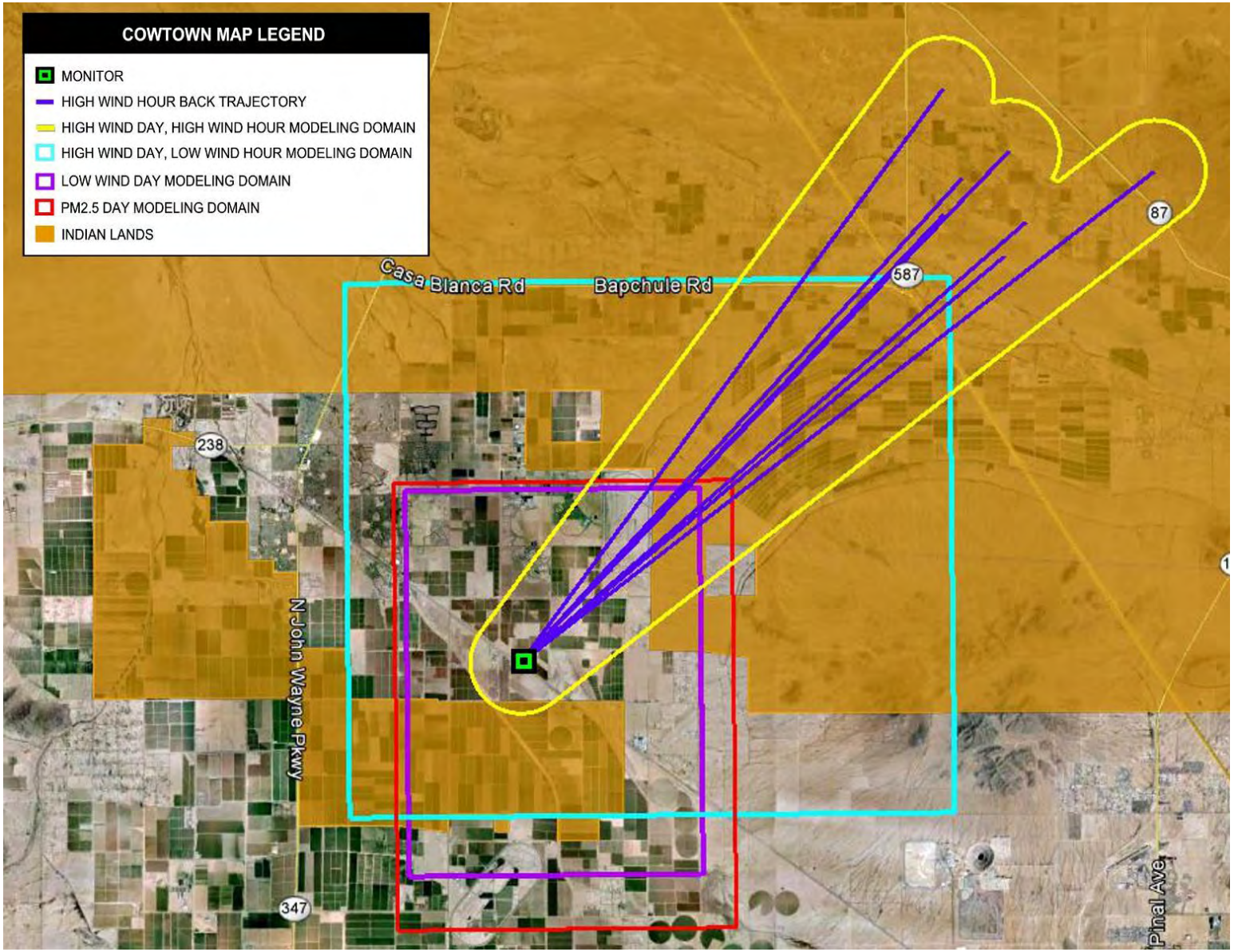
Figure 3-2
Cowtown High Wind Hour Modeling Domain During the High Wind Design Day



Cowtown – The Cowtown monitor will be the subject of three attainment demonstrations in the Pinal County PM SIP: a stagnation day PM10 demonstration, a high wind day PM10 demonstration, and a peak day PM2.5 demonstration. Each of these attainment demonstrations will be based on the modeling of controlled emissions within modeling domains whose boundaries will be set using the protocols described above. A map of the various modeling domains proposed for the Cowtown demonstrations is presented in Figure 3-3.

In Figure 3-3, the modeling domains for the stagnation day, October 29, 2008, and the PM2.5 peak day, November 20, 2008, are very similar. As a result, the larger modeling domain for the PM2.5 peak day will be used for both attainment demonstrations, and emission data from sources of both PM10 and PM2.5 will be collected simultaneously in this domain to serve both modeling efforts.

Figure 3-3
Cowtown



Maricopa – A map of the high and low wind hour modeling domains for the high wind day (October 27, 2008) attainment demonstration is provided in Figure 3-4. Because a substantial portion of the high wind hour modeling domain for the Maricopa demonstration overlays the high wind hour modeling domain for the Cowtown monitor, a single data collection effort will be undertaken to quantify windblown PM10 emissions from exposed soil surfaces common to both domains.

Pinal County Housing – The modeling domains for the Pinal County Housing (PCH) attainment demonstration do not overlay those of any other PM10 monitoring site. The location of these domains in relation to the PCH site is displayed in Figure 3-5. Emissions data will be collected in these domains following the same protocols used for the other design day monitoring sites.

Stanfield – The high and low wind modeling domains to be used in the Stanfield attainment demonstration lie just to the south of those to be used for the Cowtown modeling. As a result, the modeling domains share similar emission source mixes, and may well share similar emission factors for significant source categories. A map showing the location of the Stanfield modeling domains is presented in Figure 3-6.

Figure 3-4
Maricopa Modeling Domains

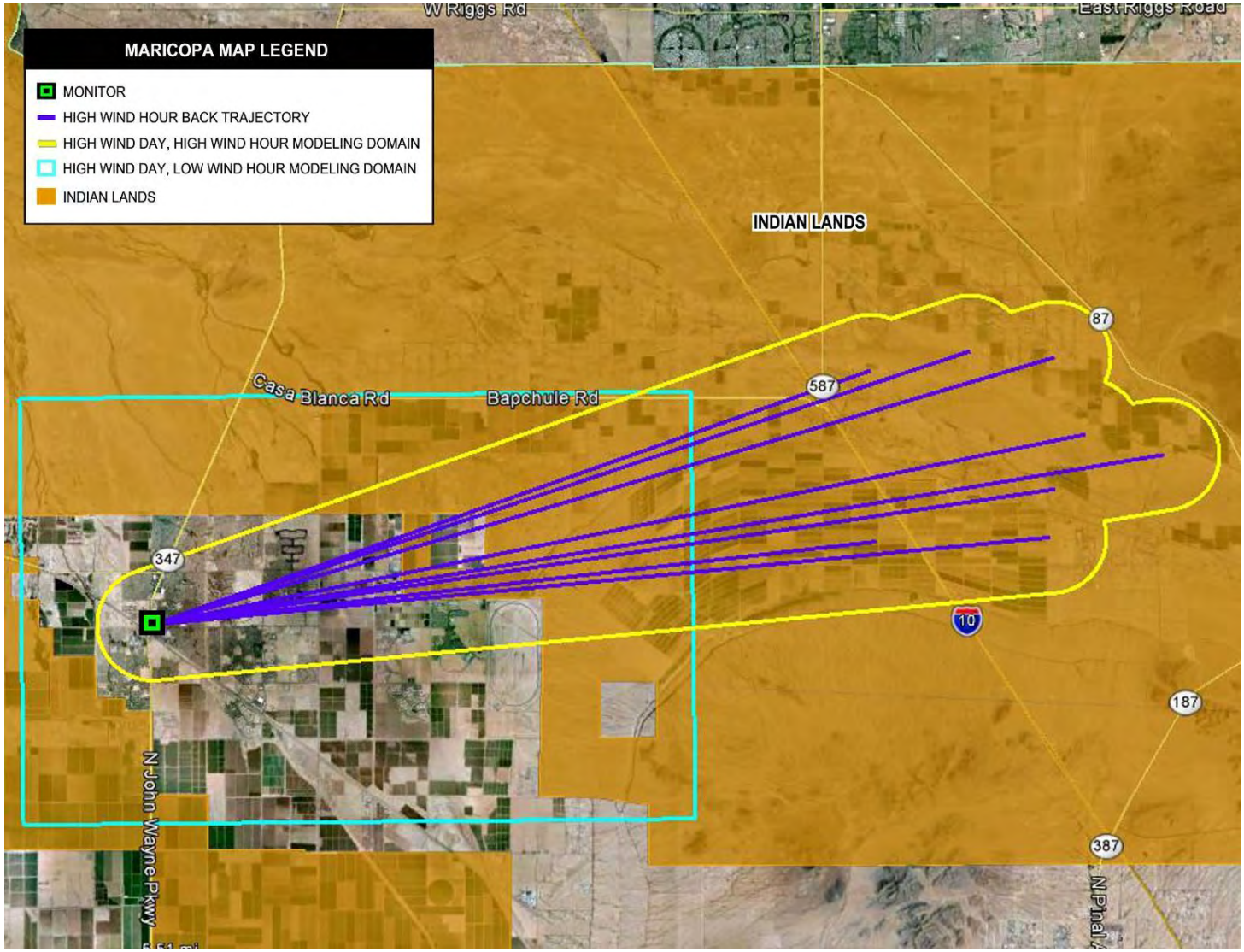


Figure 3-5
Pinal County Housing Modeling Domains

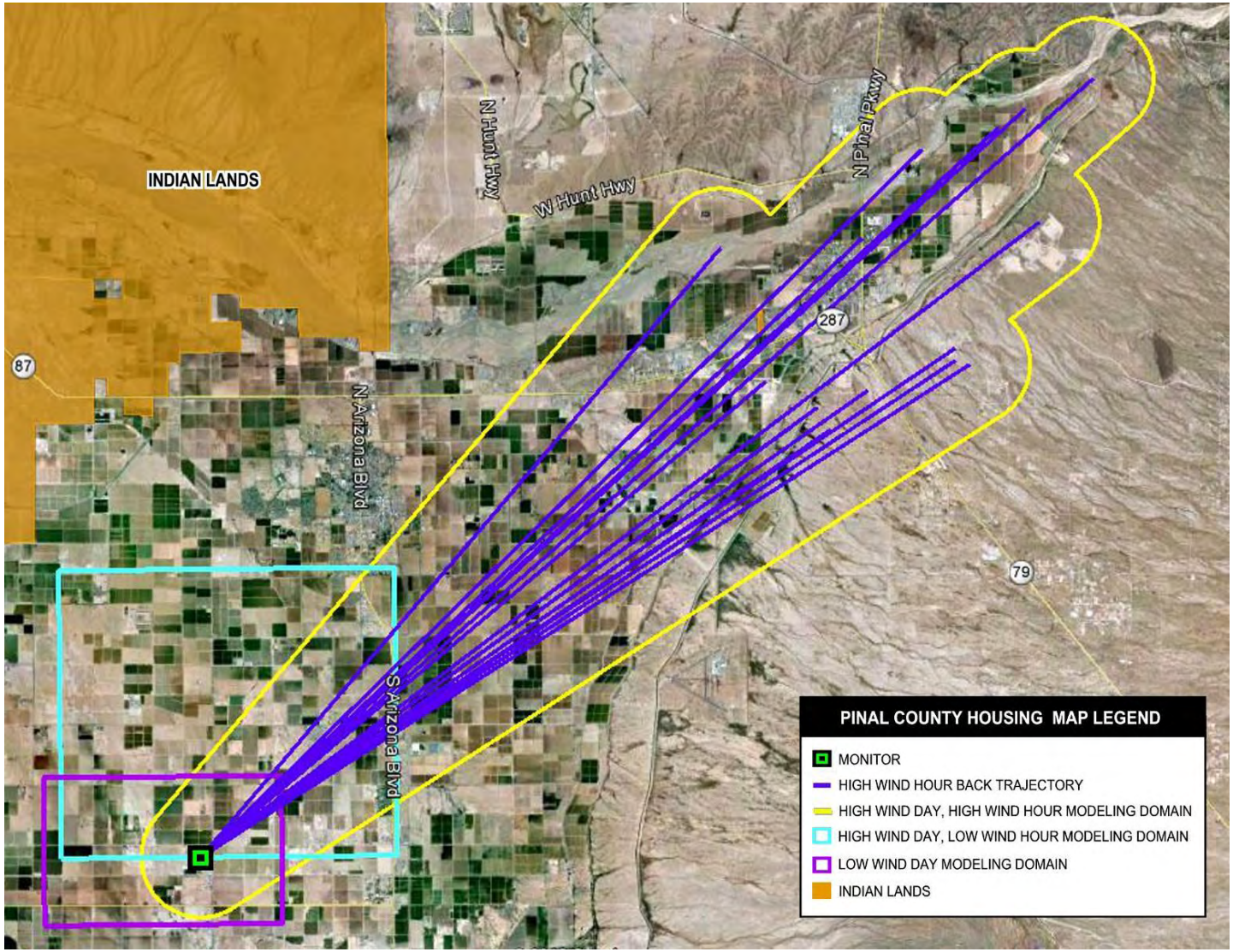
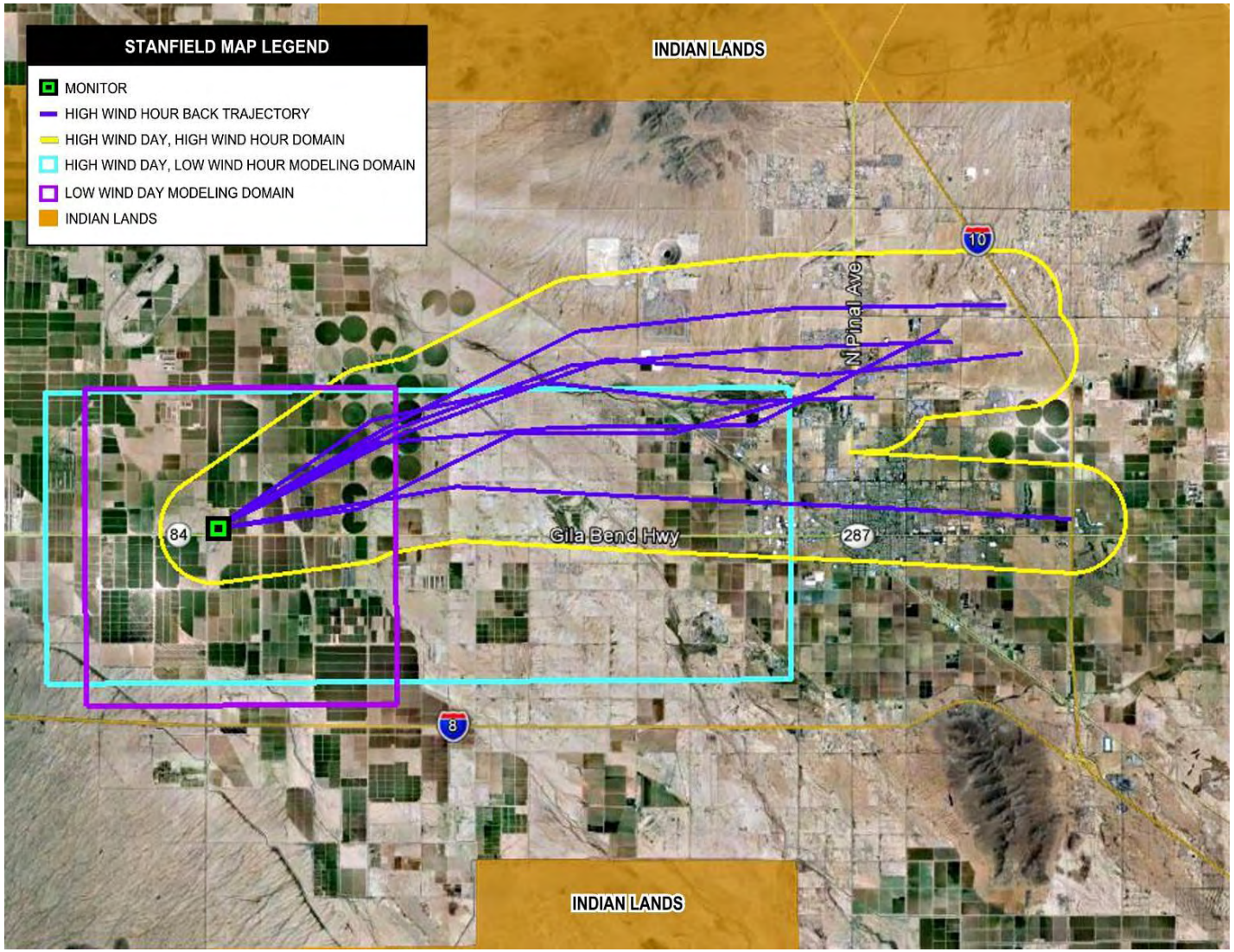


Figure 3-6
Stanfield Modeling Domains



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4. EMISSION INVENTORY PROCEDURES AND DATA SOURCES

As discussed in Section 3, for the purpose of design day selection, PM10 exceedance days in 2008 were divided into separate low and high wind event categories based on the 12 mph threshold velocity for generation of windblown dust. This threshold was estimated from limited analysis of the relationships between hourly wind speeds and PM10 concentrations over the 2008 baseline year at the monitoring stations continuously sampling these parameters. Low wind or stagnation event sources typically involve mechanical or combustion processes from which PM10 emissions can be controlled through either pre-treatment of emission-generating materials or the capture of PM10 released by these processes. High wind sources typically consist of disturbed soil surfaces that require shielding from the wind, covering of soil surfaces, or the consolidation of wind-entrainable surface particles into wind-resistant matrices in order to reduce PM10 emissions. Separate discussions of methods and data sources available to quantify emissions under low and high wind conditions are presented below. These discussions presented in this section provide a greater emphasis on area sources as previous studies[20] indicate that the crustal component of area source emissions comprise a significant portion of the overall inventory. As a result, available resources will be more heavily focused on these area source emissions calculations, whereas point and mobile source emissions calculations will utilize more standard methodologies that require less discussion.

4.1 Low Wind Emissions

Point Sources – Point sources refer to stationary facilities that release emissions to the air primarily through stacks or flues. Such facilities may also release "fugitive" emissions to the air from non-stack sources (e.g., evaporative emissions from leaks in pump seals, valves, and flanges), but the presence of emitting stacks places such facilities in the "point" source category. (Facilities with stack sources and facility-wide emissions below a certain limit or "cutoff" are treated as area sources. This section of the IPP discusses the key issues, available data, and procedures for the development of a point source emissions inventory.)

[20] Summary of Findings Report for the RARE Pinal County Source Apportionment Study. *http://www.pinalcountyaz.gov/Departments/AirQuality/Documents/Monitoring%20Network/RARE_Report_v4_1.pdf*

Land use files supplied by the Pinal County Air Quality Control Department (PCAQCD) identified a total of 44 industrial point sources within the nonattainment area in 2008 (see the land use discussion later in this section). All facilities emitting 5.5 lbs/day or 1 ton per year from stacks or vents are required to obtain permits. Annual and typical daily emission estimates for these facilities can be determined from annual source emission reports, PCAQCD investigation reports, permit files and logs, or telephone contacts with sources. For most of the sources, material balance methods will be used to determine activity rates for vented sources. Emissions will be calculated using the emission factors from AP–42, source tests, engineering calculations, or manufacturers' specifications.

PCAQCD distributes annual emissions survey forms to nearly all facilities to which operating permits have been issued. Facilities are required to report detailed information on stacks, control devices, operating schedules, and process-level information concerning their annual activities. These instructions include examples and explanations on how to complete the annual emissions reporting forms that facilities must submit to PCAQCD.

Annual emission inventory reports include calculated process-level emissions for PM10, NOx, SOx, and NH_3 from each vented source at each facility. Actual emissions for these pollutants are calculated using cited emission factors (from AP–42 or source test results) and estimated efficiencies of any control devices installed. PM2.5 emissions are typically calculated as a fraction of PM10 emissions, depending on the Source Classification Code (SCC) of the process reported, as outlined below.

- For those SCCs and control device combinations included in EPA's *WebFIRE*, this database will be used to calculate PM2.5 on the basis of EPA-recommended emission factors and typical control efficiencies.

- For processes with no PM10 controls, emission factors for PM2.5 published by the California Air Resources Board (CARB, 2004) will be used where available.

- For all other processes (where neither of the above resources provided guidance), PM2.5 will be assumed equal to PM10 as a conservative estimate.

Air quality planners are required to check inventory accuracy and reasonableness, and assure that all point sources have been identified and that the methodology applied to calculate emissions is appropriate and that the calculations are correct. Other reasonableness checks include recalculating emissions using methods other than those used to make the initial emissions calculations and comparing results. QA needs to be conducted by checking all emissions reports submitted to PCAQD for the year 2008 for missing and questionable data and by checking the accuracy and reasonableness of all emissions calculations made for such reports. Notes concerning follow-up calls and corrections to calculations need to be documented on each 2008 annual emissions report.

The QA point source coordinator should review and check calculations, identify errors, and perform completeness, reasonableness and accuracy checks.

Area Sources – Area sources are facilities or activities whose individual emissions do not qualify them as point sources. Area sources represent numerous facilities or activities that individually release small amounts of a given pollutant, but collectively can release significant amounts of a pollutant. Emissions from stationary sources that were not identified as point sources in this report have been included in the area source inventory. Examples of area source categories include agricultural operations, such as tillage, harvesting, and cotton ginning; offroad recreational vehicle use; construction activities; and windblown dust from disturbed soil areas.

Tillage – The use of mechanical operations such as discing, digging, ripping, overturning and land planing is generally referred to as tillage, which produces fugitive dust. Several methods are available to estimate tillage emissions. The first was used in the 2008 Periodic Emission Inventory PEI for Maricopa County. Tillage emissions were estimated using the tillage emission factor equation and Maricopa County specific soil silt content for agricultural land (URS and ERG, 2001). The agricultural tillage emission factor was calculated as follows:

$$EF = k\,(4.8)\,s^{0.6}$$

where:

EF = Agricultural emission tillage factor (lbs PM10/acre-pass)
k = Particle size multiplier (value of 0.15 for PM10)
s = Silt content of soil (%) = 35.2% (URS and ERG, 2001)

Thus: $EF = 0.15 \times 4.8 \times (35.2)0.6 = 6.10$ lbs PM10/acre-pass. This estimate does not take into account reductions for agricultural best management practices.

According to the 2008 PEI documentation, data on the majority of planted acres were obtained from the 2008 Arizona Agricultural Statistics Bulletin (AASS, 2009). Planted acres for potatoes and sorghum for grain were obtained from the USDA National Agricultural Statistics Service for 2008 (USDA, 2008b) and vegetables and citrus acreage were obtained from the 2007 Census of Agriculture (USDA, 2007a). Crop-specific annual land preparation operations data were obtained from the Technical Support Document for Quantification of Agricultural Best Management Practices (URS and ERG, 2001).

The key uncertainty in this emissions calculation is the estimate of activity that occurred on the design day. Since date-specific field operations data are extremely difficult to obtain, the approach used to estimate activity necessarily assumes that tilling operations can occur on any of the days during a crop's tilling season. This has the effect of producing an estimate of activity that, while statistically correct, significantly underestimates the level of activity on days when the activity occurs (i.e., since on many days no activity occurs). Thus, estimates developed using this methodology have the potential to significantly underestimate agricultural emissions when tilling occurs.

The second method uses tilling activity-specific emission factors from CARB[21] for Agricultural Land Preparation. Those values are summarized in Table 4-1.

Table 4-1
CARB Land Preparation Emission Factors Used to Prepare Agricultural Estimate of Agricultural Fugitive Dust Emissions

Land Preparation Operation	Emission Factor (lbs/acre pass)
Discing, Tilling, Chiseling	1.2
Ripping, Subsoiling	4.6
Land Planing & Floating	12.5
Forming/Planting[a]	0.8
Average	4.8

a. Discussions with CARB staff indicated that the weeding emission factor would be appropriate for this activity.

Additional information on plow-down speeds is needed to determine the acre passes per operation (e.g., disc implement width and speed can be used to determine the number of acres tilled per hour). The number of operations and the time of year in which they occur vary by crop type; therefore it is necessary to determine not only the acres of crop under cultivation, but the mix of crops being farmed on the selected design days.

MAG's 2007 Five Percent Plan[22] contrasted emission estimates using the two methods and found the above method produced an estimate of emissions for corn tillage that was an order of magnitude higher than produced by the first methodology. AERMOD performance evaluations determined that the lower values provided a better fit with concentration measurements. This indicates that care should be taken in determining which methodology to employ.

Data Sources – The following data are needed:

- Acreage under cultivation within modeling domains selected for low and high wind design days;
- The distribution of crops being cultivated within the selected modeling domains, either on average or within finer spatial domains; and
- The number of operations being conducted by crop type on the design days.

Information on the first two categories should be available from responsible government agencies, including the Arizona Department of Agriculture and USDA. The results

[21] *http://www.arb.ca.gov/ei/areasrc/fullpdf/full7-4.pdf*
[22] Air Quality Modeling for the Salt River Area in Support of the Five Percent Plan for PM-10, prepared for Maricopa Association of Governments, by Sierra Research, November 2007

should be reviewed by the County Agricultural Agent to confirm their representativeness. Data on the number of operations are available only from farmers who were active on the design days. It is recommended that the results of the above analysis be shared with the local farm organizations to determine representativeness and to request additional information on activities that took place on selected design days.

Harvesting – The 2008 PEI used crop-specific emission factors (CARB, 2003) to estimate harvest emissions. Table 4-2 lists the crop types and associated PM10 emission factors used to calculate emissions from agricultural harvesting.

Table 4-2
CARB Harvest PM10 Emission Factors
(lb/acre-yr)

Crop Type	PM10 Emission Factor
Cotton	3.4
Wheat	5.8
Barley	5.8
Alfalfa Hay	0.0
Other Hay	1.68
Corn	1.68
Sorghum for Grain[a]	5.8
Potatoes	2.7
Vegetables[b]	0.08
Citrus	0.08

a. Assumed same emission factor, control efficiency, and number of harvest days per year as wheat and barley.
b. Includes melons, excludes potatoes.

Annual PM10 emissions from agricultural harvesting were calculated using the following equation:

Uncontrolled annual harvestCrop emissions = *EFcrop* × *ACrop* × ton / 2,000 lb

where:

harvestCrop = harvest emissions for each crop type (tons PM10/yr)
EFCrop = harvest emission factor (lbs PM10/acre)
ACrop = number of harvested acres for each crop type per year

Example:

EFCotton = 3.4 lbs PM10/acre for cotton
ACotton = 18,800 acres of cotton

Uncontrolled annual harvestCotton emissions =
3.4 lbs PM10/acre ×18,800 acres × 1 ton/2,000 lbs
= 31.96 tons PM10/yr

Key issues to be resolved in estimating harvest emissions are the control efficiency produced by applicable agricultural BMPs and whether fields located within the selected modeling domains were harvested on the selected design days.

Data Sources – Maricopa County obtained the majority of crop-specific harvest acreage from the 2008 Arizona Agricultural Statistics Bulletin. Harvest acres for potatoes were obtained from the USDA National Agricultural Statistics Service for 2008, and vegetables and citrus were obtained from the 2007 Census of Agriculture. These sources should be reviewed to determine if similar information is available for Pinal County. The data will be available only at a county level of disaggregation; if possible, more detailed data should be pursued to address the distribution of crops being cultivated within the selected modeling domains. It is suggested that the County Agricultural Agent be contacted to determine if a finer spatial resolution of cultivation is available.

Cotton Ginning – Annual emission reports are available from all permitted cotton gins in Pinal County. Daily emission levels can be calculated from facility-specific operating schedules. A review of the coordinates determined that seven cotton gins are located within the nonattainment area.

Data Sources – Each of the seven cotton gins should be contacted to determine their daily operating schedules.

Offroad Recreational Vehicle Fugitive Dust – EPA's NONROAD model estimates exhaust emissions for offroad recreational vehicles. Since particulate emissions are also generated by recreational vehicles traveling on unpaved surfaces, estimates of fleet size and activity are needed to support fugitive dust calculations. NONROAD provides estimates of annual mileage and number of vehicles by county for all-terrain vehicles (ATVs), offroad motorcycles (ORMs), and specialty vehicles/carts (SVCs). Daily estimates of travel can be calculated from the annual mileage and number of vehicles by category. These estimates of travel can be combined with emission factors for unpaved industrial roads, discussed in the section addressing fugitive dust from unpaved roads. The Maricopa County PEI assumed the average vehicle weight for offroad recreational vehicles was one half of a ton. ORMs (two wheeled vehicles) are assumed to emit at half the level of ATVs and SVCs (both four wheeled vehicles).

Data Sources – In addition to the variables required for estimating unpaved road fugitive dust emissions, estimates of vehicle activity in both the nonattainment area and within the modeling domains will be needed. Several options are available to allocate NONROAD estimates of vehicle class activity for the county to the nonattainment area and the individual modeling domains, including allocation by population, allocation by share of acreage, consideration of where offroad activity parks are located, etc. Contacts should be established with knowledgeable park and law enforcement officials to determine the best method for allocating activity.

Construction – Unlike most emission sources, the locations of construction activities and emissions move within modeling domains from year to year. Therefore, it is necessary to obtain information on dust control permits issued during the years of interest. Permits provide information on the project type, acreage, date issued, permit period (one year) and project location. Project types are listed below.

- Sand & Gravel
- Construction
- Unknown
- Commercial Construction
- Site Development
- Vacant
- Low Density Residential

To estimate emissions for each permit for the 2008 PEI, Maricopa County multiplied the number of acres by an emission factor that varied by project type (in units of tons/acre-month) by the number of months of construction duration, which also varied by project type.

Estimates for the duration of house and apartment construction were obtained from EIIP guidance (U.S. EPA, 2002). Estimates for the duration of nonresidential construction and road construction were obtained from the WRAP Fugitive Dust Handbook (WRAP, 2006a). No estimates for the duration of trenching, demolition, weed control, site prep/land development, and temporary storage yard activities were available; thus, the following activity periods are assumed, as previously cited in the MCAQD PEI:

- 1-month duration for trenching, demolition, and weed control;

- 8-month duration for site prep/land development activities (weighted average of residential and commercial duration) because the duration depends on the project type and size; and

- 12-month duration for temporary storage yard activities because these activities are frequently associated with road construction.

Emission estimates for residential (single-family and multi-family), nonresidential, road and general construction were obtained from the Western Regional Air Partnership (WRAP) Fugitive Dust Handbook. Estimates for road construction were obtained from Clark County and general construction emission factors from the WRAP Handbook were used for trenching, demolition, weed control, and temporary storage yard activities. The average duration of construction activity and emission factors for each project type are shown below in Table 4-3.

Table 4-3 Average Project Duration and Emission Factor Employed in 2008 Maricopa County PEI		
Project Type	Duration (months)	Emission Factor (tons PM10/acre-month)
Residential: single-family	6	0.032
Residential: multi-family	12	0.11
Commercial	11	0.19
Road Construction	12	0.265
Trenching	1	0.11
Demolition	1	0.11
Trenching	1	0.11
Weed Control	1	0.11
Site prep/land development	8	0.11
Temp. Storage Yard	12	0.11

Two key assumptions employed in calculating emissions are described below.

- *Acreage* – No permits were included unless the area of disturbance was equal to or greater than an acre.

- *Dates* – The County estimates of project duration (e.g., road construction, 12 months; residential single family, 6 months; commercial, 11 months) were used to count backwards from the design date and determine if a permitted site would have been active on the design day. Thus, for example, any road construction project started more than 11 months prior to the day to be modeled was excluded from the inventory of sources that impacted that date.

Data Sources – Since the county issues permits for a 12-month period and many projects have durations that are shorter than 12 months, assumptions will need to be developed about when projects start so that it can be determined whether those projects are active on the selected design days. Similarly, assumptions about whether projects are active on weekends, holidays, etc. will also be needed. Discussions with Pinal County staff indicate that there are few multi-family projects, so a decision will be needed as to whether separate estimates of single- versus multi-family construction emissions are warranted. Similarly, estimates of the duration of the construction period on active days will also need to be developed (e.g., 10-hour days, 8-hour days, etc.), along with start and ending times.

<u>On-Road Mobile Sources</u> – On-road mobile sources are defined as those vehicles that are licensed for and operated on public roads (i.e., on highways, arterials, and other local

roads) and include cars, motorcycles, trucks, and buses. For the purpose of this IPP, on-road mobile sources consist of the following types of emissions:

- Exhaust, tire, and brake wear;
- Fugitive dust from vehicles operating on paved roads;
- Fugitive dust from vehicles operating on unpaved roads; and
- Fugitive dust from unpaved shoulders.

EPA's most recent motor vehicle emission factor model, MOVES (Motor Vehicle Emissions Simulator), is required to characterize emissions for the first category. AP-42, which is EPA's Compilation of Air Pollutant Emission Factors, provides specific methodologies for quantifying fugitive dust emissions for the second and third categories.

The general approach for computing on-road mobile source emissions consists of multiplying vehicle activity expressed as vehicle miles traveled (VMT) by vehicle emission factors (in units of grams/mile) obtained from the methods noted above. In large urban areas, VMT data are generally available at the roadway link level from travel demand model outputs. Outside urban areas, VMT is typically compiled at the county or regional level from sources such as the Highway Performance Monitoring System (HPMS) maintained by the Federal Highway Administration or fuel consumption and sales data (although use of fuel sales data at the county level can be problematic in regions of heavy inter-county travel). An outline of the methods, inputs required to characterize conditions within the nonattainment area and data sources for preparing inputs is outlined below.

Exhaust, Tire & Brake Wear – EPA's MOVES model requires the collection of local data to characterize the vehicle fleet operating in the nonattainment area. This is accomplished by preparing input fields to represent vehicle population, activity, road types, inspection and maintenance, fuel supply, and meteorology for the region and time period being simulated through MOVES. Each of the individual inputs once obtained must then be properly formatted and imported through the provided MOVES importer tools into a MYSQL database.

Described below are the inputs needed to represent the nonattainment area.

- <u>Vehicle Population</u> – The vehicle population field represents the regional fleet of vehicles for each of the 13 MOVES vehicle types; these data can typically be obtained from vehicle registration information. Using a VIN decoder software tool, the raw registration information can then be parsed into the appropriate MOVES vehicle type fields.

- <u>Age Distribution</u> – A separate input field that also relates to the vehicle population is the age distribution. Each of the 13 vehicle types in MOVES must also have the age of the vehicles defined; again, the vehicle registration information can be used as the source of that information.

- Alternative Vehicle Fuels and Technologies (AVFT) – The Alternative Vehicle Fuels and Technologies input defines the fraction of each vehicle type belonging to separate fuel and engine technology groups such as diesel, gasoline, natural gas and electric vehicles. VIN-decoded DMV data are one source for deriving these data.

- VMT by HPMS Vehicle Type – Annual Vehicle Miles Traveled organized by HPMS vehicle types are required inputs for the MOVES model. Where available the output from a travel demand model for a given region is used as the source of this information.

- VMT Fraction – In order to resolve the annual VMT by HPMS into finer temporal resolution three temporal breakdowns of VMT by each MOVES vehicle type are developed. These fields represent VMT fractions by month, day, and hour. At present, MOVES differentiates only between weekdays and weekends for daily VMT breakdowns. Traffic counter data are commonly used as the source of data for the VMT fraction fields.

- Road Type Distribution – Each of the vehicle types has VMT further resolved into the 5 distinct MOVES road types. A source for this data can be the outputs from a regional travel demand model.

- Ramp Fraction – The fraction of vehicle hours traveled on ramps is calculated using VHT data from a regional travel demand model. MOVES defines two distinct ramp categories: rural restricted and urban restricted roads.

- Speed Distribution – Average speed distribution can be calculated using VHT outputs from a regional travel demand model. Speed distributions are broken into 16 different bins in MOVES and distributed across vehicle type, road type, day, and hour.

- Inspection and Maintenance Programs – I/M data tables should reflect the vehicles in the region that are required to comply with the local I/M programs along with an estimate of the compliance fractions. The table is organized by pollutant process, state, county, vehicle types, fuel types, and model year.

- Fuel Data – The fuel supply and fuel formulation should be specified as MOVES inputs reflecting the local blend of fuels available. These inputs can be derived from local fuel inspection results where available. Additionally, MOVES does provide a default set of values that may be sufficient in the absence of local data.

- Meteorology – Average hourly temperature and relative humidity by month should be obtained from local meteorology stations and used in place of the MOVES default values.

Data Sources – Inputs for characterizing the vehicle fleet can be obtained from Arizona Department of Transportation (ADOT) registration files; fuels information can be obtained from the Arizona Department of Weights and Measures; I/M program data can be obtained from the Arizona Department of Environmental Quality (ADEQ); and vehicle activity data can be obtained from several sources, including ADOT, 2008 Highway Performance Monitoring System (HPMS) records (which can be obtained from ADOT), and MAG's travel demand model, which characterizes travel on portions of Pinal County. An alternate option for configuring MOVES to represent the nonattainment area is to use inputs developed by MAG to quantify Pinal County emissions for the ozone plan.

Fugitive Dust, Paved Roads – The AP-42 methodology computes paved road emissions as a function of silt loading values and the average weight of vehicles traveling on paved road surfaces. Maricopa County classifies roads as freeways, high-traffic arterials, and low-traffic arterials to reflect different silt loading assumptions. An arterial carrying a traffic volume of less than 10,000 vehicles per average weekday is classified as low-traffic; all other roads that are not freeways are classified as high-traffic arterials. The AP-42 equation for calculating paved road fugitive dust emission factors is as follows:

$$E = k \times sL0.91 \times W1.02 \times (1 - P/4N)$$

where: E = annual average particulate emission factor (g/mile),
k = particle size multiplier for particle size range (1.0 g/mile for PM10 and 0.25 g/mile for PM2.5),
sL = road surface silt loading (g/m^2),
W = average weight of the vehicles traveling on the roads (tons),
P = annual number of "wet" days with at least 0.254 mm (0.01 in) of precipitation, and
N = annual number of days (366 days in 2008).

Data Sources – Silt loadings are available from multiple sources. Maricopa County derived them from samples collected by an EPA contractor in 1993. The values, in grams per meter squared, derived from those samples are 0.02 for freeways, 0.067 for high-traffic arterials, and 0.23 for low-traffic arterials. Alternately, measurements can be obtained for selected roads from ADOT or those values can be augmented with measurements collected by ADEQ and/or Pinal County staff from a representative sample of roadways. Average vehicle weights can be derived from ADOT vehicle registration data for Pinal County.

Fugitive Dust, Unpaved Roads – The emission equations for calculating fugitive dust from unpaved road travel developed by EPA are published in AP-42.2. The equation used in this analysis is designed to estimate particulate matter emissions from light-duty vehicle travel on unpaved roads. This equation has the following form:

$$E = [(k)(s/12)^a(S/30)^d/(M/0.5)^c - C][(365 - P)/365]$$

where: *E* = particulate matter emission rate, pound per vehicle miles traveled (lb/VMT),
k = particulate size factor (dimensionless) = 1.8 for PM10,
s = surface material silt content (%),
S = mean vehicle speed, miles per hour (mph),
M = surface material moisture content (%),
a = empirical constant = 0.2 for PM10,
d = empirical constant = 0.5 for PM10,
C = PM10 emissions from vehicle exhaust, brake wear, and tire wear (lb/VMT), and
P = number of precipitation days per year on which 0.01 inches or more rain falls (days/yr).

Data Sources – The three variables in this equation—silt content, moisture content, and vehicle speed—vary significantly from one unpaved road to another. Because of this variability, measurements of these parameters are needed to increase the accuracy of the representation of roads within the nonattainment area. Options to collect these values include use of values employed by Maricopa County in the 2008 PEI (silt content, 11.9%; moisture content, 0.5%; and vehicle speed, 25 mph on unpaved roads and 10 mph on alleys). Another source of information on silt content and moisture content is an ADOT report entitled *Identification of Emissions Sources for Pinal County ADOT*, which provides values for five separate unpaved roads along with information on average vehicle speed and average daily traffic counts collected in 2005. This information was used to prepare separate PM emission factors for each of these roads. Lacking any other data sources, these values could be extrapolated to similar roads located within the nonattainment area and modeling domains. Alternately, ADEQ and/or Pinal County staff can collect measurements from a representative sample of roadways following AP-42 data collection and measurement procedures.

With regard to vehicle activity, PCAQCD collected daily counts of selected roads between October 2001 and August 2011. Counts were generally collected to respond to complaints and employed a single tube counter for a seven-day period. Road surface distinctions include dirt, dirt w/soil stabilizer, paved and dirt/gravel. Most of the roads counted were dirt roads. Some roads were sampled multiple times and could provide a basis from tracking trends in growth. A copy of the road counts is presented in Appendix H.

Fugitive Dust, Unpaved Shoulders – The 2006 field study in the Salt River Area of Maricopa County observed blowing dust emissions on unpaved arterial road and secondary road shoulders as a result of bow wake passage. Because emissions from this source can be controlled through programs that pave or stabilize shoulders and were found to be significant in the MAG PM SIP plans, they should be addressed in both the nonattainment area and modeling PM emissions inventories.

Although the literature reports very few truck bow wake emission studies, MAG used one good study from the San Joaquin Valley to estimate bow wake emissions in the Salt

River Area. The San Joaquin Valley study measured wind energy levels and particulate flux away from a paved road on which trucks were traveling at an average speed of 60 miles per hour.[23] The PM10 emission factor was computed to be 7.75 grams per vehicle kilometer traveled, or 12.47 g/mi. This emission factor cannot be directly applied to Pinal County traffic because of the lower truck speeds on arterial roads found in the nonattainment area.

Truck bow wake emissions were assumed in this study to vary with the square of the truck speed, very much as aerodynamic drag and bow wake energy vary with the square of vehicle speed. From the MAG travel demand model, Salt River Area truck speed was estimated to average 35 miles per hour. At this speed, the bow wake emission factor was computed to be 4.24 g/mi (= 12.47 g/mi x $\{35 \text{ mph}/65 \text{ mph}\}^2$) at 35 miles per hour.

MAG also computed windblown PM10 emissions from unpaved shoulders for modeling purposes. For this calculation, MAG used the "All Sites" wind erosion equation published in the 1986 Nickling and Gillies study.[24] Because the emission factor predicted by this equation is a function of the wind speed raised to the 4.355 power, it was concluded that the average hourly emission factor based on the average hourly wind speed would be less than the factor based on wind speeds measured during sub-hour increments. Because five-minute average wind speed data were available from MCAQD for the two monitors during the December 2006 field study period, a statistical analysis of this relationship found the use of five-minute wind data produced an hourly emission factor that was roughly 10% higher than the factor calculated on the basis of the hourly average wind speed. As a result, the statistical model developed from the December 2006 high wind data was used to adjust the Nickling and Gillies equation to account for this phenomenon. The adjusted equation was then used to compute the windblown emission factor for each high wind hour on the high wind design day.

Emission estimates require information on the fraction of travel generated by heavy trucks, and location and extent of unpaved shoulders within the nonattainment area and within the low wind modeling domains. Unpaved shoulder lengths can be multiplied by hourly truck counts to determine bow wake vehicle miles traveled for individual road segments. These estimates can be combined with g/mi bow wake emission factors to produce estimates of fugitive dust emissions.

Data Sources – Visual analysis of aerial photographs and Google Earth images can be used to determine the extent of unpaved shoulders on arterial and secondary roads within the nonattainment area and the modeling domains. Vehicle class count data will be needed for a representative sample of arterial and secondary roads within the nonattainment area and modeling domains. If not available, these data can be collected by either visual observation or through size-specific tube counts. Alternately, the values employed in the MAG analysis can be used.

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[23] "Effectiveness Demonstration of Fugitive Dust Control Measures on Public Unpaved Roads and Unpaved Shoulders on Paved Roads," prepared for the San Joaquin Valley Unified Air Pollution Control District by Desert Research Institute, 1996.

[24] "Evaluation of Aerosol Production Potential of Type Surfaces in Arizona," prepared for Engineering-Science by W.G. Nickling and J.A. Gillies, 1986.

Open Burning – Open burning is a waste disposal tool on central Pinal County lands used for agricultural production, residential occupancy, and commercial activities. Open burning is also used with less frequency to provide fire protection training, building demolition, and destruction of certain hazardous materials. Because of the very small quantity of daily or annual emissions generated by these latter uses, the open burning portion of the emission inventory will focus exclusively on the more frequent, higher emission activities that occur on agricultural, residential, and commercial property.

Data Sources – Emission factors for open burning by activity type will be derived from AP-42 and from research studies conducted in field experiments and burn chamber tests in the western United States over the past 30 years. Activity and location data for each open burning event in 2008 will be extracted from the open burning permit database maintained by PCAQCD.

4.2 High Wind Emissions

As discussed in Section 3, high wind sources typically consist of disturbed soil surfaces that require shielding from the wind, covering of soil surfaces, or the consolidation of wind-entrainable surface particles into wind-resistant matrices in order to reduce PM10 emissions. Control strategies for high wind sources are best developed from the analysis and modeling of design days during which only these sources are contributing to ambient PM10 concentrations. For the purpose of selecting high wind design days, high wind hours were defined as those exceeding a threshold velocity of 12 mph. Additional analyses may be warranted to determine a more precise wind speed threshold velocity for the purpose of determining high wind emissions.

At this point, ADEQ is considering two completely different methods for quantifying emissions under high wind conditions. The first back calculates emission factors for upwind lands by establishing a relationship between monitored concentrations and lands located within footprints determined to be impacting the monitors, based on an analysis of meteorological conditions for specific days and conditions; this method is summarized in a report entitled "A Method for the Back-Calculation of Wind-Blown Emission Factors from Field Measured PM_{10} Emissions," which is presented in Appendix I.

The second method replicates the approach MAG employed in quantifying high wind emissions for the Maricopa County's 2008 Periodic Emission Inventory (PEI) for PM10 and MAG's 2012 Five Percent Plan; a copy of MAG's methodology is presented in Appendix J. Effort will be required to adjust the methodology to represent conditions in the Pinal County nonattainment area (e.g., meteorology, land use, precipitation, silt content, soil texture, agricultural activity, etc.). Maricopa County's 2008 PEI cited local conditions that did not reconcile with the certain underlying wind tunnel studies, and relied upon a long-established low-wind inventory to justify a "standardization" to reduce the calculated annual windblown PM10 inventory. Prevailing conditions in Pinal County may not justify such "standardization" of wind-generated emissions. In general, activity rates and emission factors for a number of areally dispersed fugitive dust sources are

extremely difficult to quantify.[25] As such, EPA has requested that a modeling analysis be prepared to assess how well the two methods represent monitored concentrations.

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[25] Air Quality Criteria for Particulate Matter, Vol. 1, EPA/600/P-99/002aF, U.S. Environmental Protection Agency, October 2004

5. QUALITY ASSURANCE

This section presents a review of the QA procedures to be employed during the development of the emission inventories. It includes all of the critical elements recommended in the U.S. EPA documents cited in the Introduction, as well as guidance provided through the Emission Inventory Improvement Program (EIIP). It also provides written instructions for the technical and quality aspects associated with development of the new emission inventories. It is designed so that QA and quality control (QC) procedures are implemented throughout the entire inventory development process. This will ensure that the inventories are as complete, accurate, comparable, and representative as possible.

Inventory tasks and QC procedures will include data checking by the inventory development team (IDT) throughout the development of the inventory and final emission report. These procedures include, but are not limited to, the following:

- The development and implementation of written procedures for data collection, data assessment, data handling, calculation of emissions, and reporting;
- Adequate management and supervision of the work;
- Review of all calculations for technical soundness and accuracy, including verification that the appropriate emission factors were used and the impacts of controls were correctly addressed;
- Correct assignment of Source Category Codes;
- Assignment of DARS scores;
- Use of technically sound approaches when developing results based on engineering judgment;
- Documentation of the data in a manner that will allow reconstruction of all inventory development activities; and
- Maintenance of an orderly master file of all the data gathered and a copy-ready version of the final inventory submitted to the U.S. EPA.

The emission inventories developed in accordance with this plan are for SIP development and are considered Level II inventories, based on guidance provided by the 1996 EIIP. The estimates contained in the inventories will be used to make decisions about the need for and types of control strategies required to ensure short-term attainment and long-term compliance with the NAAQS. As a result, they must satisfy applicable QA requirements.

The first step in this process is establishing the data quality objectives (DQO) for the new inventories. Table 5-1 summarizes the procedures to be employed in meeting the DQOs, showing that considerable effort will be focused on meeting accuracy, completeness, representativeness, and comparability objectives.

Table 5-1
Data Quality Objectives

DQO	Procedure for Achieving Objective
Accuracy	For point and onroad mobile sources, the data generator will check 100% of the calculations, and another equally qualified inventory development team (IDT) member will check 20% of the calculations. For area and nonroad mobile sources, the data generator will check 100% of the calculations, and another equally qualified IDT member will check 10% of the calculations. In all cases, the data validator will develop a written summary of his or her activities, and will conduct follow-up activities to ensure that data are corrected as needed. If more than 5% of the calculations checked by the data validator need to be revised, then 100% of the calculations will be checked.
Completeness	Extensive planning will be conducted prior to data collection to identify all applicable emission sources. After identifying these sources, the goal will be to determine 100% of the emissions from the largest emitting sources from each source category and as many of the minor sources as possible within the time frame allotted for the work. Those sources identified but not included in the inventory will be identified in the data file and final report.
Representativeness	Technical personnel will review all of the primary source data and compare them to previous emission results and similar results from comparable regions to determine the reasonableness of the emissions estimates and representativeness of the data.
Comparability	To ensure that the data are comparable, standard procedures will be followed and results for the NAA will be presented in the same units that were used in the NEI inventories.

Table 5-2 shows the data quality indicators (DQIs) that will be used to measure progress towards the DQOs. The Data Attribute Rating System (DARS)[26] will be used to verify the desired inventory accuracy.

Table 5-2
Data Quality Indicators

DQO	Inventory DQI Target Values
Accuracy	Achieve DARS score >= 0.7 for all area sources contributing >10% of total emissions Achieve DARS score >=0.8 for all point sources >=100 tons per year (TPY) Achieve DARS score >=0.7 for onroad mobile source inventory Achieve DARS score <=0.5 for nonroad mobile source inventory.
Completeness	100% of all point sources >=100 tpy 90% of all other point sources
Representativeness	Monitor specific low and high wind source characterization
Comparability	Results for the NAA will be compared to NEI pollutant inventories.

5.1 Managerial Responsibilities

ADEQ will lead the preparation of the nonattainment area emission inventories. Key assignments shall include those outlined below.

State Inventory Coordinator – The State Inventory Coordinator will be responsible for planning and managing all inventory development activities, including the development of the QAP and the final emissions report.

Source Inventory Development Managers – Source Inventory Development Managers will be responsible for planning and leading source-specific inventory development activities.

QA/QC Coordinator – The QA/QC Coordinator will be responsible for ensuring that adequate QA/QC procedures are incorporated into the inventory development process. The Coordinator will conduct QA training and revise the audit schedule as needed so that all critical phases of the inventory development process are audited prior to generation of the emission report. The QA Coordinator will attend status meetings (by teleconference if necessary) held by the Inventory Development Managers and use the information from

[26] Beck, L.L., R.L Peer, L.A. Bravo, and Y. Yan, "A Data Attribute Rating System," presented at the Air & Waste Management Association Specialty Conference on Emission Inventory Issues, Raleigh, North Carolina, November 1994

these meetings to revise the audit schedule, when appropriate, to ensure that the audit objectives are met.

The QA Coordinator will categorize and use the audit findings to evaluate the effectiveness of QC measures and QA audits. The QA/QC program will be revised to address trends that suggest that the technical and data quality objectives are not being achieved.

The QA Coordinator's responsibilities and activities are as follows:

- Help develop the QAP;
- Develop the audit checklist and audit schedule;
- Provide QA training to inventory development and QA personnel;
- Attend inventory status meetings;
- Schedule audits, conduct audits, and report findings;
- Evaluate audit findings to determine if trends exist, and keep management informed of results;
- Follow up on recommendation for corrective actions;
- Keep the Inventory Development Manager informed of audit results;
- Work with the SIP Program Manager to resolve any quality concerns that cannot be resolved at the inventory management level; and
- Maintain a file of audit findings and corresponding corrective actions.

The QA Coordinator reports directly to the State Inventory Coordinator and indirectly to the managers overseeing the development of the inventory. These reporting lines help provide an objective approach to the implementation of the QA program and reporting of quality issues.

5.2 Schedule

The schedule includes the following tasks/completion dates:

- Data collection, including field measurements – January 31, 2013

- Inventory development, including source specific emission estimates and selection of high wind estimation method – March 29, 2013

5.3 General QA/QC Procedures

QA/QC procedures described in this QAP were developed to help ensure data accuracy, completeness, representativeness, and comparability. These procedures have been incorporated in the technical procedures, where applicable, and will be implemented by the IDT throughout the planning, data collection, emission estimation, and reporting phases of the inventory development program.

QC procedures will be implemented by the IDT during inventory development to meet the technical objectives and DQOs. These activities will be conducted at the following steps in the inventory development process:

- Data collection;
- Data documentation;
- Calculation of emissions;
- Data checking and DARS scoring;
- Reporting; and
- Maintenance of the master file.

Data collection will be conducted according to U.S. EPA-approved procedures. The approach and supporting documents or references will be thoroughly documented and included in the emissions report. The documents identified in Table 5-3 will be used to determine the best data-collection approach for each emission source type. Some data sources identified in these documents are also listed in Table 5-3. All data sources will be thoroughly documented by the IDT. The IDT will also document when required data needed for specific source categories cannot be obtained or do not apply. The reason for not including a source or source category in the inventory will be clearly explained in the documentation.

All activities conducted by the IDT will be documented. The traditional approach is to use bound notebooks with indices to facilitate the retrieval of recorded information. An alternate approach is to record activities electronically and make this information available to team members located in different parts of the state. To enhance communication and productivity, team members will be allowed to employ either approach but will be encouraged to track information relative to the development of the inventory electronically. This daily log of activities will help another IDT member reproduce the emission results and allow an evaluation of data accuracy and completeness.

Table 5-3 Data Collection Guidance Documents		
Source Type	Guidance Document	Suggested Data Sources
Point	EPA-450/4-91-016[a] AP-42[b] EIIP Volume II	Existing inventories, state permit files, facility surveys, county business directories, telephone directory
Area	EPA-45-/4-91-016[a] EIIP Volume III	Existing inventories, example cases and data sources
Nonroad Mobile	EPA-450/4-81-026d[c]	Existing inventories, example cases, and data sources
Onroad Mobile	EPA-45-/4-91-010[d] EPA-450/4-91-011[e] EIIP Volume IV	Transportation or planning agency data

a."Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume I: General Guidance for Stationary Sources," U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 1991.
b. "Compilation of Air Pollutant Emission Factors, 5th Edition and Supplements, AP-42," U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina,1995.
c. "Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources," U.S. EPA, Office of Mobile Sources, Ann Arbor, Michigan, 1992.
d. "Emission Inventory Requirements for Ozone State Implementation Plans," U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 1991.
e. "Emission Inventory Requirements for Carbon Monoxide State Implementation Plans, U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 1992.

The following procedures are to be followed when documenting data in notebooks:

- Data will recorded legibly and in black ink;
- Entries will be corrected by drawing a single line through the data and writing the correct data above or below the correction (with initials, date, and explanation of corrections to allow reconstruction of the work);
- Complete descriptions of all data sources will be included (references to be included in final inventory report);
- Units of measurements will provided for emission sources that are omitted from the final inventory (justification required in report);
- The procedures used to calculate emission will be described and example calculations will be provided;
- The approach used to determine completeness for each source type will be described;

- Documents from which emission factors are taken will be identified and referenced; and

- The source, agency, group, or company providing information by telephone will be identified (include telephone number and date information was provided).

Worksheets and contact reports may also be used to maintain records of data sources or calculations; however, the same guidelines must be followed when recording information on them. A file will be developed specifically for these forms to ensure that they are retained and are easily located when the data are needed to calculate emissions. A contact report should include the date of contact; originator name, title, organization, and address of person contacted; and a summary. All worksheets, electronic spreadsheets, and notebooks will be reviewed periodically by the inventory development task leaders to determine whether the procedures described above are being followed. This review should be evidenced by a dated signature on the notebook pages or worksheets reviewed (i.e., reviewed by _____ on _____).

Data used in calculation emissions should be checked for data accuracy, reasonableness, and completeness. The results from data checking will be documented to further qualify the emission estimates. In addition to the DARS scores assigned, the number of data points checked assists reviewers in evaluating the accuracy of the completed emissions report. Documentation of DARS scoring and data checking should include descriptions of the rationale for scoring, the data checked, and the dated signature of the reviewer. An example area source form that will be used to document the data checked and the findings can be found in EIIP Volume VI, Chapter 5, Section 5, Figure 5.2.

QA activities are not directly involved in the development of the inventory. These include assessments of the effectiveness and appropriateness of the systems established by management to control data quality. This includes evaluations of the management and supervision of the work.

QA activities will include QA training and the conduct of a series of independent audits to assess the effectiveness of the QC system and management of inventory development activities. The QA coordinator and other trained personnel who are not involved in the inventory development process will conduct these activities.

Training/Education – Initial training sessions for the ADEC IDT will be conducted to discuss the items on the audit checklist and QA/QC requirements specified in this document. The QA Coordinator will conduct additional training when audits reveal the need for more QC measures or revision of existing procedures.

Occurrences that may lead to additional QA training include those listed below.

- An audit reveals a lack of understanding of QA/QC requirements or the need to develop additional QC measures.

- An audit reveals the need to provide guidance on acceptable data handling procedures because data are not maintained in a manner that allows easy verification of the accuracy of emission results and source of the supporting data.

- An audit reveals unacceptable data documentation practices that lead to entry errors or an inability to recreate emission results.

- An audit reveals that the internal data reviews do not adequately control data entry and calculation errors.

- The Inventory Development Manager requests QA training for new IDT member.

The QA coordinator will conduct the training and maintain records of each training session.

Audits – Audits will be conducted at key points in the inventory development process. These will include assessments as the inventory development process is being planned, during data collection, as emissions are being calculated, and when the results are reported. The primary goal of the audit program is to prevent quality concerns. Opportunities to incorporate preventative measures will be included during each audit.

Prior to announced audits, the auditor will inform the persons to be interviewed of the date and time of the audit and data systems to be reviewed. All of the personnel involved in inventory activities being audited will be asked to be available to respond to questions about their duties. The responses will then be compared to the requirements specified in this document and other referenced documents to determine compliance with approved procedures.

Questions that will be asked by the auditor and data to be evaluated during the audits vary by source type. The QA Coordinator will use the results of previous audits and work with the Inventory Development Manager to develop source-specific audit checklists. Example checklists for technical systems and data audits are provided in EIIP, Volume VI, Chapter 5, Appendices A, B, and C. After developing the checklists, QA training will be held to inform the IDT of the steps in the inventory development process that are considered to be of concern. These meetings will be used to increase the team's awareness of the points in the inventory development process that may require more QC and managerial oversight.

Data audits will be conducted after major data transcriptions and calculations. The auditor will evaluate consistency in data entry and manipulation between IDT members. The results from the audits will be immediately shared with the data generator and the Inventory Development Manager. IDT members involved in the audit will be asked to respond immediately to the findings that will be informally discussed after the audit.

Audit findings will be documented on the audit checklist. The audit checklist and notes will be used to summarize the preliminary findings for the IDT and Inventory Development Manager after the audit. The checklist and notes will also be used to

develop the audit report, which will be included in the QA documentation section in the inventory report.

The audit report will describe each deviation from approved procedures or finding that could compromise the successful outcome of the inventory. Documentation of each finding will include a description of the action or data reviewed that led to the quality concern and recommendation for corrective action.

At a minimum, the audit report will include the following:

- Name of auditor, Inventory Development Manager, and IDT members audited;
- Audit date;
- Audit type;
- Audit objectives;
- Audit findings; and
- Recommendations for corrective actions.

Audit reports will be distributed within two weeks of the completion of each audit to the persons interviewed and the Inventory Development Manager. A summary of the types of quality concerns found will be periodically forwarded to the Section Manager to keep her informed of the quality issues found and actions being taken to resolve them. Audit reports will be retained in a QA file and used to conduct subsequent audits and plan follow-up activities.

Recommendations for corrective actions will be presented in the audit report. Findings and actions implemented in response to each recommendation should be documented and included in the audit file on a response form. The response form should include the date, originator, problem identification, priority of problem, recommended action, problem resolution, and QA verification (a sample form is included in EIIP Volume VI, Chapter 5, Figure 2-3). The auditor will use the information on the response form to monitor the types of problems found and the phases of the inventory development process that may need additional QC to eliminate recurring quality concerns.

The urgency of the response is determined by the category of the finding, as listed below.

Priority 1: Potential for major revisions needed
Priority 2: Potential for failure to achieve DQOs
Priority 3: Suggested improvements.

Priority 1 and 2 will be immediately brought to the attention of upper management and the planned implementation dates for the corrective actions will be as soon as possible after the audit. The planned implementation date for Priority 3 findings may be later than the dates proposed for implementing actions taken in response to Priority 1 and 2 findings.

Follow-up activities will be conducted as frequently as required by the Inventory Development Manager and auditors to determine whether the recommended actions are taken. Each effort to assess the implementation of the corrective action will be documented and maintained by the QA Coordinator in an audit file established for these records.

Follow-up activities could include the conduct of additional audits or informal assessments of the data or system of concern. The type of reevaluation will be determined by considering the impact that the quality concern could have on the technical objectives and DQOs.

5.4 Data Reporting

Reporting will be accomplished by submitting written documentation and emissions summaries to the U.S. EPA. All supporting documentation, project notebooks, data sheets, and calculations shall be submitted for review.

The report will include summary tables, raw listings of equipment, activity levels and emissions from individual sources, and a QA documentation section. A detailed inventory report allows baseline inventories to be compared between one area and another and the impact of control strategies to be evaluated, and also facilitates updates to the inventory and development of projection inventories.

In addition to EIIP guidance, the U.S. EPA reports cited in the introduction will be followed. These documents provide guidance for presenting and documenting SIP emissions inventories, and contain examples of how to present and verify inventory development efforts. The QA documentation section of the emissions inventory will provide enough detail so that the inventory development described in the report can be compared to the information provided in this QAP. Any discrepancies will be identified and explained.

At a minimum, documentation should describe in general terms how the inventory data were collected and where they came from. Specific details for documentation requirements should be negotiated with the EPA regional office. The report will include the components listed below.

- A description of the geographic area included in the inventory, including documentation for any adjustments made to the original designated area. Documentation shall reference all sources of current or projected data, and include maps of boundaries for excluded areas.

- The base year of the emissions inventory.

- The population of the area, and the source of the population data.

- Efforts taken as part of QA program.

- Procedures used to temporally allocate each source category (e.g., selection of the months comprising the seasons, seasonal variations in activity levels at sources, daily variation in activity levels, etc.).

- Procedures used to spatially allocate the emissions inventory. If a dispersion model will be used for control strategy demonstrations, a map of the geographic area with the modeling domain and grid squares overlaid shall be included. The grid square sizes need to be indicated on the map.

The QA documentation section of the inventory report will also include the audit report. As discussed previously, the audit report will describe each deviation from approved procedures or findings that could compromise the successful outcome of the inventory. Documentation of each finding will include a description of the action or data reviewed that led to the quality concern, along with a recommendation for corrective action. The QA documentation section of the inventory report will then discuss how the recommended corrective actions were implemented.

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Appendix A

2008 24-Hour Average PM10 Concentrations Recorded at Six Pinal County TEOM Monitoring Sites

CASA GRANDE PM_{10} 2008 TEOM Data

24 Hour Averages (ug/m^3)

	January	February	March	April	May	June	July	August	September	October	November	December
1	120.0	29.4	41.3	69.3	60.9	50.1	42.4	50.0	12.3	58.9	78.3	37.4
2	35.6	23.6	65.2	46.4	47.9	57.7	53.3	36.3	30.5	75.0	52.4	36.8
3	51.8	26.1	21.6	46.2	50.6	59.1	70.2	37.5	25.8	52.3	54.0	44.2
4	33.9	10.5	46.3	41.0	39.5	61.8	42.9	26.1	34.7	48.5	44.3	53.6
5	24.1	15.0	56.0	51.8	58.7	63.6	44.4	49.6	46.8	70.0	52.4	46.7
6	8.4	19.6	38.2	27.5	41.7	42.1	55.7	19.6	50.5	46.6	48.9	59.0
7	9.7	26.6	43.9	54.1	28.9	54.3	25.5	115.3	40.7	45.2	66.2	54.3
8	12.9	32.7	47.6	49.9	38.9	43.0	55.2	44.0	64.6	51.5	78.7	26.8
9	18.6	30.9	34.5	58.8	65.3	52.3	27.4	27.8	32.1	48.8	**182.9**	24.8
10	25.8	28.9	38.6	62.8	57.1	53.7	25.1	31.9	25.4	55.7	85.2	25.3
11	31.4	39.5	51.8	46.4	58.5	44.0	24.2	38.6	**202.5**	99.5	55.1	55.1
12	23.1	39.5	53.9	39.8	53.6	39.5	17.9	42.9	49.0	46.4	43.4	53.6
13	16.7	32.3	20.8	38.7	46.8	66.7	17.1	43.4	32.4	51.1	61.5	64.3
14	13.9	37.6	61.4	56.1	37.1	71.8	23.5	23.7	35.9	57.2	70.1	36.5
15	49.5	13.3	47.0	47.3	62.4	61.8	29.2	31.2	49.0	58.0	103.7	25.3
16	34.5	10.6	25.5	64.1	26.1	71.2	31.9	51.1	**AN**	40.7	39.9	9.9
17	24.7	16.2	16.2	38.2	28.7	57.4	39.4	24.6	**AN**	53.3	61.1	11.4
18	41.5	22.5	35.8	55.4	29.7	74.3	38.7	29.1	53.8	52.8	58.3	9.4
19	37.7	28.4	43.2	62.6	57.3	53.0	59.0	29.3	56.3	45.4	94.8	23.4
20	40.4	30.1	47.0	29.2	47.9	65.5	10.7	28.8	35.7	53.6	96.3	21.0
21	30.8	33.2	54.9	40.4	**164.2**	67.5	23.4	34.7	25.4	55.3	113.2	22.5
22	39.2	23.7	50.6	59.4	78.8	103.2	31.6	34.6	44.9	62.0	94.8	22.7
23	42.6	19.4	42.1	75.6	29.4	75.6	27.9	72.2	50.3	77.2	86.8	14.5
24	22.0	20.8	53.3	62.1	26.2	57.3	46.2	40.0	56.4	98.6	77.3	18.9
25	36.3	39.9	55.7	58.6	17.0	63.5	43.9	39.5	44.1	86.6	136.9	11.4
26	32.6	34.3	48.2	66.4	14.6	34.3	20.1	16.4	49.3	74.7	49.7	9.4
27	13.4	26.7	49.7	74.7	27.2	24.5	21.5	24.2	31.5	125.7	7.8	13.3
28	11.9	48.3	49.9	55.7	27.6	34.9	28.4	18.2	31.1	49.5	16.7	16.2
29	27.4	51.9	37.6	62.6	30.6	49.2	28.9	24.3	48.0	74.3	16.3	26.3
30	23.7		51.3	55.4	40.5	37.2	30.9	23.0	47.0	89.5	19.0	30.6
31	13.1		51.0		39.4		54.8	10.6		78.0		60.0

1st quarter average	34.5	2nd quarter average	51.9	3rd quarter average	39.1	4th quarter average	54.3
# of valid samples	91	# of valid samples	91	# of valid samples	90	# of valid samples	92
% of samples collected	100.0%	% of samples collected	100.0%	% of samples collected	97.8%	% of samples collected	100.0%
# of 24 hr exceedances	0	# of 24 hr exceedances	1	# of 24 hr exceedances	1	# of 24 hr exceedances	1

COMBS PM_{10} 2008 TEOM Data

24 Hour Averages (ug/m^3)

	January	February	March	April	May	June	July	August	September	October	November	December
1	39.6	53.6	40.9	69.7	67.5	49.8	73.4	89.8	17.4	91.1	69.2	24.0
2	68.5	25.8	31.7	85.4	59.4	60.5	60.7	49.2	29.5	106.2	44.2	26.6
3	66.7	31.1	77.4	62.7	50.1	66.5	74.1	48.8	54.7	78.1	66.6	33.7
4	39.3	8.9	58.0	65.5	40.1	79.6	51.2	54.3	63.0	61.8	64.3	34.8
5	29.4	10.6	58.4	63.4	76.5	98.6	40.0	107.6	62.9	76.5	67.5	44.9
6	8.4	17.8	42.1	37.6	65.0	70.6	67.2	27.9	52.7	71.7	61.3	32.5
7	9.9	26.1	68.2	55.2	65.1	56.5	41.7	85.4	35.0	78.3	61.9	30.4
8	15.9	39.7	35.4	77.5	82.5	62.4	42.9	74.4	94.7	92.5	64.6	22.7
9	18.8	43.5	28.1	75.8	86.4	73.3	44.5	26.2	55.4	61.2	270.0	27.8
10	27.7	29.4	70.3	68.7	83.1	63.6	23.6	27.9	79.5	97.7	105.0	39.3
11	32.6	38.1	63.7	54.4	62.4	46.4	18.5	60.5	194.7	88.0	45.2	52.2
12	28.7	48.8	54.3	46.1	84.2	85.3	17.1	92.2	75.3	51.7	44.1	73.3
13	16.0	86.6	60.3	48.0	62.7	92.4	20.2	97.5	71.2	56.3	70.7	59.6
14	54.6	57.6	79.4	80.0	47.2	65.0	25.6	32.1	39.9	65.2	53.6	39.3
15	60.1	12.4	55.4	79.7	121.1	51.6	42.8	35.9	101.9	70.4	89.9	31.3
16	52.2	7.5	28.3	93.4	56.9	84.0	54.4	34.9	75.2	69.9	40.8	14.4
17	54.2	12.1	32.6	53.5	42.9	81.8	54.9	33.1	76.6	81.1	77.7	11.0
18	57.5	26.3	61.9	81.9	45.2	73.1	59.4	41.5	70.4	62.4	65.9	13.1
19	33.5	40.2	72.9	64.8	59.0	77.7	81.6	54.0	87.3	44.8	75.1	17.8
20	27.9	28.6	76.0	44.0	52.5	97.9	12.7	61.8	41.1	79.0	65.6	17.7
21	41.6	21.8	75.6	65.5	170.7	85.8	30.4	51.3	28.2	86.1	92.2	14.2
22	70.2	27.6	40.1	78.6	72.6	75.9	32.8	77.4	67.0	68.6	63.7	16.5
23	81.4	17.6	43.3	83.5	19.6	73.0	43.4	55.6	70.8	71.1	56.2	13.7
24	49.2	18.0	90.7	72.1	24.5	70.9	48.4	41.1	109.5	82.4	80.0	17.1
25	37.0	36.0	101.4	69.4	19.9	101.0	59.0	67.9	148.2	90.6	113.9	8.5
26	37.7	55.8	94.5	53.5	16.6	54.8	40.9	13.4	59.9	68.7	38.8	8.2
27	12.4	50.0	73.4	93.0	28.8	37.3	36.0	14.4	52.9	121.5	7.3	11.0
28	6.7	60.2	87.8	87.8	34.3	40.9	69.4	23.6	45.5	93.1	10.8	12.1
29	27.3	74.3	51.4	73.2	43.9	61.9	74.0	24.2	192.1	87.2	14.1	24.3
30	16.1		57.7	84.3	54.2	47.1	81.0	33.9	104.5	93.3	16.0	21.1
31	40.5		80.5		52.7		66.1	15.0		101.9		28.4

1st quarter average	44.6	2nd quarter average	65.9	3rd quarter average	57.6	4th quarter average	57.2
# of valid samples	91	# of valid samples	91	# of valid samples	92	# of valid samples	92
% of samples collected	100.00%	% of samples collected	100.00%	% of samples collected	100.00%	% of samples collected	100.00%
# of 24 hr exceedances	0	# of 24 hr exceedances	1	# of 24 hr exceedances	2	# of 24 hr exceedances	1

CWTN 1400 PM_{10} 2008 TEOM Data

24 Hour Averages (ug/m^3)

	January	February	March	April	May	June	July	August	September	October	November	December
1	67.7	35.2	111.3	239.0	239.0	133.7	200.3	169.6	26.4	299.8	192.5	42.1
2	86.4	34.5	135.5	230.4	327.4	240.1	172.2	126.1	87.6	286.1	147.5	38.1
3	110.1	30.8	50.9	354.8	306.3	264.2	211.3	137.4	100.5	271.4	219.8	54.1
4	51.3	20.3	167.7	436.1	303.5	216.1	91.3	99.9	126.0	237.7	146.8	63.0
5	44.2	15.7	114.9	240.7	243.5	280.9	88.7	306.4	163.2	188.8	148.9	63.4
6	10.9	15.0	106.4	216.7	303.8	169.4	155.6	56.1	149.3	255.7	207.1	98.6
7	22.8	AN	182.6	323.7	199.7	174.2	77.3	336.4	174.0	153.9	283.7	62.1
8	14.5	AN	106.1	419.9	225.6	226.5	217.9	47.0	172.8	275.6	313.1	45.1
9	19.1	AN	127.8	276.9	272.1	226.0	131.9	41.9	64.2	204.6	527.8	44.2
10	22.5	AN	183.3	301.5	344.1	289.3	104.6	61.9	43.0	177.2	156.0	59.4
11	27.6	68.7	294.2	389.4	352.7	195.7	21.3	76.1	63.7	326.1	177.8	83.4
12	31.4	68.1	159.8	369.6	304.4	228.5	19.9	106.3	70.4	188.3	196.0	91.8
13	23.8	65.2	437.9	163.9	180.4	313.4	49.4	114.7	83.8	168.1	216.1	58.6
14	13.9	123.6	310.3	337.6	200.9	262.7	23.8	70.5	160.9	263.1	264.8	65.2
15	58.4	30.2	224.5	326.4	265.1	217.5	54.8	63.2	83.1	210.1	125.7	59.3
16	47.9	11.9	93.3	376.0	268.7	198.3	98.6	73.7	AN	191.8	45.7	38.8
17	31.8	13.5	206.8	327.4	363.8	195.4	100.3	82.0	AN	344.6	268.5	9.5
18	80.0	28.9	334.1	361.6	290.0	306.3	110.2	102.0	AN	207.6	209.4	21.4
19	63.9	37.8	123.3	306.1	224.1	363.8	128.0	185.0	216.8	218.1	400.5	21.8
20	61.4	75.3	228.7	162.8	375.2	367.8	25.4	199.3	133.7	223.7	345.0	18.4
21	50.7	48.0	539.3	266.6	608.6	250.9	51.9	237.1	173.9	256.3	174.5	19.9
22	88.7	27.6	406.0	213.6	167.8	293.5	64.6	126.4	262.8	172.0	379.7	18.7
23	59.3	55.3	237.7	226.5	27.9	249.4	92.0	239.6	136.4	337.2	268.7	18.9
24	35.5	AN	372.6	336.6	24.8	326.3	149.6	106.6	166.3	273.4	273.5	13.4
25	23.0	AN	496.8	404.6	21.3	196.9	147.3	142.8	75.4	288.2	274.5	9.8
26	57.6	58.4	335.7	246.2	30.8	114.2	21.3	69.4	218.6	367.6	85.9	19.9
27	20.8	54.8	252.9	168.3	58.8	143.8	47.3	53.6	155.9	279.7	13.1	14.9
28	11.4	79.4	273.7	238.0	77.0	165.4	83.4	31.5	104.4	247.9	18.2	17.7
29	26.5	64.0	225.3	334.6	84.8	135.3	121.0	29.1	210.1	188.8	19.1	20.0
30	33.0		267.9	285.0	113.5	242.5	105.5	37.5	241.2	244.5	17.6	43.7
31	14.1		134.7		117.2		143.5	17.0		176.7		54.6

1st quarter average	113.1	2nd quarter average	250.5	3rd quarter average	116.0	4th quarter average	162.3
# of valid samples	85	# of valid samples	91	# of valid samples	89	# of valid samples	92
% of samples collected	93.4%	% of samples collected	100.0%	% of samples collected	96.7%	% of samples collected	100.0%
# of 24 hr exceedances	21	# of 24 hr exceedances	78	# of 24 hr exceedances	24	# of 24 hr exceedances	50

MARICOPA PM_{10} 2008 TEOM Data

24 Hour Averages (ug/m^3)

	January	February	March	April	May	June	July	August	September	October	November	December
1	20.0	37.2	42.8	63.9	56.8	45.2	106.1	67.7	16.9	73.9	89.5	45.9
2	134.7	37.4	91.5	62.4	42.2	69.4	87.8	49.3	28.2	98.2	70.9	46.8
3	42.6	24.2	25.3	39.5	59.7	58.0	65.3	37.6	34.5	104.7	88.4	47.4
4	55.3	14.9	50.8	58.8	58.5	103.5	54.2	42.0	41.1	76.8	50.7	65.2
5	29.9	33.3	44.7	85.9	93.9	136.3	34.0	92.7	56.8	82.0	61.6	52.1
6	12.4	27.5	35.2	43.0	54.0	58.6	61.4	29.4	61.0	67.4	65.4	65.5
7	12.7	41.7	42.1	59.7	40.4	71.4	60.9	213.3	57.2	63.9	65.0	62.7
8	17.5	53.4	60.0	70.3	65.2	49.2	108.8	51.4	78.8	79.0	85.8	29.7
9	27.5	39.1	28.8	72.7	114.2	81.9	80.3	26.8	37.5	75.6	520.3	29.3
10	34.4	30.6	56.0	63.0	79.1	71.3	65.4	31.6	30.8	68.7	82.5	31.9
11	42.3	42.4	64.0	48.3	62.0	54.8	15.8	36.2	170.4	157.0	67.2	53.3
12	33.4	51.6	70.2	50.2	104.6	65.1	21.0	50.8	60.6	30.3	77.9	66.8
13	19.5	50.2	72.3	45.2	74.4	78.2	45.9	46.1	21.7	40.8	90.9	61.5
14	16.9	73.1	78.2	56.8	104.8	60.8	23.3	36.4	37.8	38.9	106.5	38.7
15	41.2	19.8	53.3	73.3	94.3	54.1	35.0	35.1	59.2	91.1	58.6	53.6
16	39.6	11.8	30.7	81.7	41.1	67.3	38.3	34.3	31.3	79.6	41.8	16.2
17	25.2	20.3	25.5	48.6	62.6	63.6	50.6	28.3	42.0	100.7	91.4	15.5
18	47.4	29.9	52.0	96.8	52.6	86.6	AN	32.4	61.2	79.3	110.7	25.3
19	34.9	34.1	74.3	75.6	74.3	63.8	AN	38.5	AN	61.3	116.5	37.5
20	35.6	34.7	61.9	38.8	84.2	76.6	AN	45.9	52.8	69.5	125.8	23.4
21	38.2	29.7	69.0	68.2	317.1	87.5	AN	46.8	43.1	73.1	153.2	21.7
22	53.2	27.4	55.3	81.1	86.5	123.1	42.2	49.1	71.7	61.6	93.8	26.5
23	47.7	20.8	46.3	72.5	27.8	106.5	53.7	51.7	63.8	65.4	108.3	21.0
24	36.9	24.6	65.8	61.3	26.0	108.2	61.3	43.1	87.4	136.6	81.1	18.5
25	23.8	39.2	91.2	47.8	18.8	98.6	70.9	99.2	59.3	113.9	129.6	10.5
26	32.9	37.3	63.9	62.5	20.0	68.5	21.1	21.1	67.5	84.0	62.8	14.3
27	15.2	33.6	68.7	54.5	34.3	43.3	23.3	38.2	55.3	159.4	9.6	17.4
28	16.5	51.5	76.4	73.6	34.4	47.5	32.1	AN	31.2	72.6	14.7	16.2
29	37.7	63.3	63.8	95.7	29.2	56.0	50.2	AN	75.8	106.5	18.1	23.3
30	30.7		91.2	75.4	49.8	80.0	52.4	27.2	51.4	103.2	22.5	32.8
31	20.1		39.9		43.4		64.1	13.6		114.0		33.7

1st quarter average	42.9	2nd quarter average	68.9	3rd quarter average	52.1	4th quarter average	70.6
# of valid samples	91	# of valid samples	91	# of valid samples	85	# of valid samples	92
% of samples collected	100.00%	% of samples collected	100.00%	% of samples collected	92.39%	% of samples collected	100.00%
# of 24 hr exceedances	0	# of 24 hr exceedances	1	# of 24 hr exceedances	2	# of 24 hr exceedances	3

PINAL COUNTY HOUSING PM_{10} 2008 TEOM Data

24 Hour Averages (ug/m^3)

	January	February	March	April	May	June	July	August	September	October	November	December
1	264.9	29.6	50.6	76.9	62.8	64.7	159.2	76.5	16.0	79.5	122.1	36.9
2	71.8	23.9	51.5	62.4	67.0	58.5	64.6	69.6	32.4	118.3	77.2	41.9
3	53.9	34.7	36.4	57.3	106.5	63.6	106.2	32.7	47.7	85.6	72.9	45.2
4	32.1	8.6	55.4	69.9	60.6	99.3	67.1	39.6	50.7	144.6	57.6	100.5
5	33.4	7.5	61.7	72.0	63.3	64.7	61.9	59.8	80.7	81.1	93.7	68.3
6	9.0	12.3	75.9	36.3	113.3	93.9	75.8	22.0	65.2	93.7	120.6	66.7
7	9.4	36.4	65.8	64.1	47.6	79.4	22.8	60.5	53.8	101.4	96.5	54.1
8	7.8	19.4	64.0	70.3	68.4	71.0	55.1	69.3	129.9	95.4	122.3	BJ
9	11.8	24.7	54.7	71.4	88.6	80.7	33.4	31.0	68.1	70.4	285.2	BJ
10	15.2	27.6	51.9	59.6	130.8	65.6	23.4	38.2	33.6	71.9	81.2	46.6
11	23.3	29.7	63.9	64.9	AN	62.2	22.4	50.4	217.1	97.5	47.3	77.9
12	18.1	32.6	56.7	116.5	AN	76.8	17.4	60.1	55.9	50.1	50.3	93.2
13	18.3	27.1	60.3	65.5	AN	100.4	24.0	58.7	40.1	85.9	86.4	141.0
14	17.1	50.6	66.1	77.2	52.4	110.2	27.2	25.4	70.3	88.5	83.5	30.8
15	23.5	12.3	54.8	64.9	221.1	64.0	37.3	204.1	92.3	78.3	81.3	20.3
16	38.4	8.1	37.5	78.8	36.9	75.5	55.3	89.1	46.7	90.8	47.7	14.7
17	44.0	12.1	29.7	67.7	AN	80.0	77.9	22.2	64.4	81.2	81.5	11.3
18	60.1	18.1	45.5	102.7	AN	105.6	61.0	42.0	80.0	62.5	79.5	10.1
19	43.7	24.4	83.1	102.3	AN	88.0	77.9	43.5	87.3	60.7	130.3	22.4
20	42.0	19.6	75.9	46.9	64.0	110.9	12.9	54.3	61.0	79.5	160.6	22.2
21	46.9	34.1	73.5	67.4	273.8	86.4	24.7	66.3	31.7	78.2	98.8	31.1
22	68.0	18.5	78.3	73.8	98.7	141.6	49.4	66.8	60.7	94.5	116.3	29.5
23	58.7	24.5	72.4	83.0	24.4	89.7	46.5	67.7	59.1	106.2	94.4	13.3
24	27.4	25.1	69.9	83.8	25.6	73.9	54.1	57.1	57.0	117.7	84.4	13.7
25	37.6	50.4	107.5	94.8	18.6	103.3	71.2	45.9	65.5	89.7	AN	36.3
26	53.0	42.1	80.2	75.1	17.6	71.0	27.5	15.1	56.4	85.3	AN	30.9
27	14.3	38.4	63.7	127.7	33.1	33.6	29.1	23.6	66.4	153.3	9.3	11.5
28	5.8	44.1	95.6	83.7	33.8	55.3	52.2	19.7	47.9	78.6	13.4	15.0
29	20.1	63.2	49.2	72.4	44.9	68.3	74.8	16.6	68.3	178.0	28.2	22.5
30	16.7		80.1	106.0	51.8	64.2	59.8	22.6	86.9	140.7	19.8	33.3
31	14.0		66.8		49.6		96.9	37.6		159.1		40.1

1st quarter average	43.7	2nd quarter average	77.1	3rd quarter average	57.1	4th quarter average	75.2
# of valid samples	91	# of valid samples	85	# of valid samples	92	# of valid samples	88
% of samples collected	100.00%	% of samples collected	93.41%	% of samples collected	100.00%	% of samples collected	95.65%
# of 24 hr exceedances	1	# of 24 hr exceedances	2	# of 24 hr exceedances	3	# of 24 hr exceedances	4

STANFIELD PM_{10} 2008 TEOM Data

24 Hour Averages (ug/m^3)

	January	February	March	April	May	June	July	August	September	October	November	December
1	255.3	24.2	52.3	57.4	57.3	52.6	127.5	74.8	20.8	96.6	137.8	34.1
2	61.8	23.8	141.9	50.3	72.2	71.6	116.4	60.9	33.1	105.8	64.8	46.0
3	58.9	45.2	49.3	67.5	106.3	79.5	157.8	54.5	34.3	56.2	70.2	49.5
4	40.0	14.5	45.3	55.2	43.0	114.4	43.4	52.5	48.8	74.0	63.0	51.8
5	21.5	12.3	44.7	75.9	125.2	76.2	57.0	115.3	43.9	76.1	83.0	50.0
6	10.1	19.7	49.6	44.9	43.2	59.4	44.3	35.2	59.1	118.3	108.6	70.0
7	10.6	22.7	58.5	76.0	43.4	69.7	67.1	364.3	65.2	105.3	112.5	52.8
8	10.0	34.7	54.4	46.3	81.8	54.5	86.6	58.3	264.2	86.3	82.5	18.3
9	9.7	31.6	62.4	66.6	79.7	111.4	41.8	31.2	36.5	49.6	375.1	24.5
10	13.8	26.3	66.8	104.9	161.7	60.6	29.5	40.7	31.4	98.6	92.3	31.0
11	22.2	33.0	60.3	68.9	56.9	54.4	24.4	67.7	178.2	103.6	57.8	62.7
12	21.3	38.0	75.2	144.2	83.9	102.3	20.4	90.7	55.1	83.0	99.3	70.9
13	20.4	40.9	49.1	152.9	89.0	115.0	44.2	53.4	42.0	104.7	73.3	178.2
14	36.5	57.3	74.0	97.1	56.2	146.6	29.5	37.4	51.8	94.5	89.7	46.7
15	39.3	18.4	69.9	58.2	89.6	134.3	26.5	33.8	65.4	119.6	240.7	41.7
16	30.4	10.2	25.3	95.3	65.7	107.7	36.4	63.3	35.9	115.1	75.8	69.9
17	29.7	14.9	18.6	49.6	55.2	89.1	49.2	32.0	36.1	131.6	141.9	8.8
18	40.0	18.2	49.0	82.1	46.9	83.7	52.0	46.8	75.3	91.2	153.7	8.5
19	40.5	28.8	56.8	88.3	115.4	84.2	101.2	42.1	52.8	67.2	117.0	16.1
20	30.4	24.7	65.7	49.0	61.6	126.8	13.6	41.1	47.8	107.5	123.9	16.9
21	27.5	28.2	64.6	AN	323.0	106.3	24.5	54.7	25.6	94.1	178.6	16.2
22	51.3	17.4	83.5	100.4	134.1	149.3	41.9	71.2	56.3	91.5	138.6	17.6
23	42.7	18.5	153.0	141.4	25.2	103.2	60.2	100.7	73.7	AV	102.1	11.9
24	19.7	26.2	112.5	67.8	24.4	79.4	145.5	99.8	74.6	AV	116.2	16.9
25	22.9	38.0	94.1	145.3	19.2	105.9	67.4	49.0	64.7	125.7	149.8	26.7
26	33.0	48.1	57.3	207.5	18.8	52.2	24.2	23.8	65.8	86.2	55.4	6.5
27	14.5	44.2	57.8	125.4	30.3	47.1	28.6	58.0	64.4	212.6	7.4	9.3
28	10.1	60.0	62.2	92.6	30.3	73.9	49.4	14.5	56.5	87.8	8.8	11.9
29	22.7	60.5	66.6	63.1	36.9	78.7	57.2	18.9	79.8	162.1	19.3	18.3
30	28.5		60.3	89.1	53.4	70.9	78.2	34.6	122.2	131.3	20.8	26.8
31	14.0		71.2		75.1		70.5	10.9		121.0		31.0

1st quarter average	44.2	2nd quarter average	83.7	3rd quarter average	62.1	4th quarter average	81.1
# of valid samples	91	# of valid samples	90	# of valid samples	92	# of valid samples	90
% of samples collected	100.00%	% of samples collected	98.90%	% of samples collected	100.00%	% of samples collected	97.83%
# of 24 hr exceedances	1	# of 24 hr exceedances	3	# of 24 hr exceedances	4	# of 24 hr exceedances	6

Corresponding Color Codings		AQS Codings
24 hour exceedances	any sample > 154.5 ug/m^3	
PCAQCD Exceptional Event	HIGH WIND EVENTS	
	HIGH WIND EVENTS - EPA CONCURRED.	###[A]
Noise excedences	when the noise on the monitor is greater than 1.0 for more than 1 hour	AN
Status flow out of range	flow out of range for more than 1 hour	AH
	status codes other than 0 for more than 1 hour	AN
General maintenance	monitor is down for general maintenance activities or filter exchanges for more than 1 hour	BA
Negative data readings	data readings > - 10.4 ug/m^3 or	AI
	Operator Error for more than 1 hour	BJ
Power failures	power outage for more than 1 hour	AV
CAL / VER / AUDIT	monitor is down to perform monthly verification or	AT
	annual system calibrations or	AT
	bi-weekly flow verification or	AX
	QC Audit (ADEQ) for more than 1 hour	AZ

Appendix B

Plots of Hourly PM10 Concentration, Wind Speed, Wind Direction, and Mixing Height Recorded or Modeled at Cowtown, Pinal County Housing, and Stanfield Monitoring Sites on October 29, 2008

STAGNATION DAY, 10/29/2008, COWTOWN

Figure B1. PM10 vs. Wind Speed

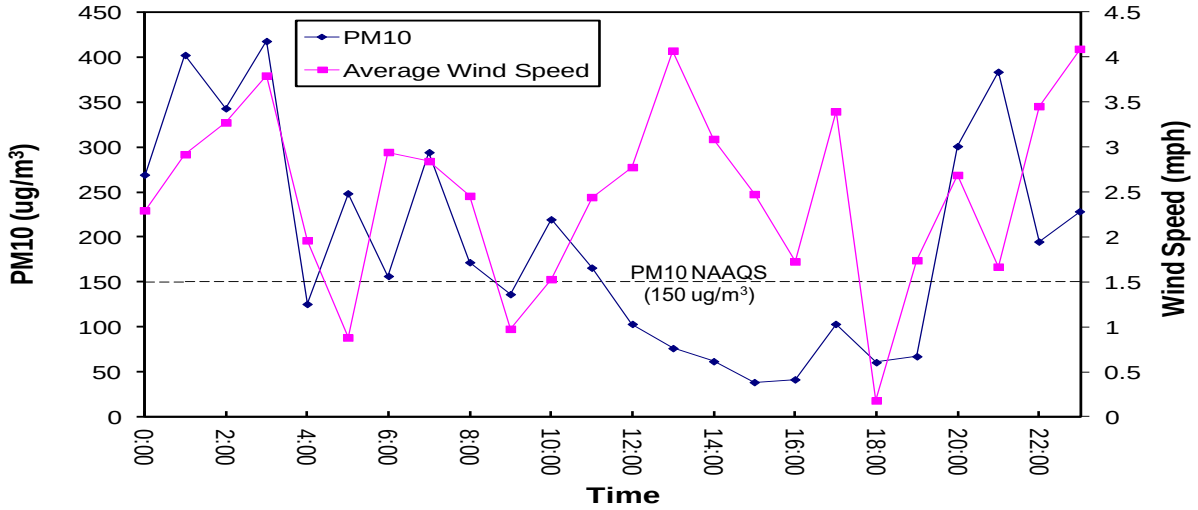


Figure B2. Wind Direction vs. Wind Speed

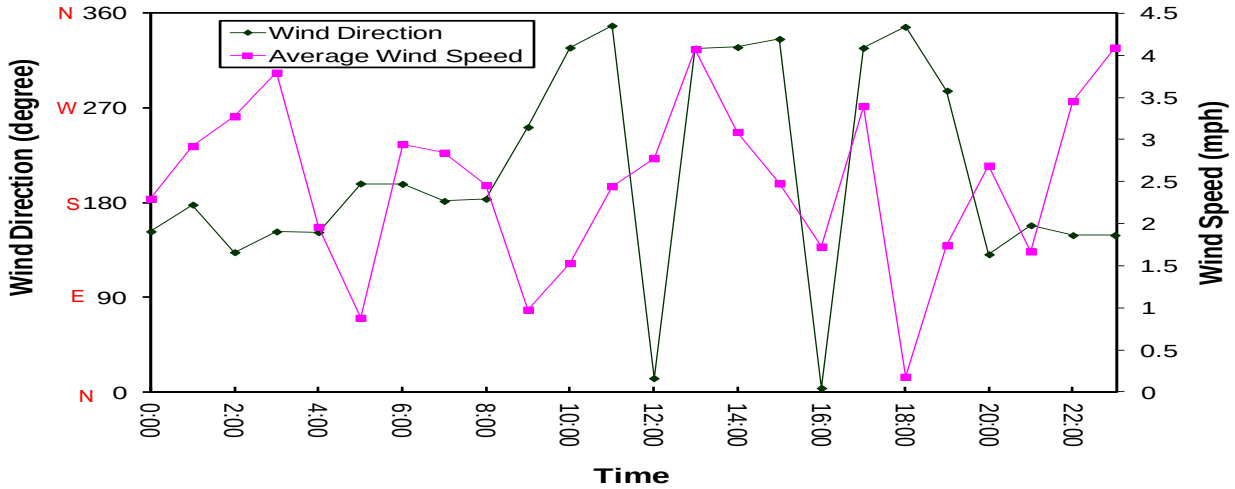
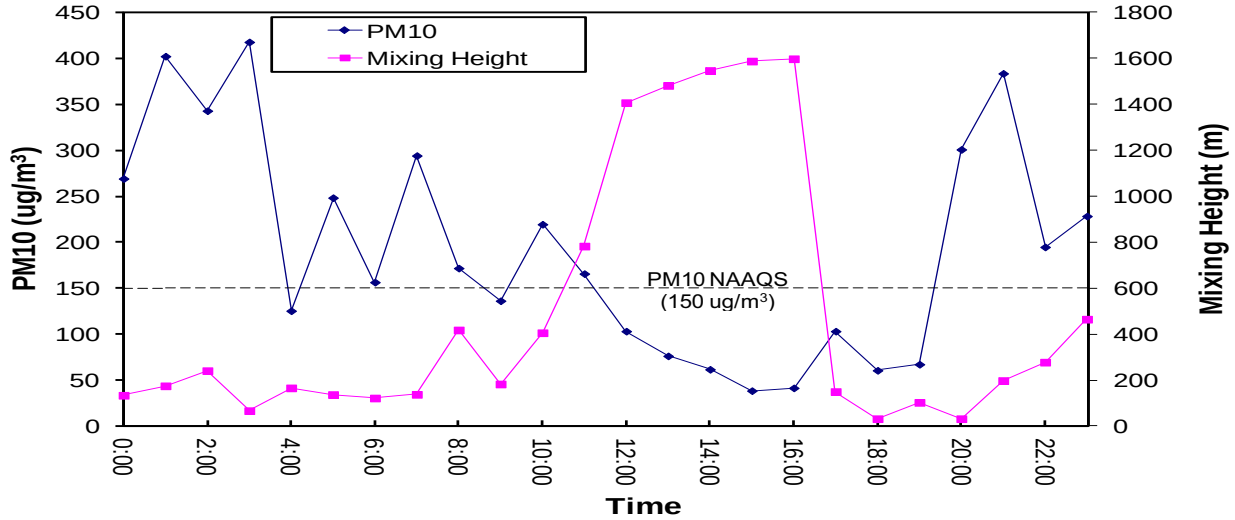


Figure B3. PM10 vs. Mixing Height



STAGNATION DAY, 10/29/2008, PINAL COUNTY HOUSING

Figure B4. PM10 vs. Wind Speed

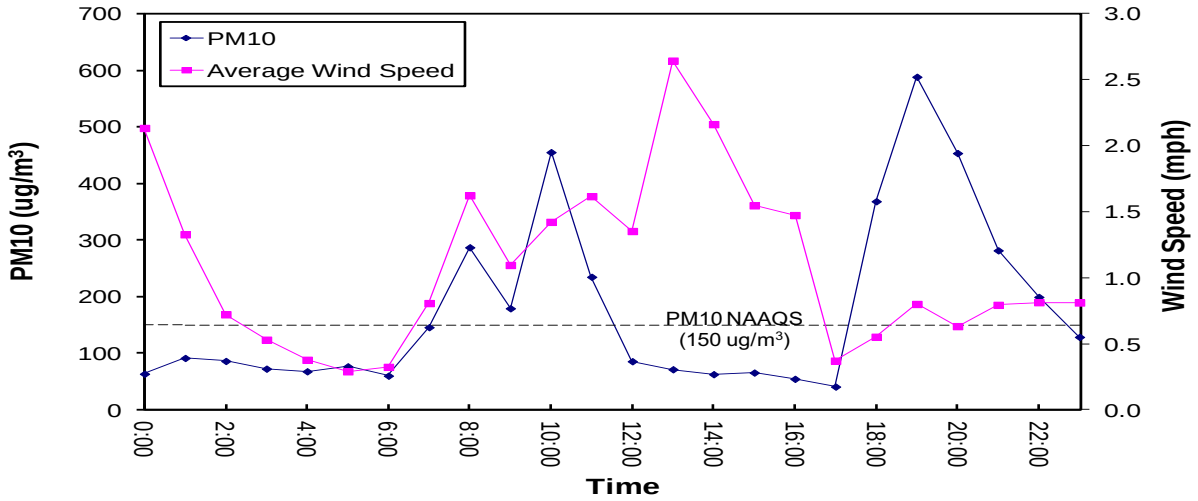


Figure B5. Wind Direction vs. Wind Speed

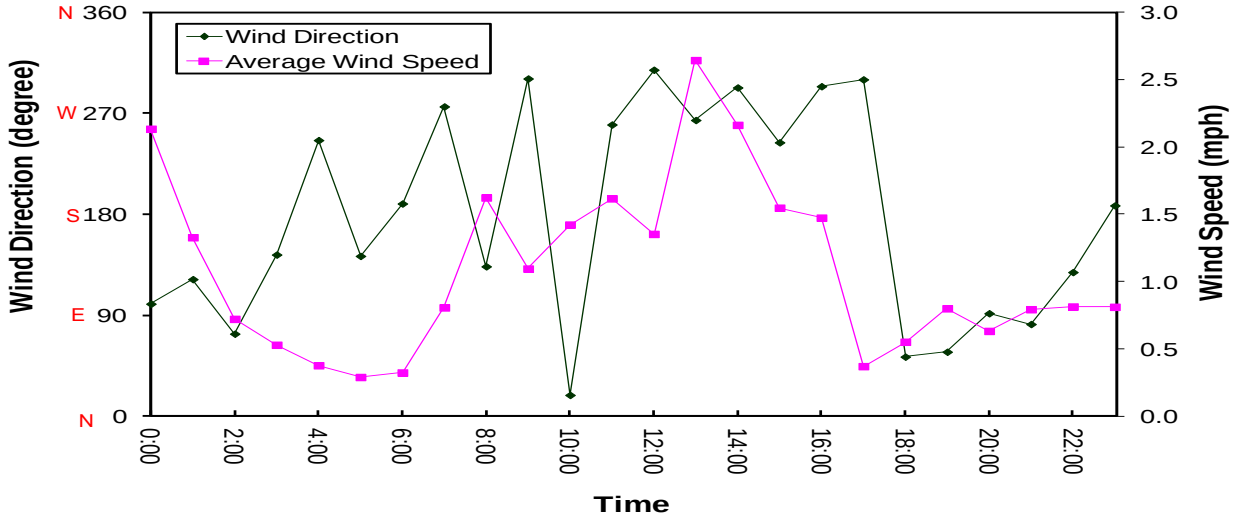
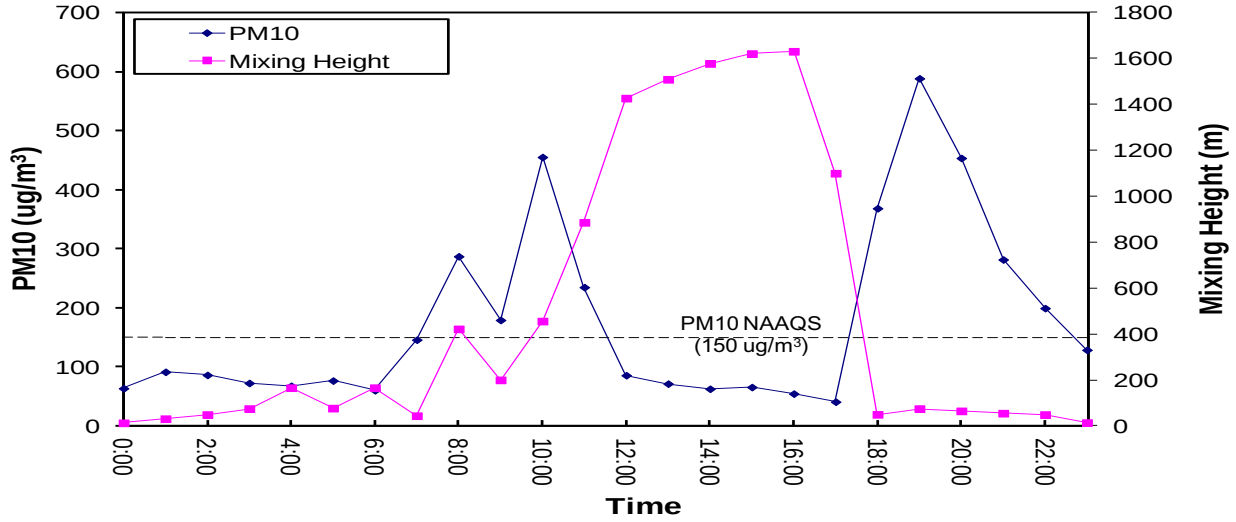


Figure B6. PM10 vs. Mixing Height



STAGNATION DAY, 10/29/2008, STANFIELD

Figure B7. PM10 vs. Wind Speed

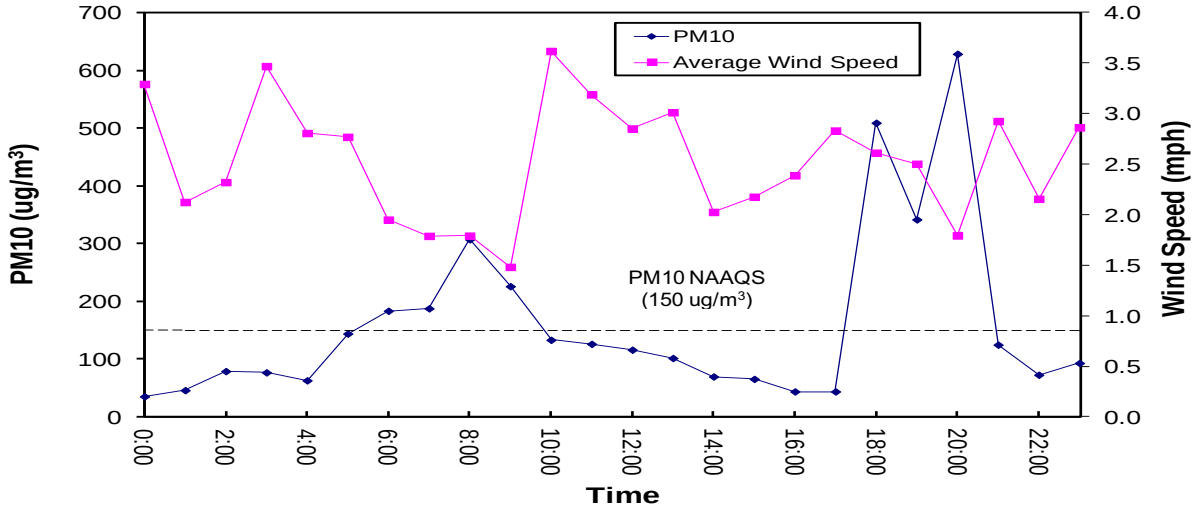


Figure B8. Wind Direction vs. Wind Speed

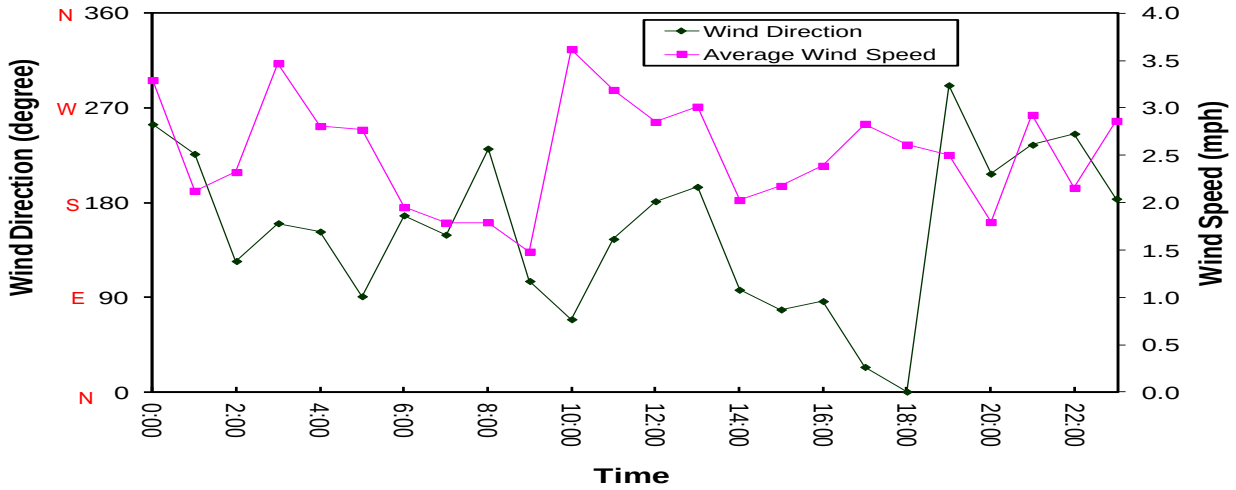
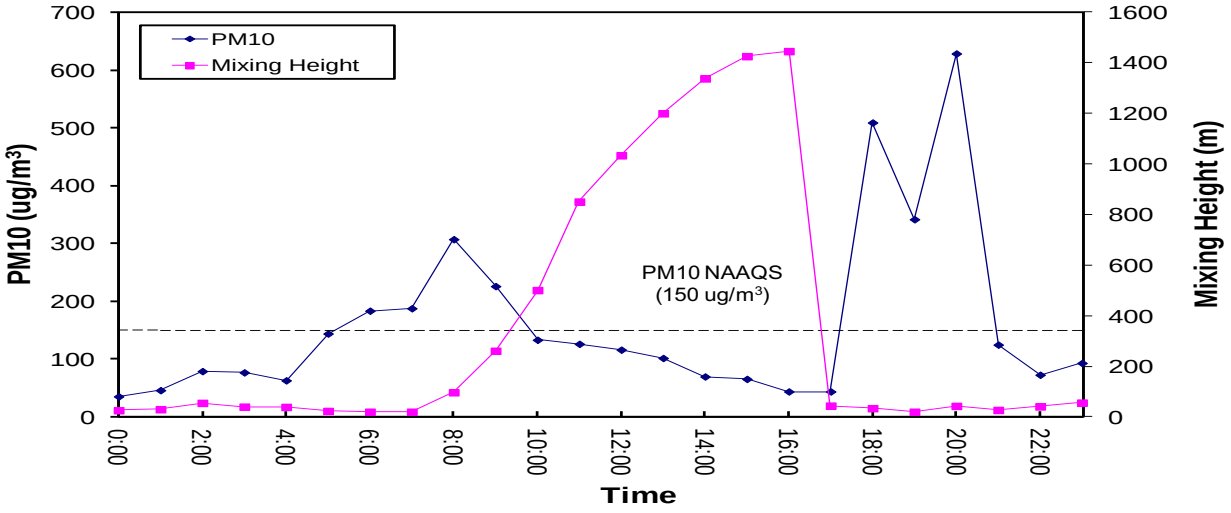


Figure B9. PM10 vs. Mixing Height



Appendix C

Statistics of the High Wind PM10 Exceedance Days at Cowtown in 2008

Table C1. Statistics of the PM10 High Wind Exceedance Days at Cowtown in 2008

Date	Number of High Wind Hours	Daily Average PM10 (ug/m^3)	Daily Average WSPD (mph)	Daily Max WSPD (mph)	Correlation of Hourly Wind Speed and PM10	Number of High Wind Non-feedlot Hours
5/21/2008	12	609	11	19	0.643	0
11/9/2008	10	528	12	22	0.540	0
4/8/2008	1	385	6	12	-0.118	0
4/16/2008	4	376	4	16	0.432	0
4/15/2008	2	326	7	14	-0.464	0
8/7/2008	3	336	6	22	0.498	0
10/11/2008	12	326	11	18	0.462	0
3/14/2008	5	310	8	13	-0.237	0
6/18/2008	2	306	6	13	-0.326	0
8/5/2008	1	306	5	16	0.384	1
5/6/2008	3	304	7	16	-0.034	0
5/12/2008	3	304	8	15	0.236	0
10/27/2008	9	280	10	20	-0.076	9
5/9/2008	1	272	7	13	-0.300	0
4/30/2008	6	285	10	18	0.110	0
4/9/2008	1	277	8	12	-0.401	0
5/15/2008	1	265	5	19	0.250	1
3/30/2008	2	268	7	15	0.309	0
5/16/2008	3	269	7	14	-0.427	3
10/4/2008	2	238	7	14	-0.098	0
5/5/2008	6	243	9	16	0.012	0
10/28/2008	3	248	6	17	-0.470	3
4/5/2008	2	241	7	13	-0.353	0
6/30/2008	1	242	5	13	-0.288	1
4/2/2008	2	230	6	13	0.217	0
6/4/2008	8	216	10	17	0.476	0
5/1/2008	4	219	8	14	-0.122	0
9/29/2008	5	210	8	18	-0.010	5
7/1/2008	2	200	6	15	0.125	2
7/8/2008	2	200	5	13	0.321	1
5/13/2008	2	180	8	17	-0.112	1
5/22/2008	4	168	9	14	0.577	0
10/10/2008	4	177	9	15	0.096	0
4/27/2008	7	168	7	16	0.191	7
11/21/2008	8	160	8	19	0.127	6
4/13/2008	2	164	5	13	0.038	2

HIGH WIND DAY, 04/27/2008, COWTOWN

Figure C1. PM10 vs. Wind Speed

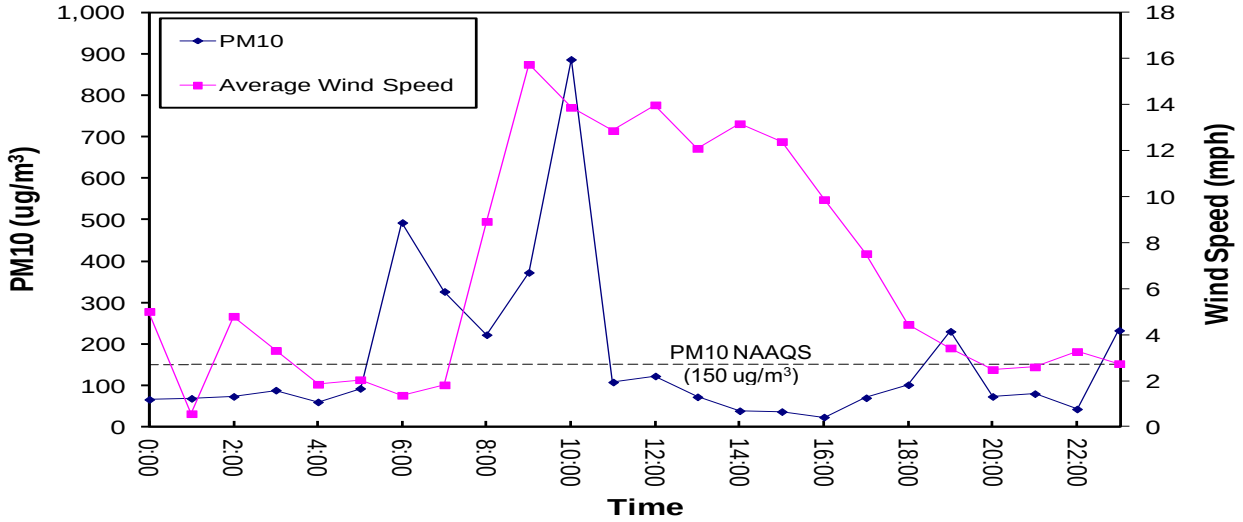


Figure C2. Wind Direction vs. Wind Speed

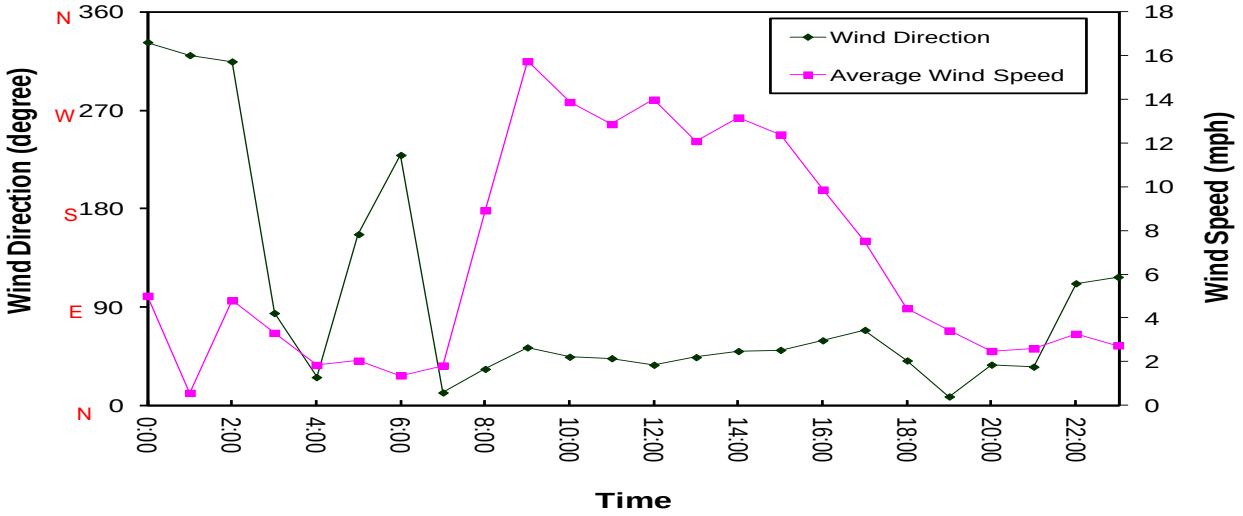
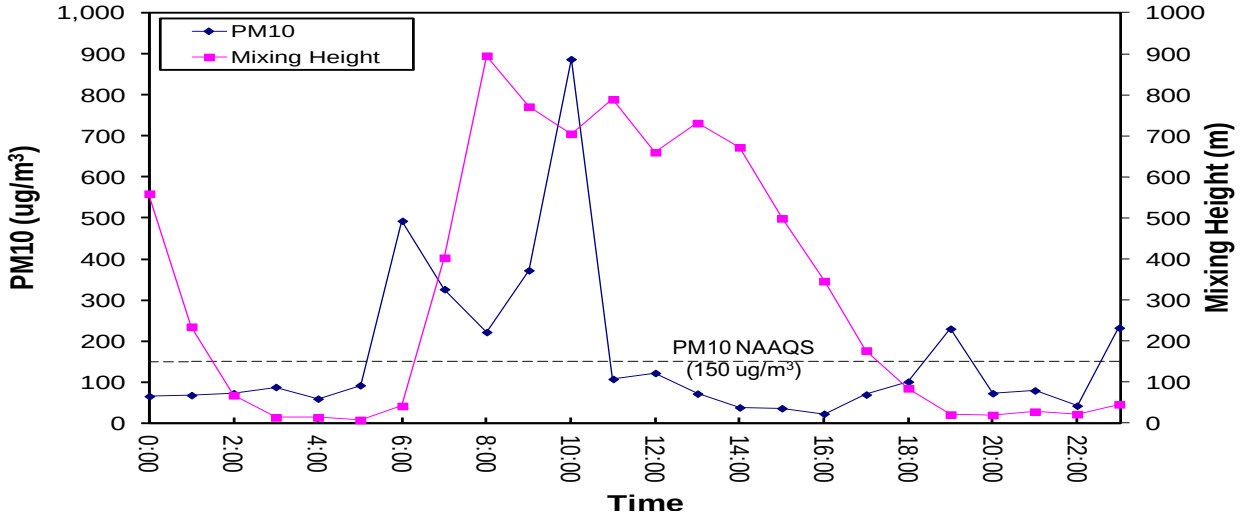


Figure C3. PM10 vs. Mixing Height



Appendix D

Statistics of the High Wind PM10 Exceedance Days at Stanfield in 2008

Table D1. Statistics of the PM10 High Wind Exceedance Days at Stanfield in 2008

Date	Number of High wind hours	Daily Average PM10 (ug/m^3)	Daily Average WSPD (mph)	Daily Max WSPD (mph)	Correlation of Hourly Wind Speed and PM10
11/9/2008	7	371	9	22	0.7494
8/7/2008	3	365	6	21	0.6961
5/21/2008	15	317	14	21	0.8545
1/1/2008	11	255	10	21	0.5550
11/15/2008	7	244	8	18	0.5942
10/27/2008	5	211	7	16	0.4814
11/21/2008	7	178	7	16	0.6289
9/11/2008	2	177	6	27	0.8111
12/13/2008	7	177	8	15	0.6429
7/3/2008	1	159	5	12	0.5470
4/13/2008	3	158	6	18	0.3838

HIGH WIND DAY, 05/21/2008, STANFIELD

Figure D1. PM10 vs. Wind Speed

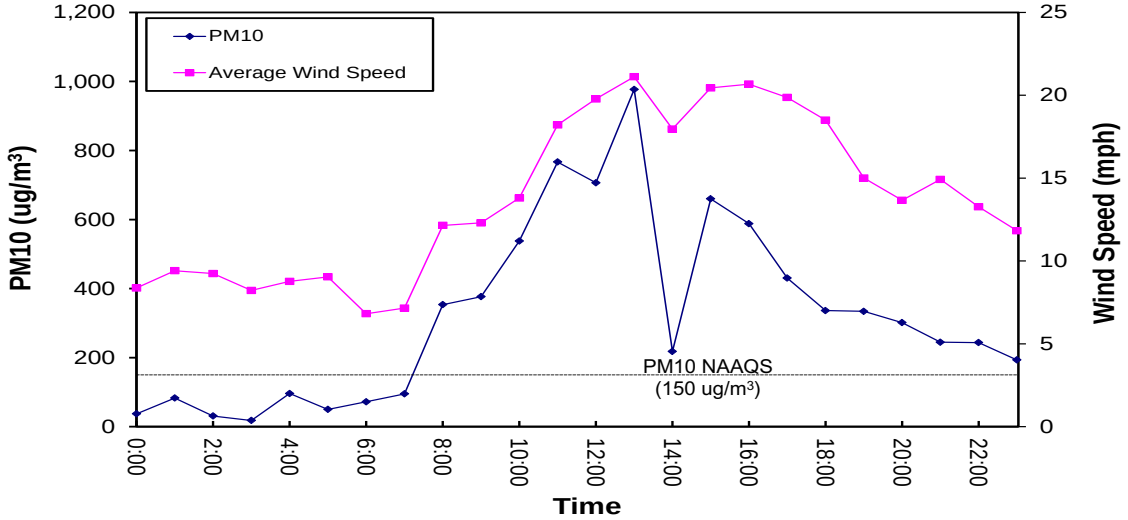


Figure D2. Wind Direction vs. Wind Speed

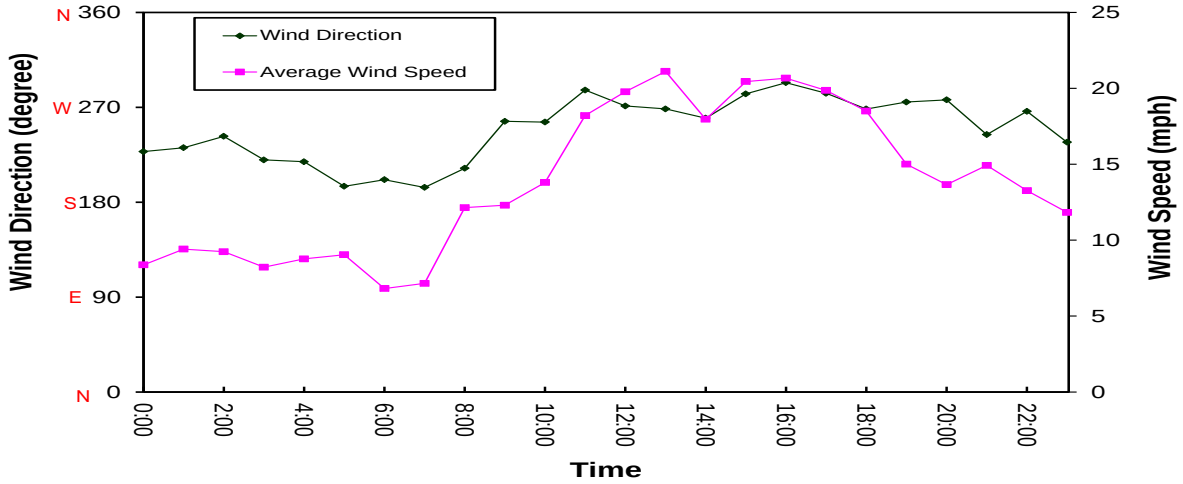
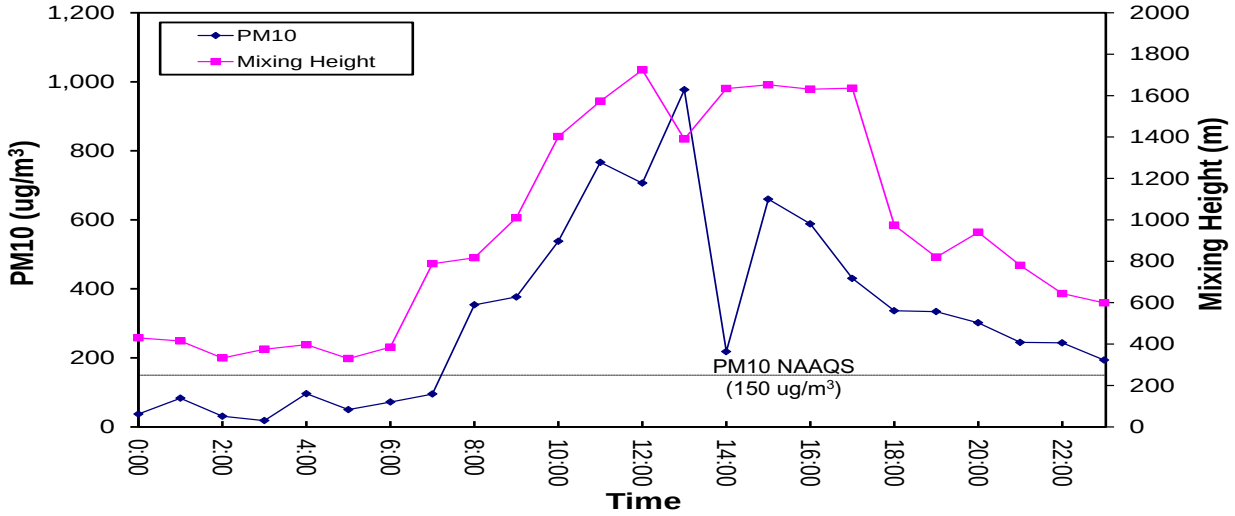


Figure D3. PM10 vs. Mixing Height



HIGH WIND DAY, 11/09/2008, STANFIELD

Figure D4. PM10 vs. Wind Speed

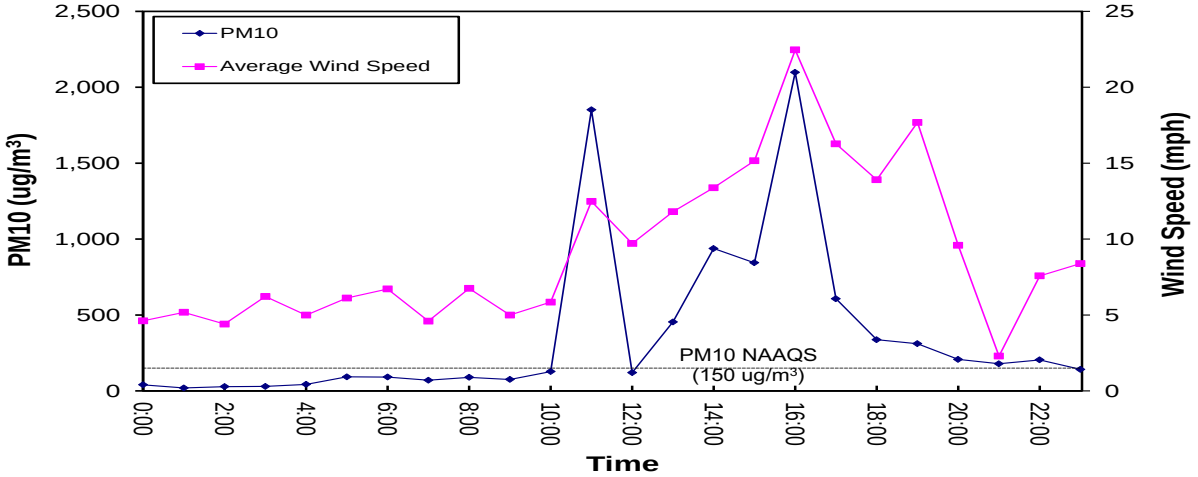


Figure D5. Wind Direction vs. Wind Speed

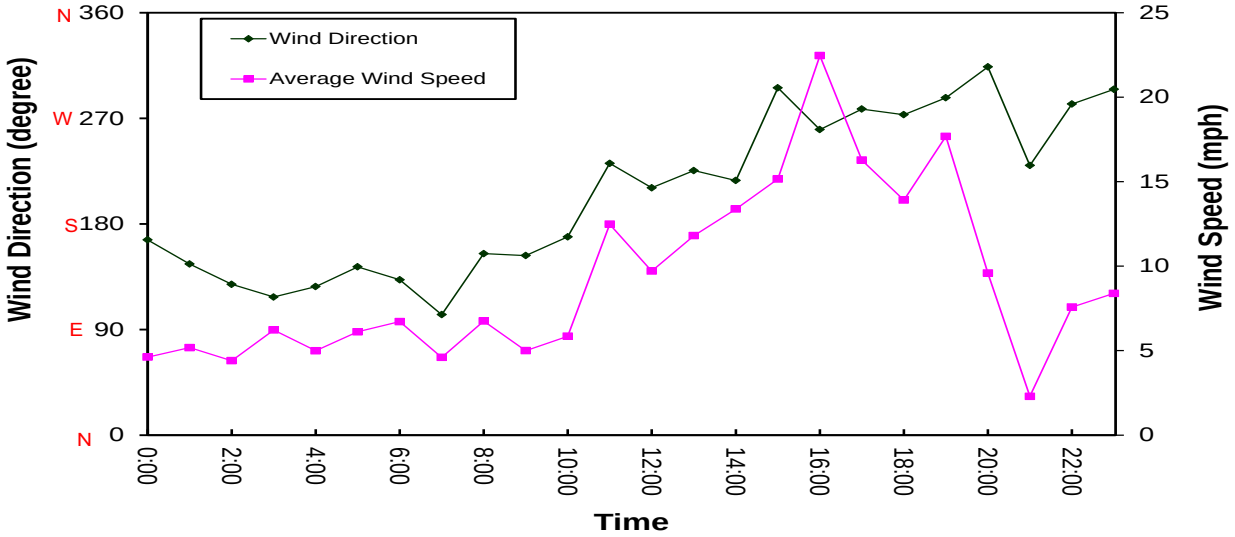
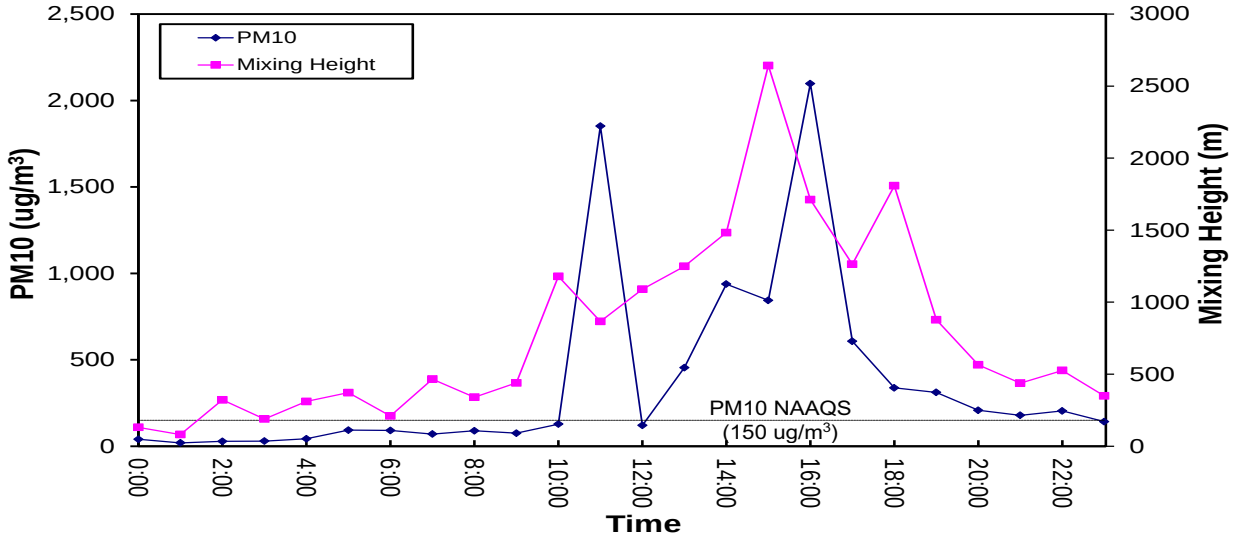


Figure D6. PM10 vs. Mixing Height



HIGH WIND DAY, 12/13/2008, STANFIELD

Figure D7. PM10 vs. Wind Speed

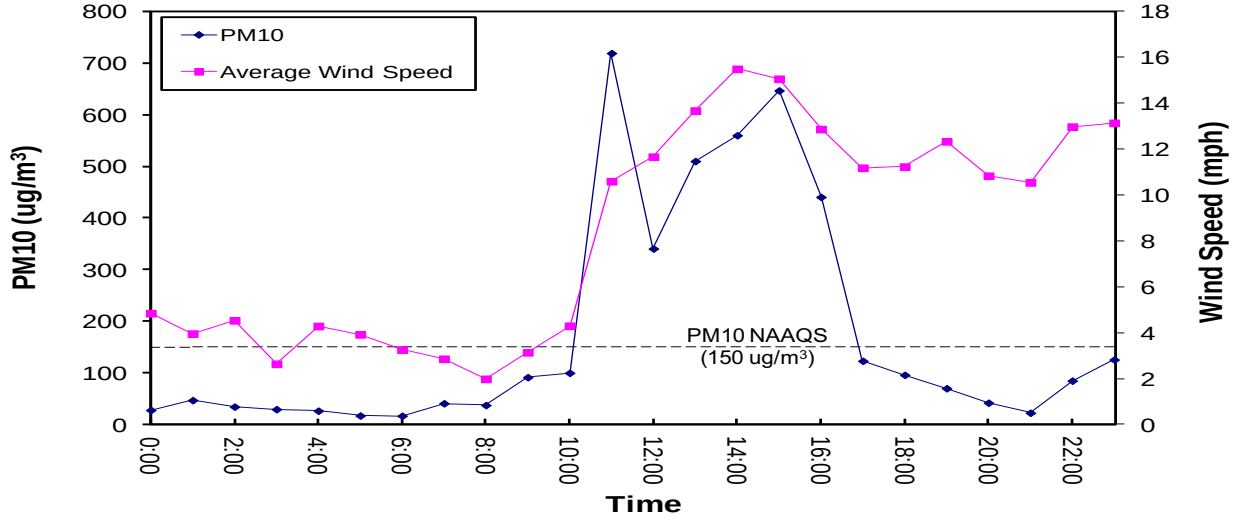


Figure D8. Wind Direction vs. Wind Speed

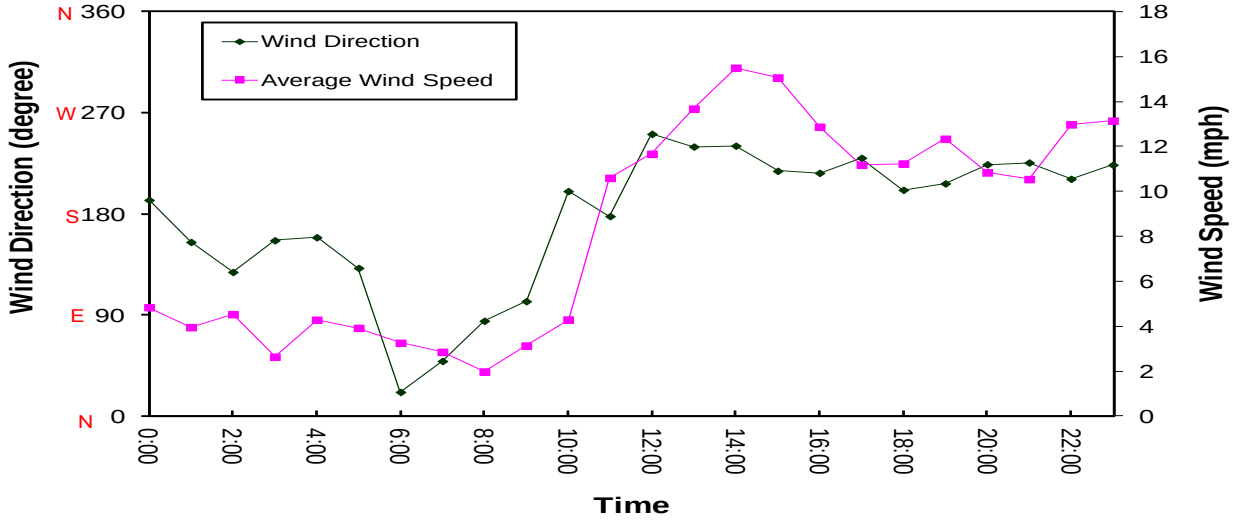
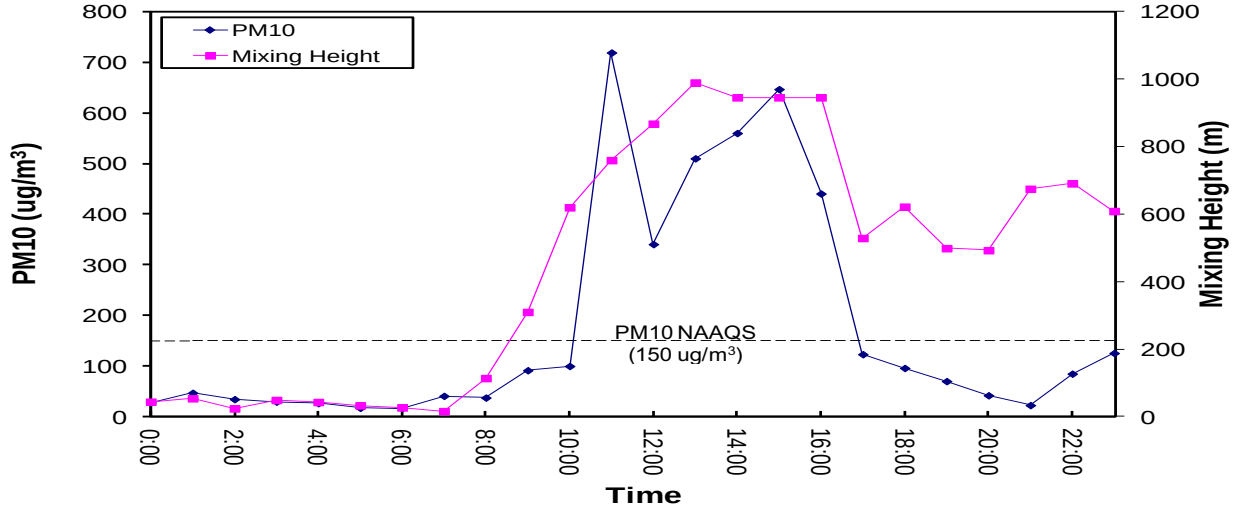


Figure D9. PM10 vs. Mixing Height



HIGH WIND DAY, 11/21/2008, STANFIELD

Figure D10. PM10 vs. Wind Speed

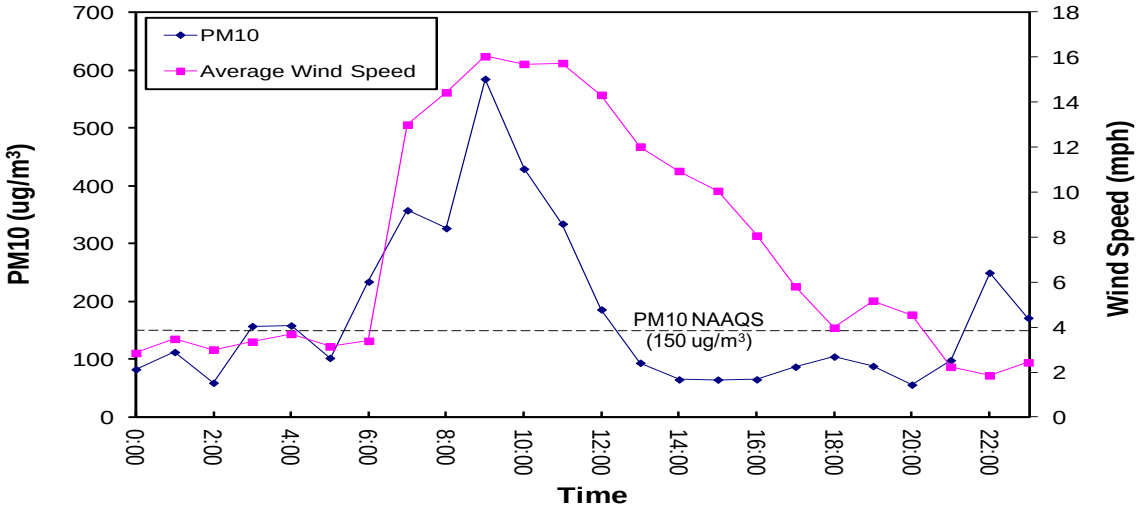


Figure D11. Wind Direction vs. Wind Speed

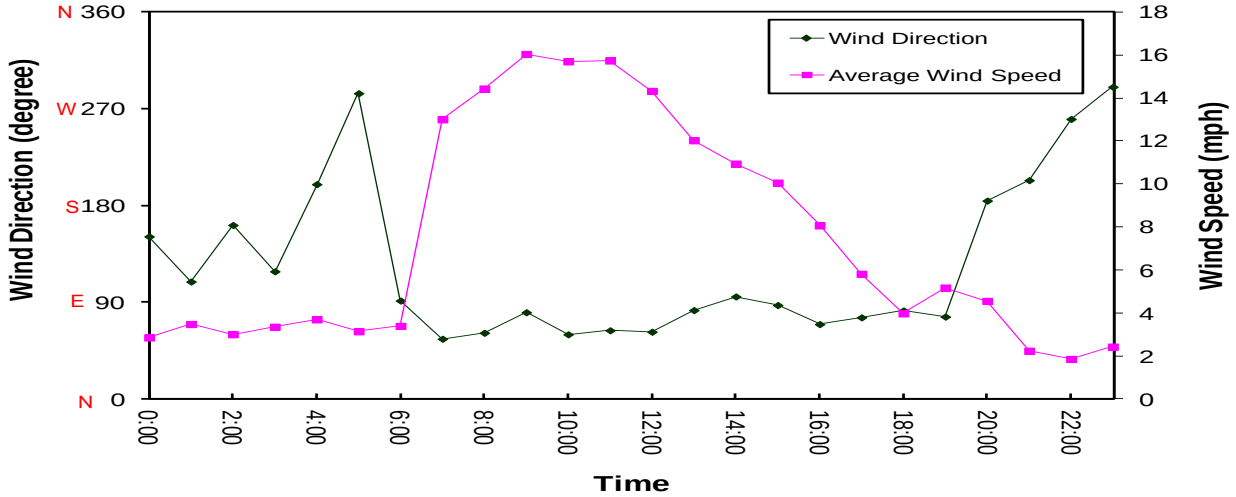
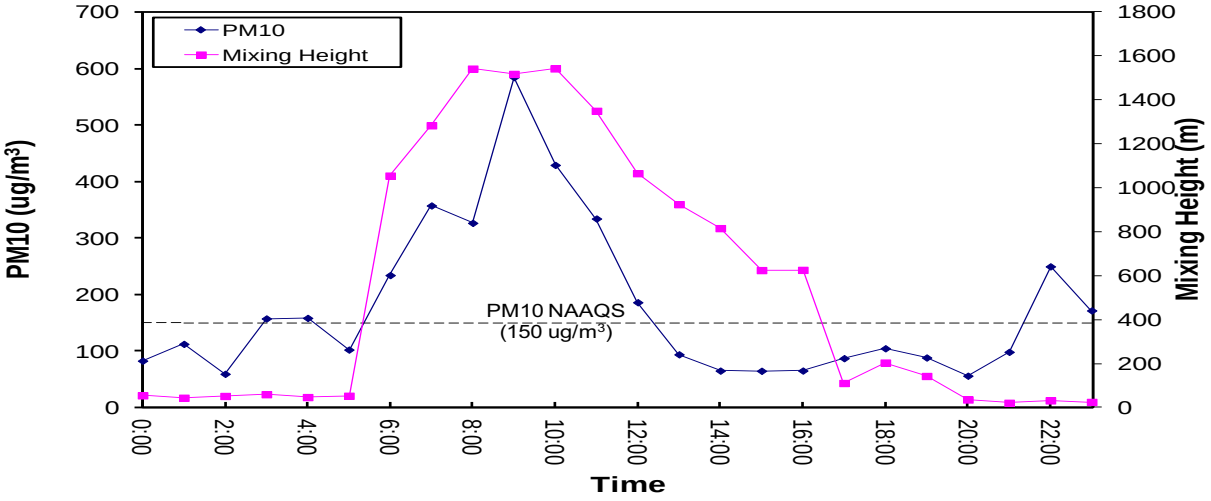


Figure D12. PM10 vs. Mixing Height



Appendix E

Statistics of the High Wind PM10 Exceedance Days at Pinal County Housing in 2008

Table E1. Statistics of the PM10 High Wind Exceedance Days at Pinal County Housing in 2008

Date	Number of High wind hours	Daily Average PM10 (ug/m^3)	Daily Average WSPD (mph)	Daily Max WSPD (mph)	Correlation of Hourly Wind Speed and PM10
11/9/2008	4	282	5	17	0.7954
5/21/2008	13	271	11	17	0.4827
1/1/2008	15	260	11	20	0.6639
5/15/2008	2	222	5	15	0.5432
9/11/2008	2	213	4	18	0.7246
8/15/2008	1	172	4	14	0.7661
10/27/2008	7	156	7	15	0.7750

HIGH WIND DAY, 01/01/2008, PINAL COUNTY HOUSING

Figure E1. PM10 vs. Wind Speed

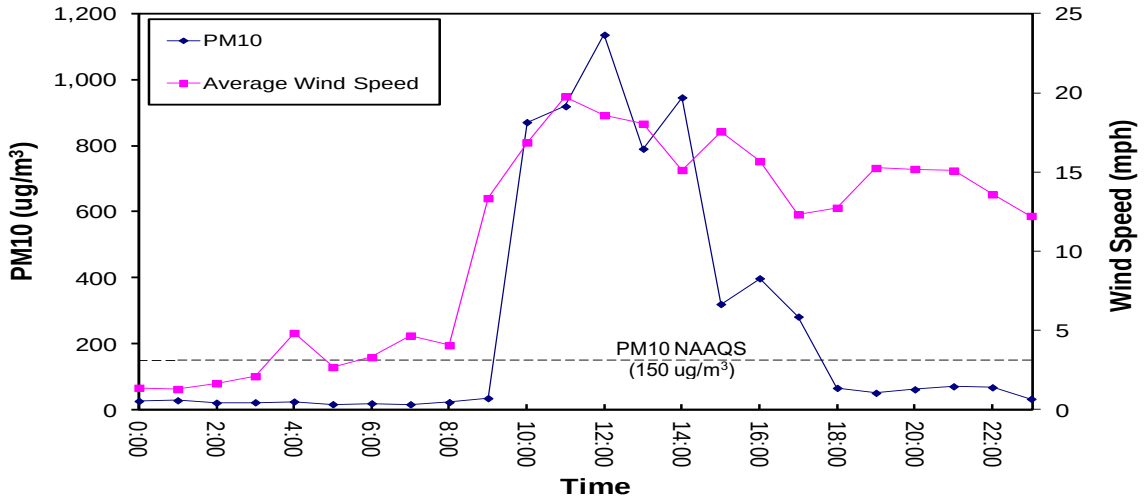


Figure E2. Wind Direction vs. Wind Speed

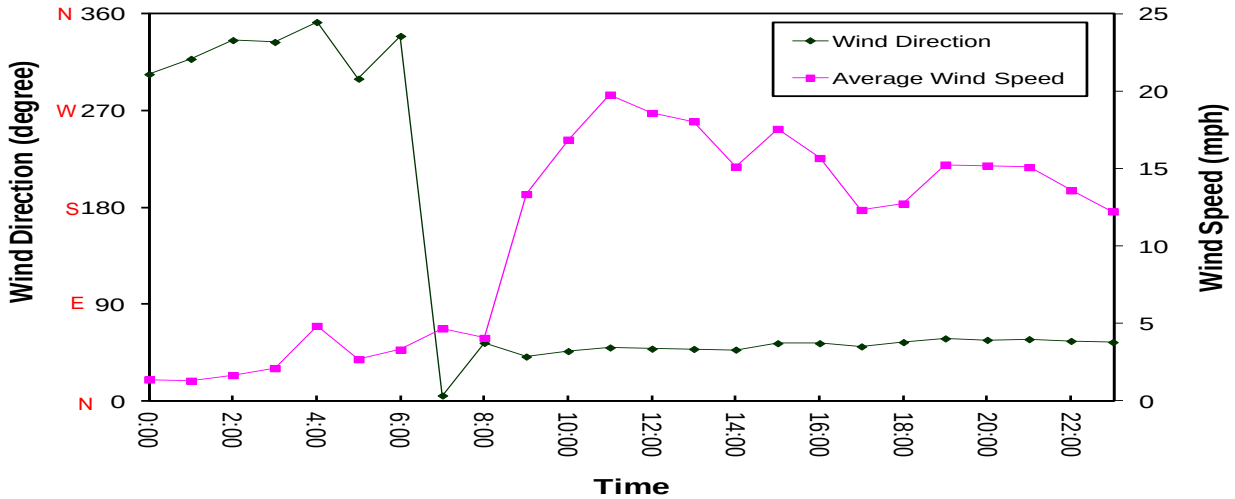
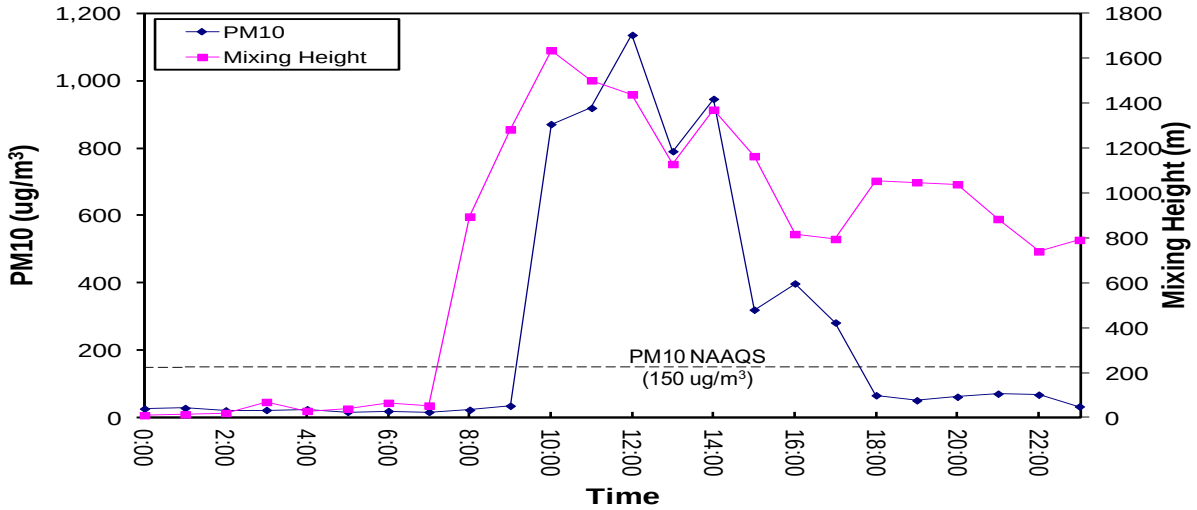


Figure E3. PM10 vs. Mixing Height



Appendix F

Statistics of the PM10 Exceedance Days at Maricopa in 2008

Table F1. Statistics of the PM10 High Wind Exceedance Days at Maricopa in 2008

Date	Number of High wind hours	Daily Average PM10 (ug/m^3)	Daily Average WSPD (mph)	Daily Max WSPD (mph)	Correlation of Hourly Wind Speed and PM10
1/1/2008	12	317	11	19	0.7112
8/7/2008	3	213	6	22	0.7717
9/11/2008	2	170	6	21	0.6398
10/11/2008	7	157	8	14	0.5433
10/27/2008	9	159	9	18	0.4384
11/9/2008	6	520	8	18	0.6795

HIGH WIND DAY, 10/27/2008, MARICOPA

Figure F-1. PM10 vs. Wind Speed

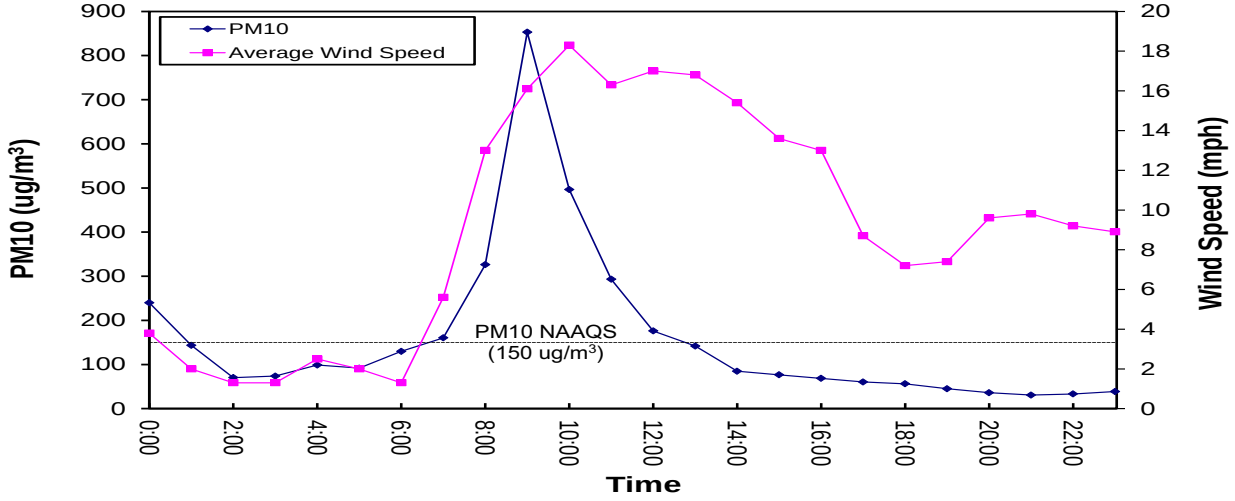


Figure F-2. Wind Direction vs. Wind Speed

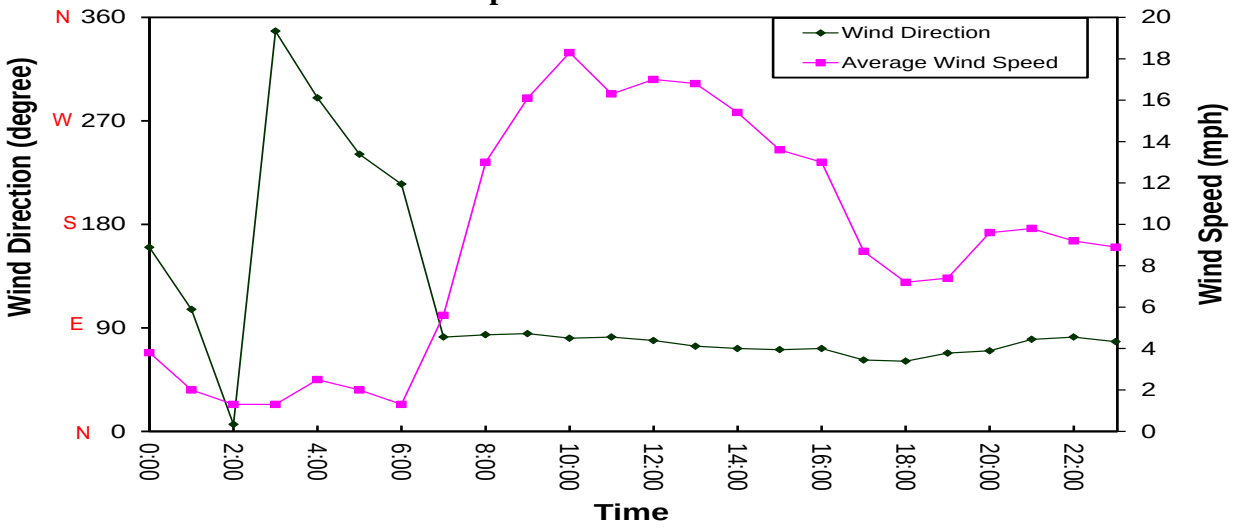
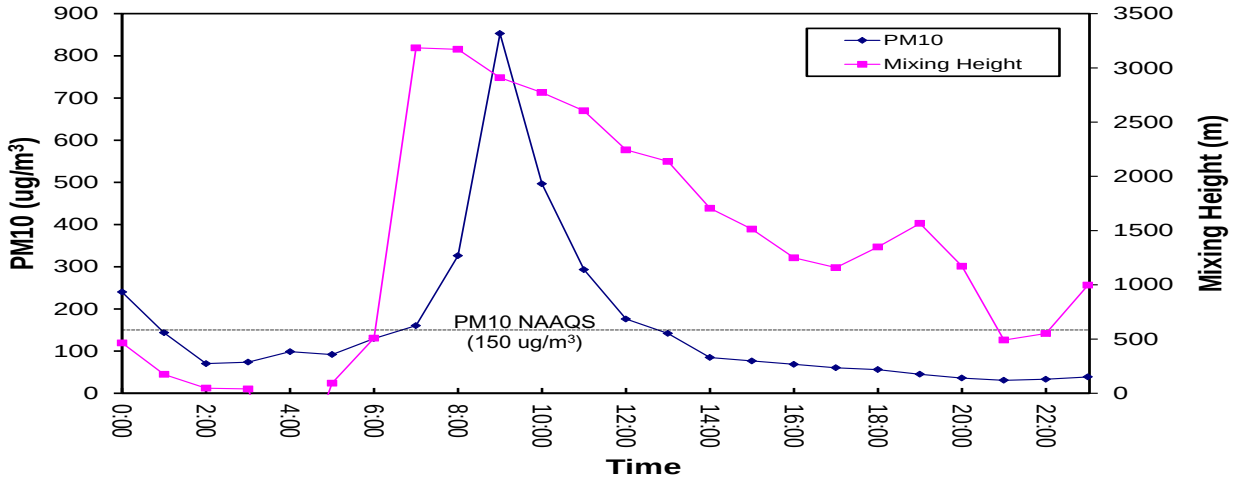


Figure F-3. PM10 vs. Mixing Height


PM10
Mixing Height
PM10 NAAQS
(150 ug/m³)
PM10 (ug/m³)
Mixing Height (m)
Time
900
800
700
600
500
400
300
200
100
0
3500
3000
2500
2000
1500
1000
500
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00

Appendix G

Statistics of the PM2.5 Exceedance Days at Cowtown in 2008

Table G1. Statistics of the PM2.5 Exceedance Days at Cowtown in 2008

Date	Daily Average PM2.5 (ug/m^3)	Daily Average PM10 (ug/m^3)	Daily Average WSPD (mph)	Daily Max WSPD (mph)
3/25/2008	42	497	3	5
4/12/2008	41	370	4	10
5/6/2008	40	304	7	16
4/30/2008	40	285	10	18
11/20/2008	38	345	3	6
6/23/2008	37	249	6	11
4/18/2008	36	362	3	7

PM2.5 DAY, 03/25/2008, COWTOWN

Figure G1. PM10 vs. Wind Speed

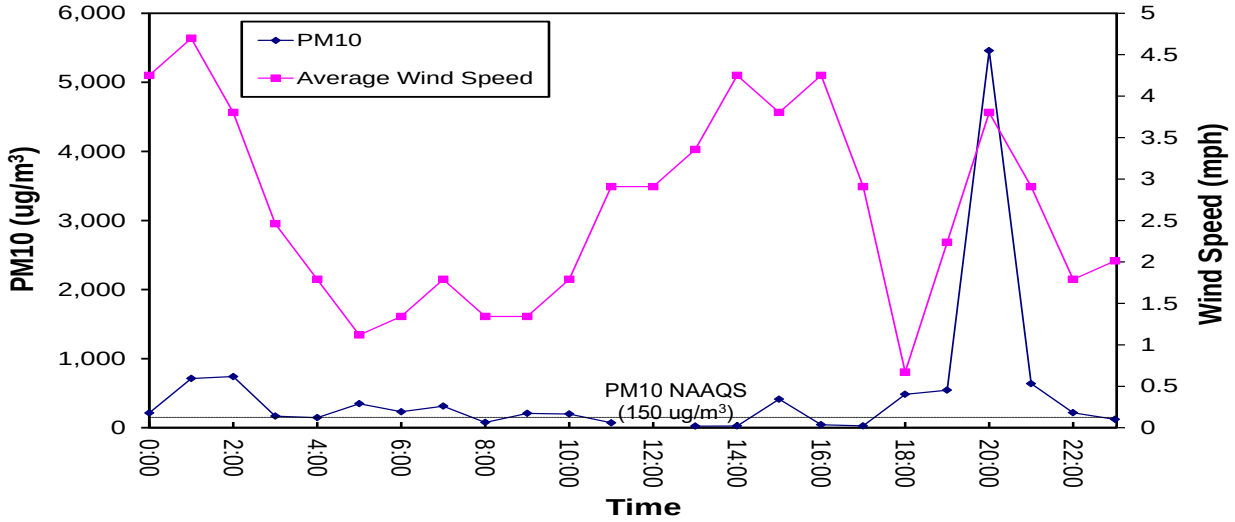


Figure G2. Wind Direction vs. Wind Speed

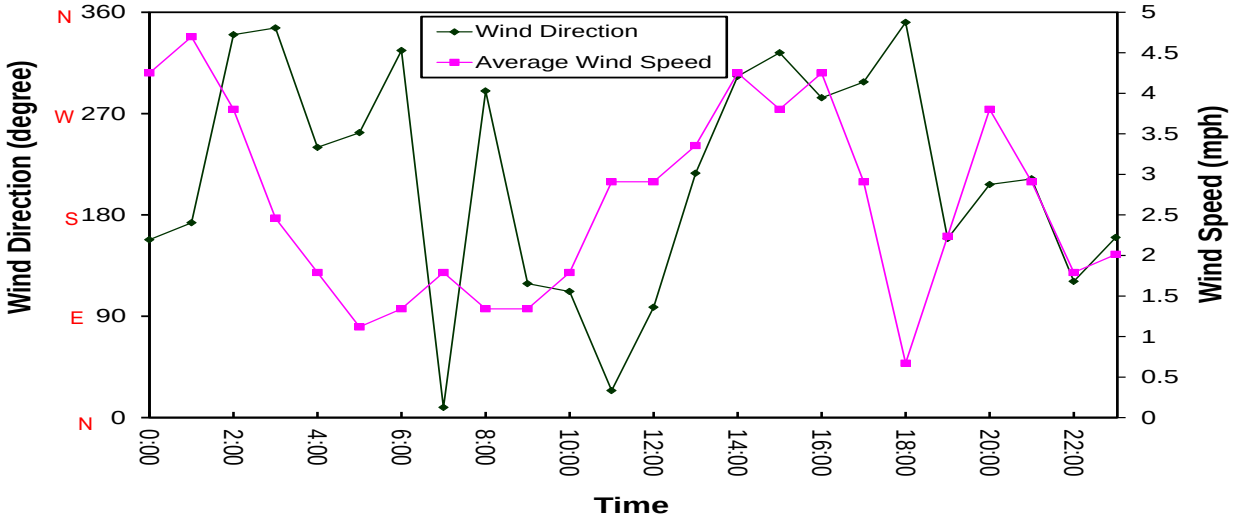
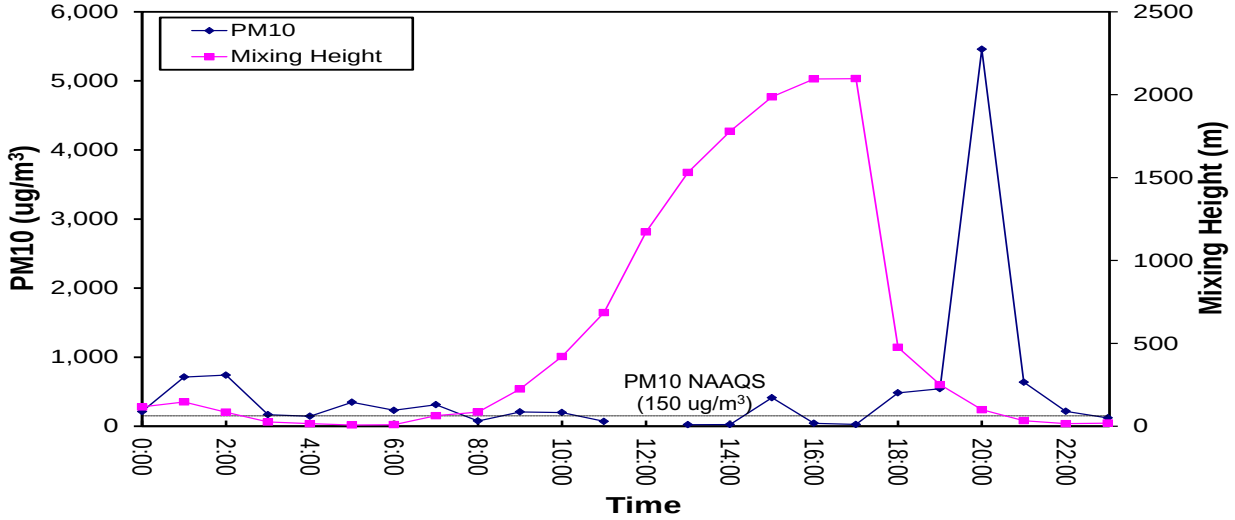


Figure G3. PM10 vs. Mixing Height



PM2.5 DAY, 04/12/2008, COWTOWN

Figure G4. PM10 vs. Wind Speed

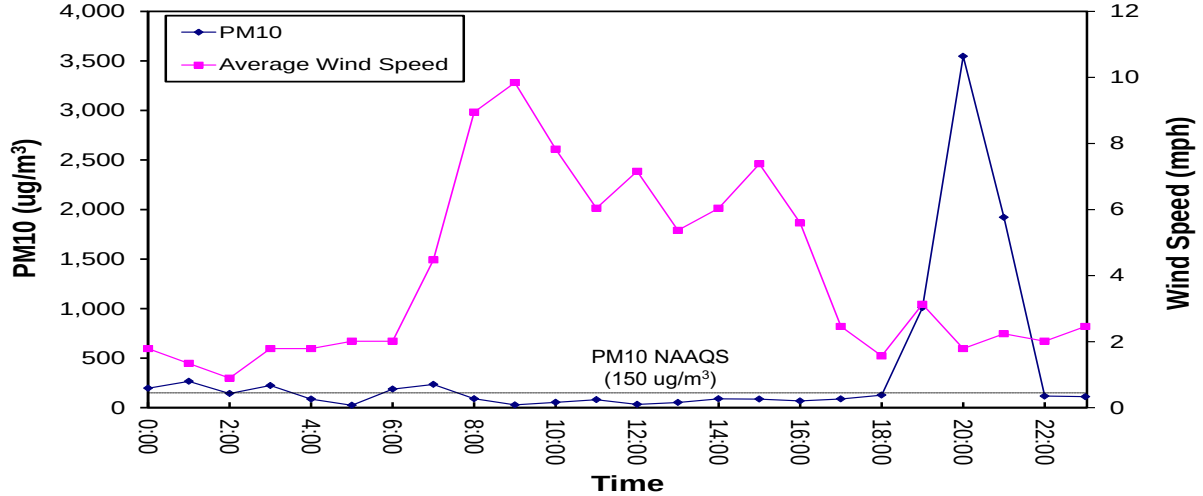


Figure G5. Wind Direction vs. Wind Speed

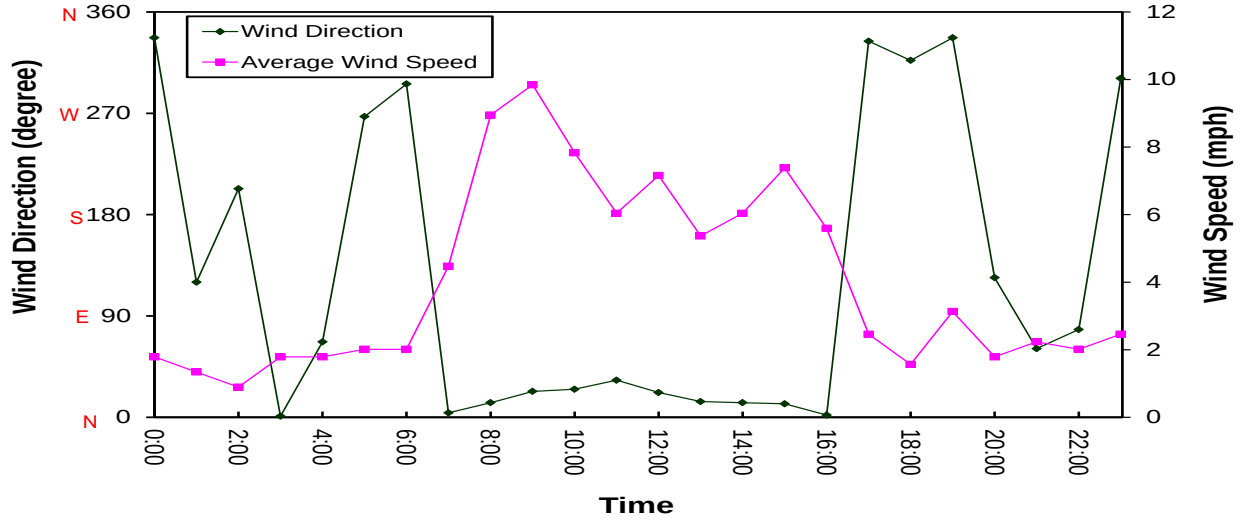
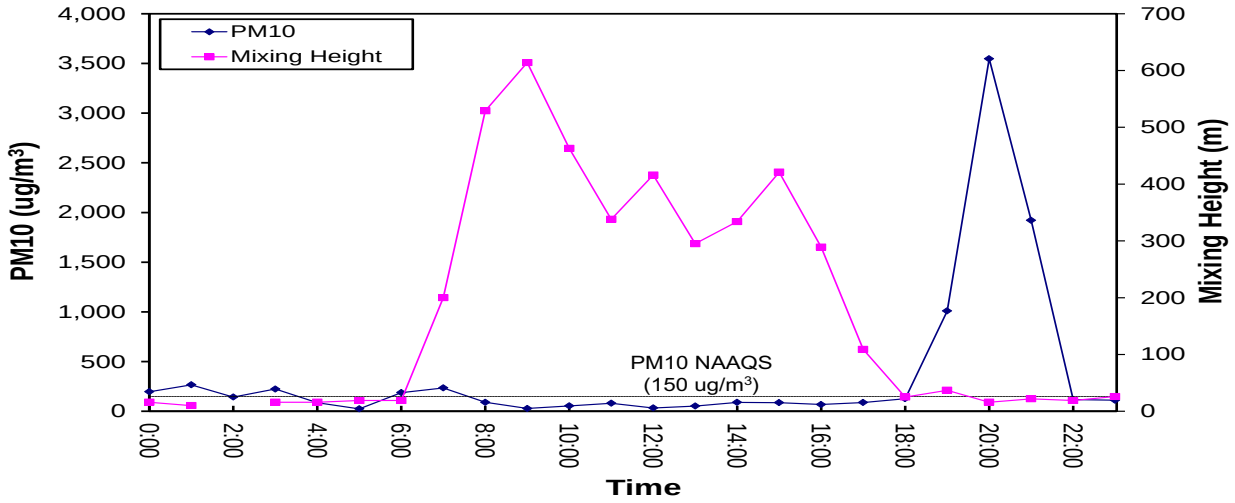


Figure G6. PM10 vs. Mixing Height



PM2.5 DAY, 05/06/2008, COWTOWN

Figure G7. PM10 vs. Wind Speed

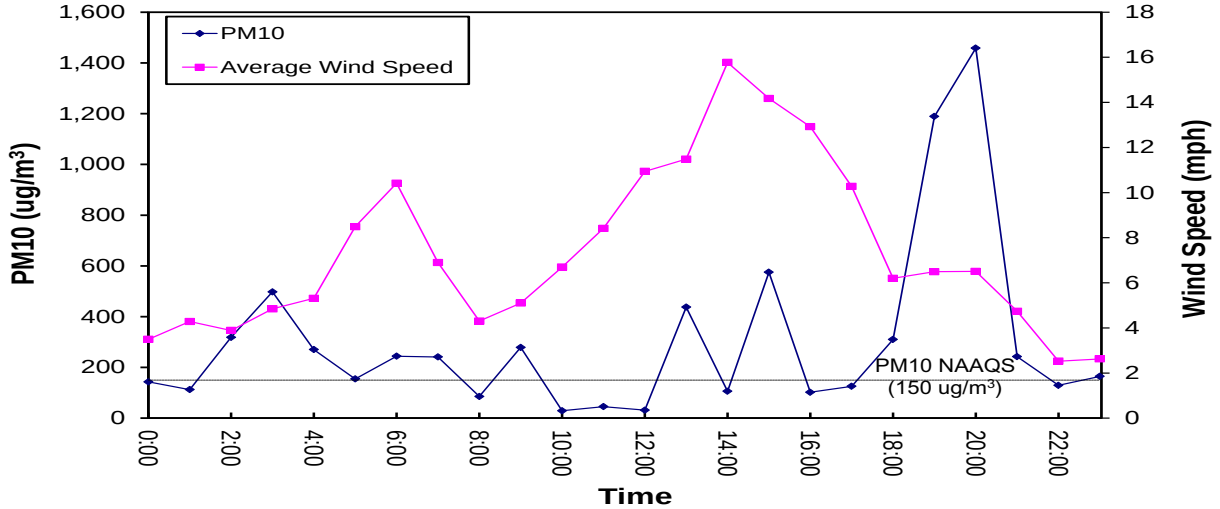


Figure G8. Wind Direction vs. Wind Speed

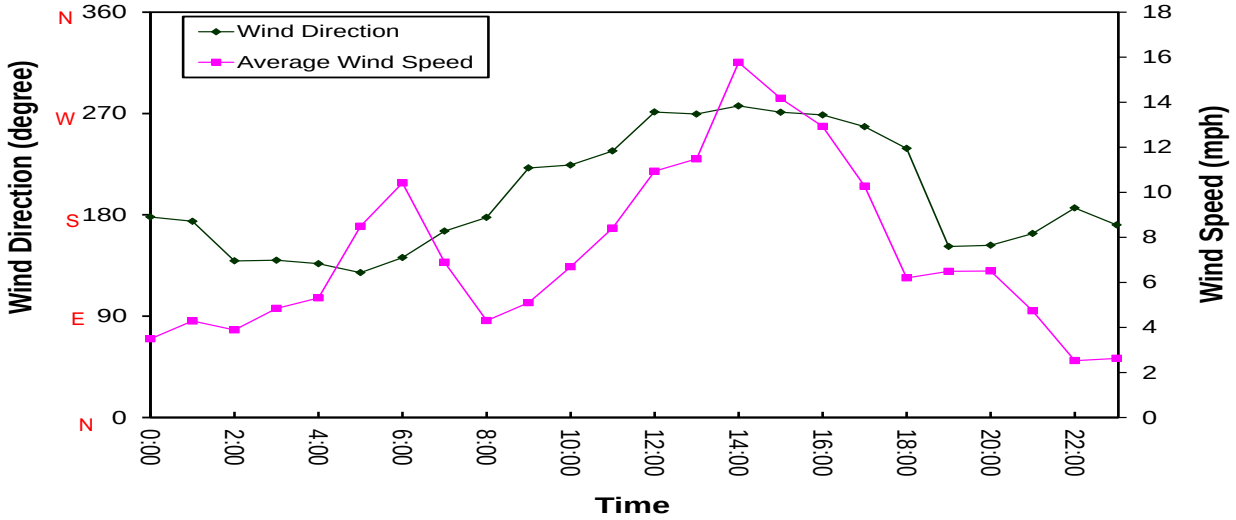
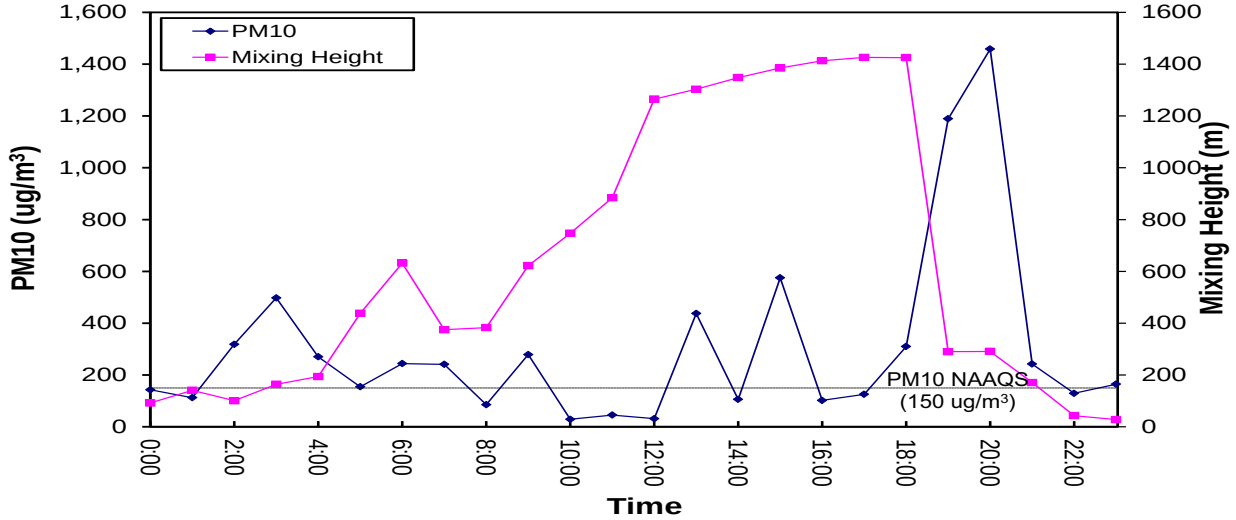


Figure G9. PM10 vs. Mixing Height



PM2.5 DAY, 04/30/2008, COWTOWN

Figure G10. PM10 vs. Wind Speed

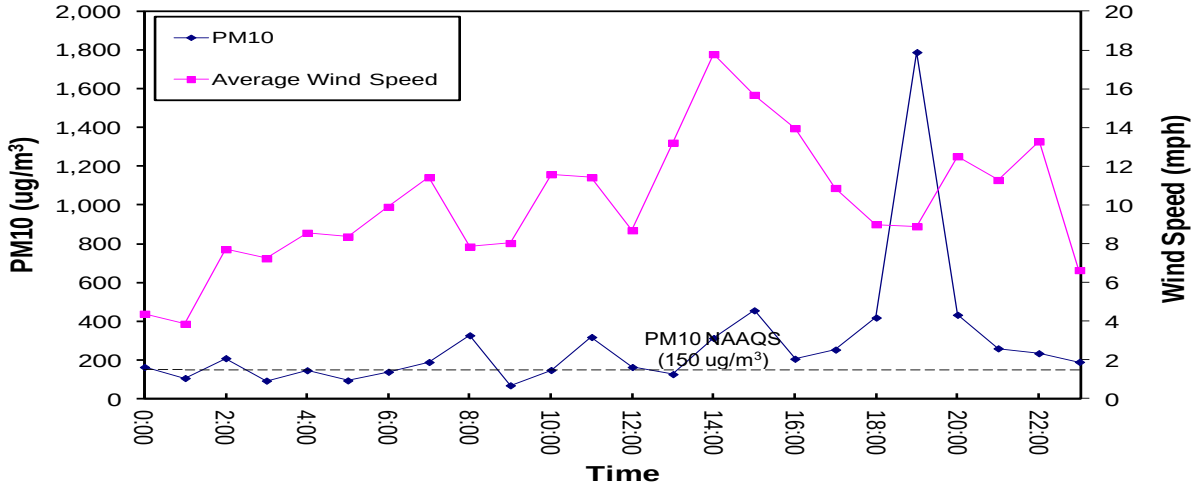


Figure G11. Wind Direction vs. Wind Speed

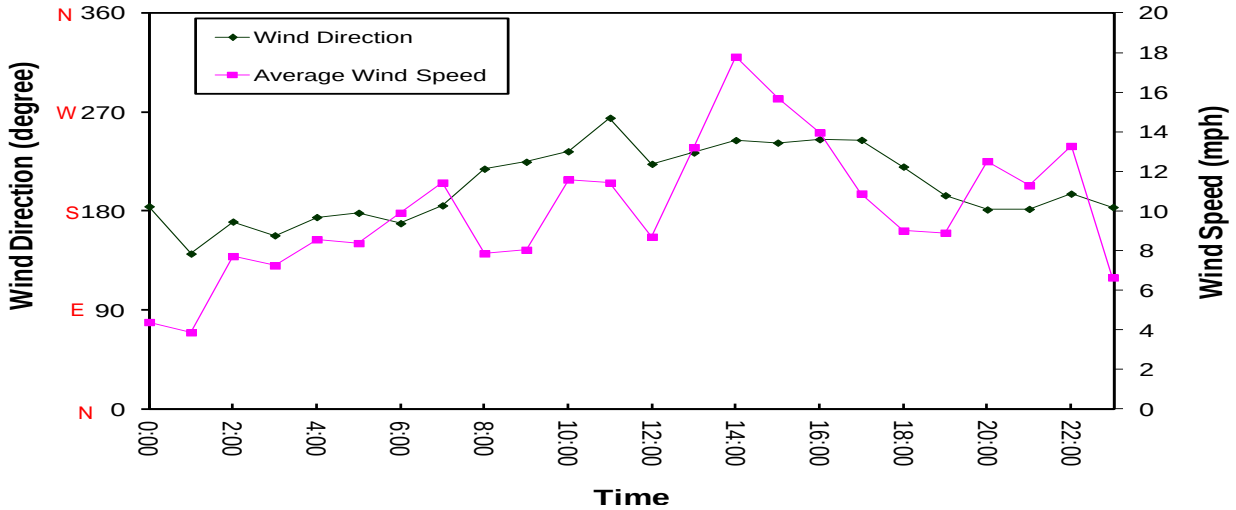
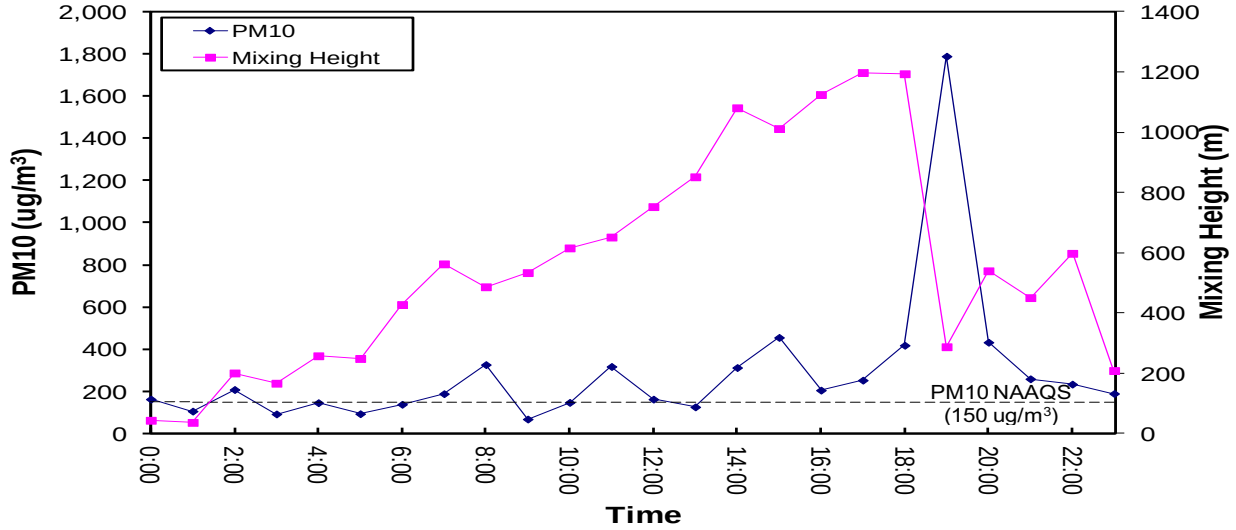


Figure G12. PM10 vs. Mixing Height



PM2.5 DAY, 11/20/2008, COWTOWN

Figure G13. PM10 vs. Wind Speed

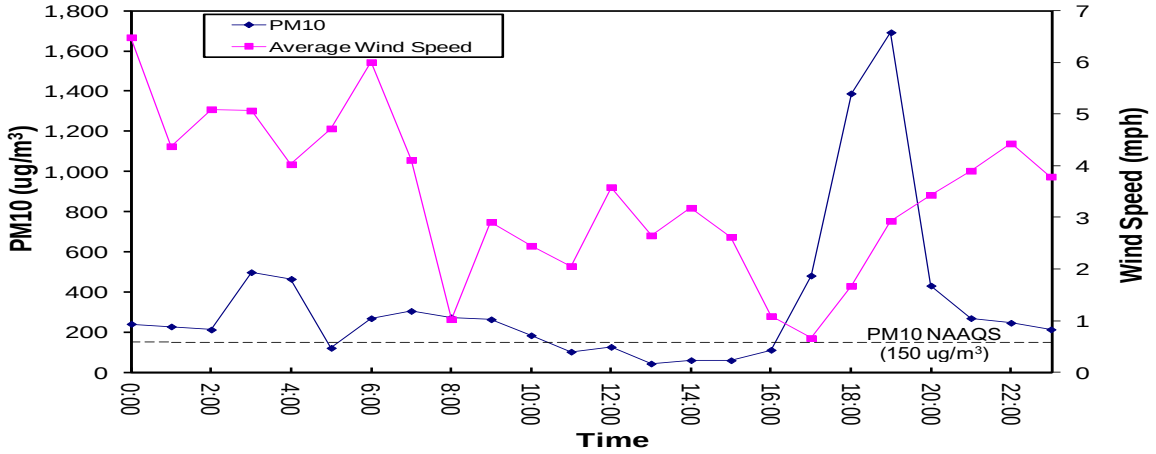


Figure G14. Wind Direction vs. Wind Speed

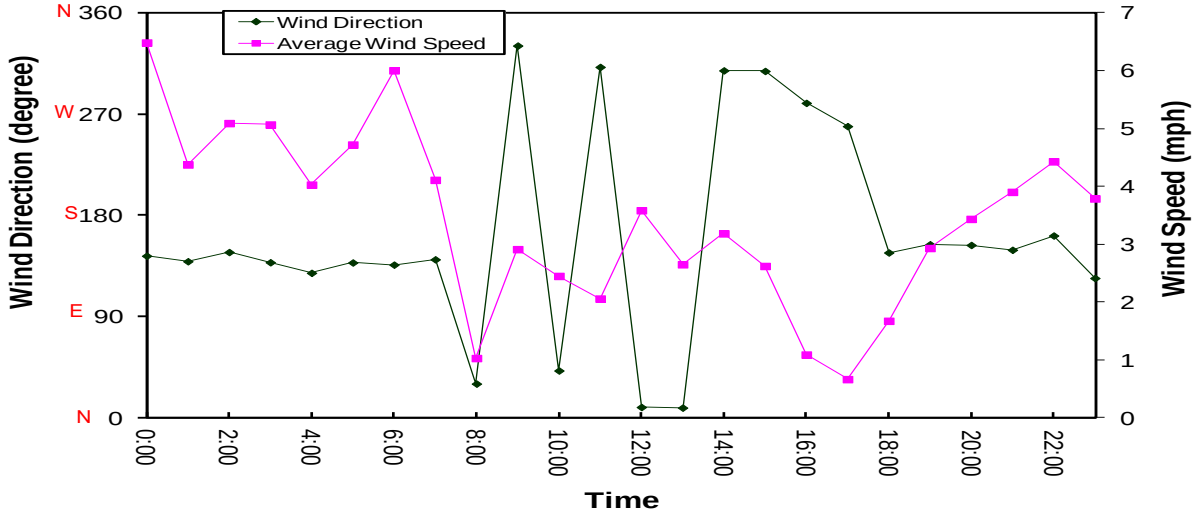
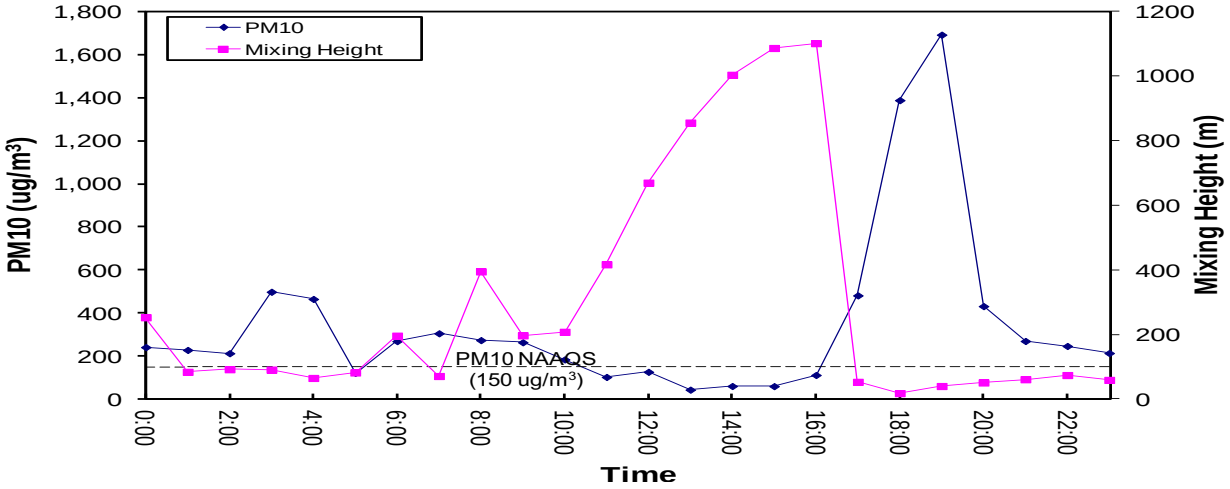


Figure G15. PM10 vs. Mixing Height



PM2.5 DAY, 06/23/2008, COWTOWN

Figure G16. PM10 vs. Wind Speed

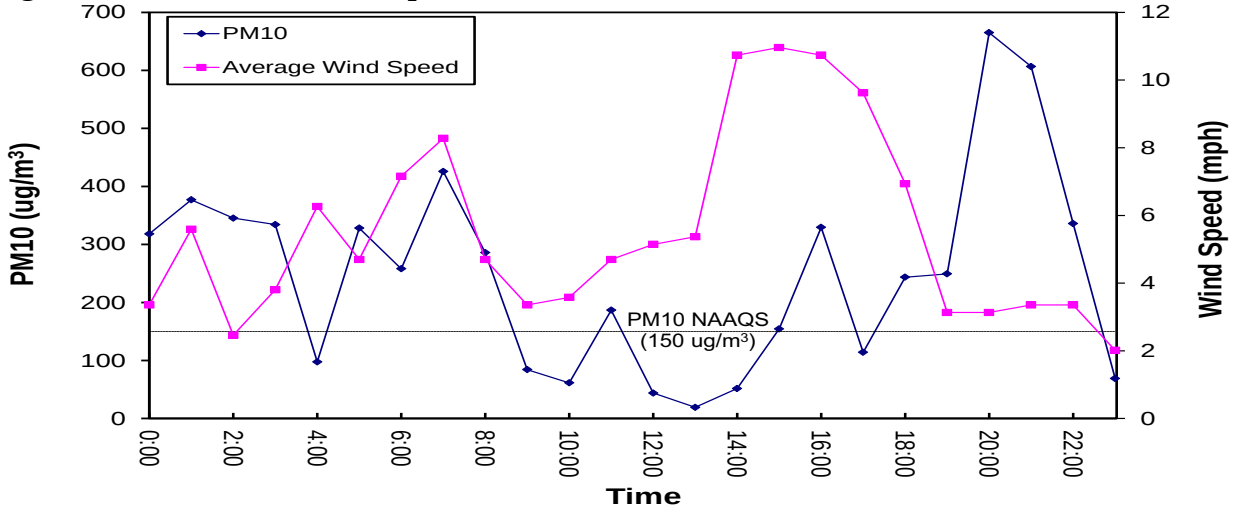


Figure G17. Wind Direction vs. Wind Speed

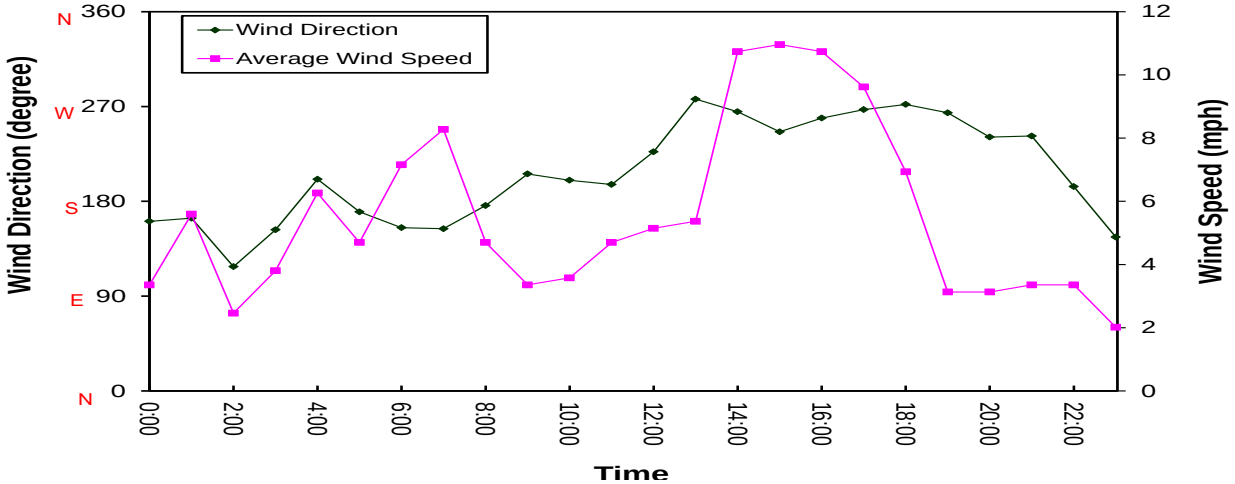
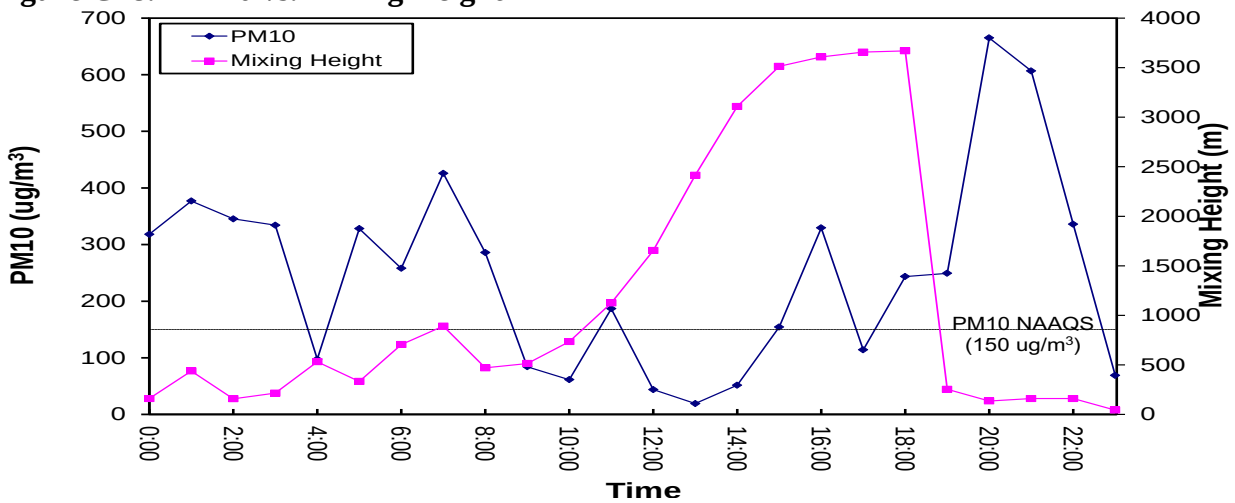


Figure G18. PM10 vs. Mixing Height



PM2.5 DAY, 04/18/2008, COWTOWN

Figure G19. PM10 vs. Wind Speed

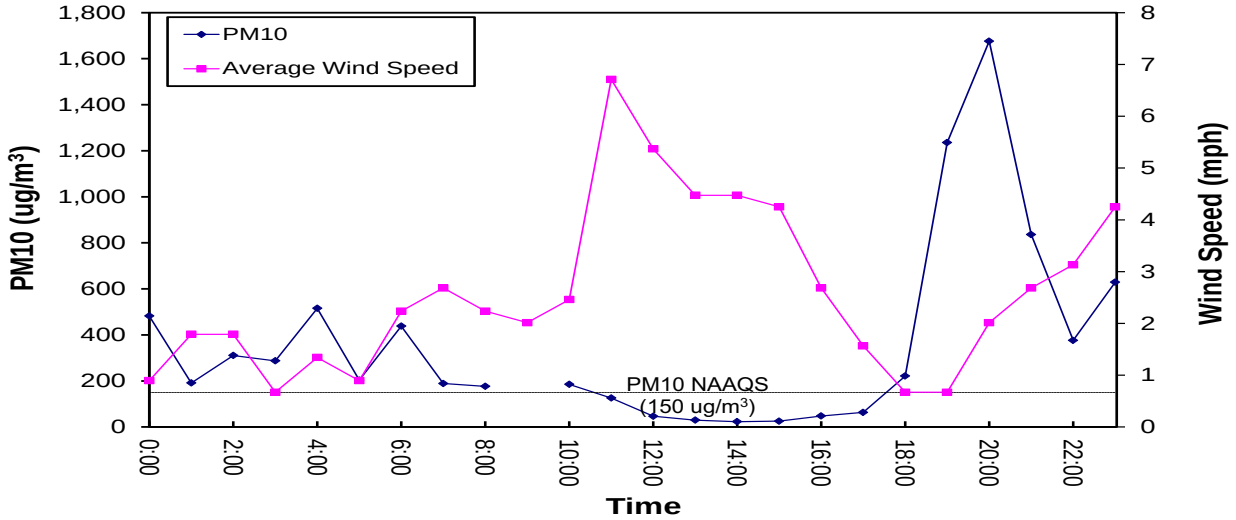


Figure G20. Wind Direction vs. Wind Speed

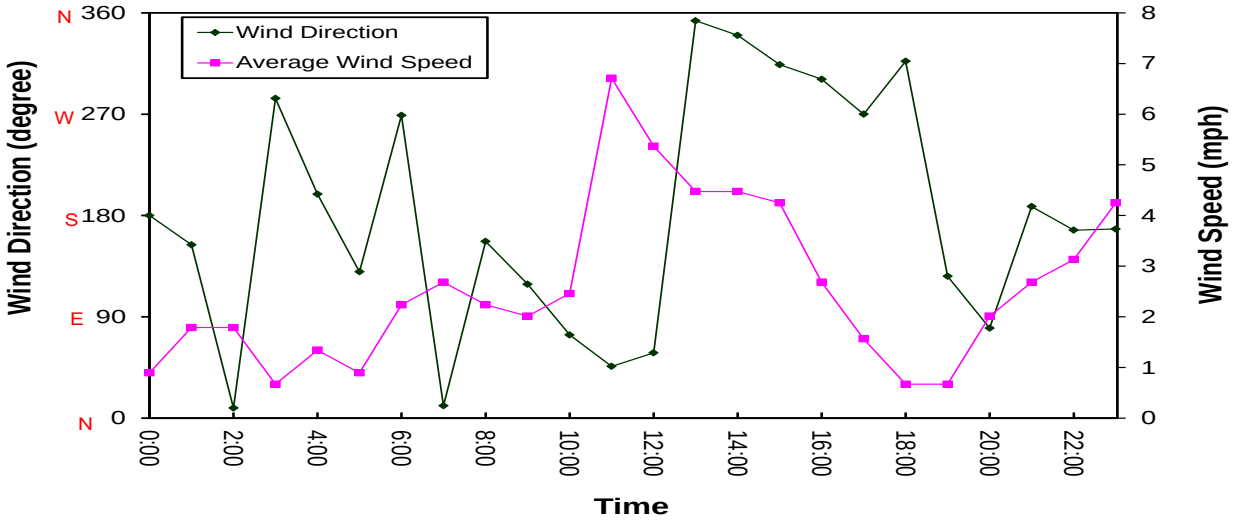
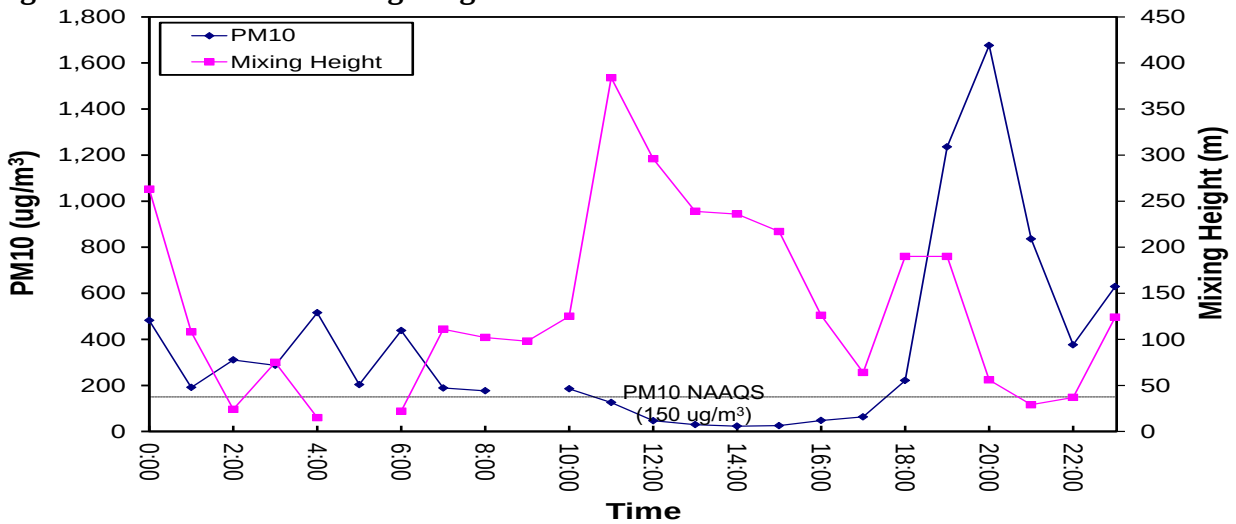


Figure G21. PM10 vs. Mixing Height



Appendix H

Road Count Data

ROAD COUNTS CONDUCTED BY PINAL COUNTY AIR QUALITY

Road Name	Road Surface	Location of Count	Month/Year of Count	Cars per day
Signal Peak Road	Dirt	~1/2 mile south of Hwy 87	October 2001	228
Diversion Dam Road	Dirt	At the end of the pavement	November 2001	127
Gary Road	Dirt	Between Lind Rd and Gail Rd	November 2001	904
Tweedy Road	Dirt	Just south of Kleck Road	December 2001	133
Bartlett Road	Dirt	Just west of Kenworthy Road	January 2002	139
Arizona Western Road	Dirt	~1/4 mile west of Eleven Mile Corner Road	January 2002	83
Judd Road	Dirt	~1/4 mile west of Gary Road	March 2002	154
Sossaman Road	Dirt	~1/2 mile south of Empire Blvd	April 2002	117
Ellsworth Road	Dirt	~1/4 mile south of Hunt Hwy	May 2002	193
White and Parker Road	Dirt	~0.1 mile north of Farrell Road	June 2002	456
Hartman Road	Dirt	~0.1 mile north of Maricopa-Casa Grande Highway	June 2002	88
Warren Road	Dirt	~0.1 mile south of Farrell Road	July 2002	80
Amarillo Valley Road	Dirt	~0.1 mile south of Clayton Road	July 2002	643
Christensen Road	Dirt	~2 miles north of Highway 287	August 2002	21
Peralta Road	Dirt	~0.1 mile northeast of Fransisco de Coronado Road	September 2002	86
San Juan Road	Dirt	~0.1 mile north of Solano Road	September 2002	343
Ivar Road	Dirt	~0.1 mile west of Gary Road	September 2002	200
Sherry Lane	Dirt	~0.1 mile west of Schnepf Road	October 2002	65
Hash Knife Road	Dirt	~0.2 mile east of Schnepf Road	November 2002	416
Mammoth Road	Dirt	~0.5 mile north of Selma Hwy	November 2002	50
Honeycutt Road	Dirt	~1.0 mile east of Hwy 387	December 2002	423
Barnes Road	Dirt	~0.6 mile east of Ralston Road	December 2002	115
Warren Road	Dirt	~0.1 mile south of Century	January 2003	340
Houston Road	Dirt	~0.4 mile west of Ganzel	February 2003	1042
Southwood Road	Dirt	Near the intersection with Country Lane	February 2003	81
Combs Road	Dirt	~0.2 mile east of Schnepf Road	February 2003	94
Macrae Road	Dirt	~0.1 mile south of Vah Ki Inn	March 2003	166
Jacob Waltz Road	Dirt	~0.1 mile west of Mountain View Road	March 2003	268
Mountain View Road	Dirt	~0.1 mile south of Lost Dutchman Road	April 2003	494
Lost Dutchman Road	Dirt	~0.1 mile west of Mountain View	April 2003	312
Price Road	Dirt w/ soil stabilizer	~0.3 mile east of Highway 79 (Friday thru Monday of Country Thunder)	April 2003	6676
Price Road	Dirt w/ soil stabilizer	~0.3 mile east of Highway 79 (Friday thru Wednesday of Country Thunder)	April 2003	4061
Navajo Road	Paved	~50 feet mile south of Papago Road (next to Stanfield monitor)	May 2003	91
Macrae Road	Dirt	~0.1 mile south of Vah Ki Inn	May 2003	174

Foothill Road	Dirt	~0.1 mile east of Cortez Road	June 2003	110
Signal Peak Road	Dirt	~0.1 mile north of Woodruff	August 2003	206
Signal Peak Road	Dirt	~0.4 mile south of Highway 87	August 2003	127
Hidalgo Street	Dirt	~0.1 mile west of Val Vista	August 2003	91
Lost Dutchman Road	Dirt	~0.1 mile east of Val Vista	September 2003	129
Hartman Road	Dirt	~0.1 mile north of Maricopa-Casa Grande Highway	September 2003	96
Farrell Road	Dirt	~0.9 mile east of White and Parker Road	October 2003	134
White an Parker Road	Dirt	~0.1 mile north of Maricopa-Casa Grande Highway	October 2003	343
Maricopa-Casa Grande Highway	Paved	~0.1 mile southeast of White and Parker Road (next to the Cowtown monitor)	October 2003	2717
Cowtown Road	Dirt	~0.1 mile northwest of Hartman Road	November 2003	146
Saddle Butte Street	Dirt	~0.1 mile east of Ironwood Drive	November 2003	319
Plaza Drive	Dirt	~0.1 mile south of Smoketree St	December 2003	114
Combs Road	Paved	~0.2 mile east of Ganzel Road (next to Combs monitor)	December 2003	2459
Wagon Wheel Road	Dirt	~0.1 mile north of Dove Roost Road	January 2004	173
Magma Road	Dirt	~0.1 mile east of Gary Road	January 2004	84
Davis Ranch Road	Dirt	~0.6 mile west of Bootleg Road	February 2004	220
Grande Valley Road	Dirt	~0.1 mile east of Way Out Road	February 2004	83
Tomahawk Road	Dirt	~0.1 mile north of McKellips Road	February 2004	231
Cactus Road	Dirt	~0.1 mile north of McKellips Road	March 2004	184
Blanco Drive	Dirt	~ 0.1 north of Val Vista Road	March 2004	126
Greasewood Street	Dirt	~ 0.1 mile east of San Marcos	March 2004	41
Desierto Road	Dirt/Gravel	~0.1 mile eat of Estrella Road	April 2004	118
Toluca Drive	Dirt/Gravel	~0.1 mile eat of Estrella Road	April 2004	51
Price Road	Dirt w/ soil stabilizer	~0.3 mile east of Highway 79 (Thur. thru Mon. of Country Thunder)	April 2004	5737
Caballero Road	Dirt/Gravel	~0.1 mile eat of Estrella Road	May 2004	122
Eleven Mile Corner Road	Paved	~0.1 mile south of Storey Road (next to PCH monitor)	June 2004	653
Gary Road	Dirt	~0.3 mile south of Judd	June 2004	141
Judd Road	Dirt	~0.1 mile west of Bryce Trail	July 2004	245
Brenner Pass Road	Dirt	~0.1 mile south of Phillips Road	July 2004	347
Bianco Road	Dirt	~0.1 mile south of Peters Road	August 2004	66
Florence-Kelvin Hwy	Paved	~1.1 mile south of Hwy 177	August 2004	75
Arroya Road	Dirt	~0.1 mile south of Superstition Blvd.	August 2004	17
Pacific Street	Paved	~0.1 mile north of Broadway	October 2004	164

		Ave		
Rolling Ridge Road	Dirt	~0.1 mile east of Schnepf Road	October 2004	362
Queen Anne Drive	Paved	~0.2 mile south of Cavendish Drive	November 2004	785
Arizona Hwy 88 (conducted by ADOT)	Paved	~0.1 mile southwest of Superstition Blvd	November 2004	3848
Arizona Hwy 347 (conducted by ADOT)	Paved	~0.5 mile south of AZ Hwy 238	June 2004	6787
Price Road	Dirt	~0.2 mile east of Hwy 79 (non-event weekend)	February 2005 2/25 AM thru 2/28 AM	213
Price Road	Dirt	~0.2 mile east of Hwy 79 (non-event weekend)	March 2005 3/4 PM thru 3/7 AM	175
Price Road	Dirt	~0.2 mile east of Hwy 79 (Girl Scout Jamboree weekend)	March 2005 3/11 AM thru 3/14 AM	541
Selma Highway	Dirt	~0.1 mile west of Peart Rd.	March 2005	89
Price Road	Dirt w/ soil stabilizer	~1.3 mile east of Highway 79 (Fri. thru Mon. of Country Thunder)	April 2005	6243
Hidden Valley	Dirt	~0.1 mile north of Farrell Rd.	April 2005	Road tube cut twice
Evans Road	Dirt	~0.1 north of Warren Rd.	July 2005	73
Southern Avenue	Dirt	~0.1 mile east of Geronimo Rd.	July 2005	120
Moon Vista Road	Dirt	~0.1 mile east of Ironwood Rd.	September 2005	105
Hunt to Empire Short Cut T3SR7E between S2&3	Private Property – not a road – Dirt	~0.1 mile north of Hunt Hwy	September 2005	216
Hash Knife Road	Dirt	~0.1 mile east of Schnepf	October 2005	424
Cooper Road	Dirt	~0.1 mile north of Arizona Farms Rd	October 2005	370
Scorpio Road	Dirt	~0.1 mile west of Henness Road	October 2005	25
Tweedy Road	Dirt	~0.1 south of Hwy 287	December 2005	95
Varnum Road	Dirt	~0.1 mile south of Judd Road	January 2006	71
Libra Road	Dirt	~0.1 mile east of Sagittarius Road	February 2006	55
Hewitt Station Road	Dirt	~1.8 mile north of Hwy 60	March 2006	125
Reddington Road	Dirt	~ 0.1 mile north of the County line	March 2006	112
Reddington Road	Dirt	At the end of the pavement	March 2006	162
Price Road	Dirt w/ soil stabilizer	~1.3 mile east of Highway 79 (Thu. thru Mon. of Country Thunder)	April 2006	5952
Price Road	Dirt	~1.3 mile east of Highway 79 (Fri. thru Mon. of non-event weekend)	April 2006 4/14/06 AM thru 4/17/06 AM	212
Mitchell Trail	Dirt	~0.1 mile south of Arizona Farms Rd.	April 2006	165

Southwood Road	Dirt	~0.1 mile east of Kenworthy	May 2006	174
Sherry Lane	Dirt	~0.1 mile east of Kenworthy	May 2006	213
Hartman Road	Dirt	~0.1 mile north of Honeycutt Rd.	July 2006	81
Cooper Road	Dirt	~0.1 mile south of Judd Rd.	September 2006	225
Gary Road	Dirt	~0.1 mile north of Silverdale	October 2006	742
Hopi Road	Dirt	~0.1 mile east of Trekell	November 2006	170
Arabian Road	Dirt	~0.2 mile south of Organ Pipe Rd.	December 2006	61
Dune Shadow Road	Dirt	~0.1 mile west of Amarillo Valley Rd.	January 2007	291
Phillips Road	Dirt	~0.1 mile east of Sunland Gin Road	January 2007	100
Geronimo Road	Dirt	~0.1 mile north of Broadway Road	January 2007	270
Arabian Road	Dirt	~0.2 mile south of Organ Pipe Rd.	January 2007	60
Magma Road alignment (utility easement)	Dirt	~0.1 mile east of Edwards Rd.	February 2007	37
Mountain View Road	Dirt	~0.1 mile south of Lost Dutchman Rd	March 2007	214
Mountain View Road	Dirt	~0.1 mile north of Lost Dutchman Rd	March 2007	74
Mountain View Road	Dirt	~0.1 mile north of Jacob Waltz Rd	April 2007	206
Mountain View Road	Dirt	~0.1 mile east of Mountain View Rd	May 2007	181
Price Road	Dirt w/ soil stabilizer	~1.3 mile east of Highway 79 (Thu. thru Mon. of Country Thunder)	April 2008 4/17/08 AM thru 4/21/09 AM	9150
Clayton Road	Dirt	~0.1 mile east of Ethington Rd.	June 2008	103
Bianco Road	Dirt	~0.1 mile south of Peters Rd.	June 2008	115
Ethington Road	Dirt	~0.1 mile south of Clayton Rd.	June 2008	126
Price Road	Dirt w/ soil stabilizer	~1.3 mile east of Highway 79 (Wed. thru Mon. of Country Thunder)	April 2009 4/1/09 AM thru 4/6/09 AM	6681
Price Road	Dirt w/ soil stabilizer	~1.3 mile east of Highway 79 (Tue. thru Mon. of Country Thunder)	April 2010 4/13/09 AM thru 4/19/09 AM (4/15 6pm thru 4/16 8am lost)	6760
Cooper Road	Dirt	0.1 mile south of Magma Rd.	August 2011 (8/12-19/11)	383
Cooper Road	Dirt	0.1 mile south of Magma Rd.	August 2011 (8/22-29/11)	310

Appendix I

A Method for the Back-Calculation of Wind-Blown Emission Factors from Field Measured PM10 Concentrations

Arizona Department of Environmental Quality
Air Quality Division

A Method for the Back-Calculation of Wind-Blown Emission Factors from Field Measured PM_{10} Concentrations

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ABSTRACT

Regional variability in soil characteristics, meteorological trends, and surface disturbances lead to changes in wind blown emission factors (EFs) for a given land use (LU). Therefore, it is prudent to determine accurate EFs for Pinal County in order to provide the most accurate wind blown Emission Inventory (EI) for the completion of the Pinal County State Implementation Plan (SIP). Emission Factor Back Calculation (EFBC) is currently being proposed as a method of wind blown EF estimation in place of wind blown EF literature values for the creation of the Pinal County PM_{10} State Implementation Plan (SIP). This method relies on the use of field measured PM10 concentrations and meteorological data to back-calculate EFs for different land uses. The method depends on accurate completion of the following steps: 1) Land Use Classification, 2) Meteorological and Emission Data Processing, 3) Estimation of Emission Origination Area, 4) ArcGIS Data Integration, and 5) EF Statistical Optimization. Furthermore, the model uses the following simple linear approach during the statistical optimization step:

$$E_n = A_n * EF_n$$

where E_n is total emissions for each land use within a given footprint (tons/hr), A_n is the calculated area of each land use located within each footprint (m^2), and EF_n is the estimated emission factor for each land use located within a given footprint.

This paper presents the steps taken in the EFBC process and further presents a testing of the model, where the proposed SIP design day for the Pinal County Housing monitor of 1/1/2008 was modeled to estimate EFs for 9 different land uses. The estimated hourly EFs were then used to calculate hourly emissions for the design day. Individual hour variability between model estimated PM10 concentrations and PM10 concentrations measured in the field varied between 2% and 282% over the 24 hour period. The average 24 hour PM_{10} concentration for PCH on 1/1/2008 was 264.9 $\mu g/m^3$ as measured at the monitor. The model predicted a 24 hour average concentration for PCH on the design day of 260.4 $\mu g/m^3$.

INTRODUCTION

The Arizona Department of Environmental Quality (ADEQ) in cooperation with the Pinal County Air Quality Department is in the process of preparing a State Implementation Plan (SIP) for particulate matter less than 10 µm (PM_{10}). The purpose of the SIP is to protect human health and welfare through: 1) air monitoring data and analysis, 2) PM_{10} emission inventory, 2) air dispersion modeling to determine maximum concentrations of pollutants, and 4) control measures used in controlling particulate emissions in order to attain the PM_{10} and $PM_{2.5}$ standard.

Airborne particles are a serious threat to human health. Major health concerns due to exposure to PM_{10} include: effects on breathing and respiratory systems, damage to lung tissue, cancer, and premature death. The elderly, children, and people with chronic lung disease, influenza, or asthma, are especially sensitive to the effects of particulate matter.

Ambient levels of PM_{10} measured at air quality monitoring stations within Pinal County show widespread, frequent, and in some instances, severe, violations of the PM_{10} standard, dating back to 2002. Pinal County's PM_{10} levels are among the highest in the country. Based on 2009 – 2011 certified air quality data, the Pinal County Housing monitor, located approximately 11 miles east of Casa Grande, averaged over 14 recorded exceedances per year of the 1987 PM_{10} ambient air quality standard of 150 micrograms per cubic meter ($\mu g/m^3$).

Ambient monitors located in the new nonattainment area routinely record concentrations two to three times the level of the standard and several monitors have recorded levels approaching or exceeding the significant harm level of 600 ($\mu g/m^3$). After reviewing available data, EPA redesignated much of the western half of Pinal County to nonattainment for the 1987 24-hour PM_{10} National Ambient Air Quality Standard (NAAQS) on May 23, 2012. See 75 FR 60680, October 1, 2010.

Redesignation of the western portion of Pinal County to nonattainment requires the State to create a State Implementation Plan (SIP) which proposes reasonable control methods to reduce PM_{10} emissions in Pinal County to levels which comply with EPA's PM_{10} ambient air quality standard. Conformity with these standards are exhibited through modeling of exceedance days prior to and following control technology implementation to demonstrate adequate emissions reductions have been estimated. Modeling is highly dependant on an intimate understanding of the factors within a region that contribute to emissions during low wind, stagnation, and high wind periods.

Low wind emissions are dominated by mechanical activities which cause the entrainment of particulate matter into the atmosphere. As wind speeds increase, wind blown dust entrainment increases resulting in a lower proportion of field measured PM10 concentrations originating from activity based PM entrainment. The degree to which wind blown emissions contribute to ambient air PM_{10} concentrations is dependant on the land use being analyzed. Different land uses can exhibit varying degrees of soil moisture,

soil texture, soil disturbance, surface roughness, and impermeable layer coverage. Furthermore, these characteristics can change for land uses within different regions of the US, State, or even County. For this reason, it is important to identify site specific windblown emission factors (EFs) rather than relying on literature based EFs which may originate from measurements taken from a variety of different locations.

Since performing field measurements of windblown EFs for a variety of land uses using a wind tunnel is resource intensive, ADEQ proposes another method of estimating windblown EFs. The Emission Factor Back Calculation (EFBC) method utilizes field measured meteorological and PM10 concentration data for the sites and periods of interest in order to estimate EFs for land uses that are characteristic for that region. Using field measured meteorological data, the EFBC method estimates emission particle origination areas in order to determine what land uses are contributing emissions impacting the monitor during a period of interest. The method then employs a statistical optimization approach to estimate the most logical EF for each land use within the contributing area.

In this document, ADEQ presents the steps taken to implement the EFBC method. ADEQ further tests the estimated EFs to determine how well PM10 concentrations are calculated using these EFs against the field measured PM10 concentrations for the proposed model design day and location of 1/1/2008 for the Pinal County Housing monitor.

METHODS

The process behind EF back-calculation first relies on land use classification into distinct categories. These categories should cover all land uses necessary to perform a comprehensive EI calculation for the non-attainment area. The second step of the EF back-calculation process is data processing of meteorological and PM10 concentration field data in order to remove periods of incomplete data. This step further requires wind speed, wind direction, mixing height (the height at which there is negligible vertical atmospheric mixing), air temperature, sensible heat flux (the conductive heat flux from the Earth's surface to the atmosphere), and PM10 concentration data be averaged at the daily scale and for some categorizes to be analyzed for variability to insure a group of representative sample periods are utilized for analysis. The third step utilizes the Korman and Meixner analytical footprint model in order to estimate particle emission origination location. This method utilizes probability analysis to calculate an area from which particles (PM_{10}) are most likely to have originated. The next step requires the integration of aerial photography, calculated footprint extents, and land use information into ArcGIS in order to characterize the land uses located within each footprint surrounding the monitors of interest. One footprint analysis is performed for each land use classification previously categorized. The idea is to use the total emissions (as determined from PM_{10} monitor measurements) and the calculated area of each land use (as determined from ArcGIS) within a footprint to back calculate the unknown emission factors utilizing the equation:

$$E_n = A_n * EF_n$$

These equations cannot be solved individually, but must be solved utilizing a statistical optimization technique such as the Newton Method. The Newton Method requires an equal number of equations as unknowns. Therefore, if nine land use types have been identified for EF estimation, nine different equations and thus nine individual footprints must be described. Once all footprints have been created, the Newton Method can be used to solve for all EF's simultaneously by using the Excel Addin known as Solver.

The following sections will outline the steps which were taken to implement this method for the Pinal County Housing (PCH) proposed design day of January 1, 2008. The following steps to the EFBC method are described:

- Land Use Classification
- Meteorological and PM10 Concentration Data Processing
- Estimation of Emissions Origination Area
- ArcGIS Data Integration
- EF Statistical Optimization

Following the estimation of EFs, the proposed design day for PCH of January 1st was modeled to assess the accuracy of these EFs to produce field collected PM10 concentration values.

Land Use Classification

The first step in the EFBC method is to identify and classify the land use types which require EF determination. This will be limited to those land use types within approximately 6 km of the PM_{10} monitors (the distance from the monitors will change with the wind speed examined). For all meteorological conditions tested, land use classification for a 6 km radius area surrounding the monitor was adequate since the Footprint estimation model only identifies those land uses contributing 90% of total emissions to the monitor. Therefore, the footprint emissions origination model predicts that for the meteorological extremes tested in Pinal County, emissions originating from >6 km from the monitor will always comprise < 10% of the total emissions impacting the monitor. Aerial photography and activity records supplied by Pinal County Air Quality Department (PCAQD) were used to classify land uses. The following land uses were identified within 6 km of the Stanfield, Cowtown, Maricopa, and Pinal County Housing monitors:

- Developed Urban Lands
- Developed Rural Lands
- Paved Roads
- Unpaved Roads
- Cleared Areas

- Construction Areas
- Concentrated Animal Feeding Operations - CAFOs (Feedlots & Dairies)
- Desert Shrubland
- Cropland (Fallow & Vegetated)

Characterization of land use for the 1/1/2008 design day was achieved through the examination of an aerial photograph taken of the western portion of Pinal County in early April of 2008 (LandisCor), PCAQD and ADEQ road maps, and 2008 active CAFO location maps and active construction areas provided by PCAQD. Each land use required the creation of 1 emission footprint (as discussed later in this document). Therefore, 9 land use classifications will require 9 footprints with each footprint's extent covering a unique land use classification.

Meteorological and Emission Data processing

The next step requires the acquisition and processing of wind speed, wind direction, mixing height, sensible heat flux, and field measured PM10 concentration data from the stations of interest. For the purposes of testing the PCH 1/1/2008 design day, data was processed from 4 monitors within the nonattainment area: Cowtown, Pinal County Housing, Stanfield, and Maricopa. These 4 monitors recorded the highest number of exceedances during the year of 2008 providing the most conservative datasets available from a regulatory standpoint. Furthermore, processing multiple meteorological and PM10 concentration datasets allowed ADEQ to create EFs representative of the entire nonattainment area rather than for a small section of the nonattainment area.

The first step of data processing was to isolate only the hourly data which occurred during the winter of 2008 (December 22nd – March 20th). Arizona Meteorological Network (AZMET) rainfall data was analyzed for all rain gauges located within the nonattainment area. Any date when a rain gauge registered greater than 2 mm for the day was removed from the data pool to minimize the effects of precipitation. Hourly periods where data were missing were interpolated. Wind speed, wind direction, and PM_{10} concentration values were taken from field measurements. Mixing heights and sensible heat fluxes were calculated by AERMET using meteorological data (including upper air sounding information) from Tucson, AZ. Hourly seasonal temperature was averaged from AZMET values for the year of 2008. Hourly data at each station was then separated by hour of the day, wind direction, and wind speed at a 10 m height into the following groupings:

Hour periods: 0-700, 800-1500, 1600-2300
Wind Direction: 20 degrees increments
Wind speed periods (mph): 0-3. 3-6, 6-9, 9-12, 12-15, 15-18, 18+

Data was then averaged in each group. Averaging of similar data allows the model to create sample sizes greater than 1 to reduce the effect of outliers. The averaged data created a representative dataset of meteorological and PM10 concentration data to be utilized for emission footprint creation.

Estimation of Emissions Origination Area

Characterization of the land uses contributing to emissions impacting the monitor requires the estimation of the area from which the emissions originate. Back trajectories were considered for this purpose; however, the use of back trajectories does not account for particle deposition rates. In order to account for this, emission footprints were estimated using the EdiTools program known as "Footprint" *(http://www.geos.ed.ac.uk/abs/research/micromet/EdiTools/).* Footprint creates an image representative of the measurement site of interest dependent on the meteorological characteristics input into the model. This image can then be imported into ArcGIS for characterization contributing land uses. The Footprint model is a windows desktop implementation of the Korman and Meixner analytical footprint model (2001). This model accounts for vertical turbulence and cross-wind dispersion in order to back calculate particle motion based on a range of meteorological inputs such as: wind speed, wind direction, distance to obstructions, air temperature, sensible heat flux, mixing height, and surrounding vegetation canopy density and height. The model originates from the advection/diffusion equation but has shown good agreement with a Lagrangian stochastic particle dispersion model (Kljun *et al.* 2003).

The following information was utilized for creation of footprints for the modeling of the PCH 1/1/2008 design day:

- "Map X/Y dimension, meters" is the distance from the station to the nearest large obstruction (i.e. hill, mountain, etc) in the direction from which the wind flow originates, which was determined from aerial photography of the region to be approximately 15 km for each of the monitors,
- "Maximum Fetch" was determined by the length of the footprint,
- "Measurement height" was set to the height at which the PM10 concentration measurements were taken and varied for each monitor,
- "Canopy Height" was estimated as 0.6m,
- "Canopy Area Density" was estimated as 1.0,
- "Boundary Layer Depth" is the average mixing height estimated by AERMET,
- "Sensible Heat Flux" was estimated by AERMET,
- "Air Temperature" was estimated to hourly averages for the season based on AZMET data from 2008,
- "Wind Speed" was obtained from field measurements at the monitors,
- "Wind Direction" was obtained from field measurements at the monitors,
- And the "Brightness distribution footprint boundary, %" was set to 90% to estimate the origination area of 90% of the emissions.

A single emission estimation origination footprint was created for each EF needed to model the January 1, 2008 proposed design day for PCH. For each unique wind speed and hour of day grouping it was necessary to create 9 footprints. Each of these footprints contained a unique land use type so that EFs could be created for all 9 land use types for

each wind speed/hour of day grouping. The total number of footprints created for the testing of the PCH 1/1/2008 design day was 80.

ArcGIS Data Integration

The next step of the method utilized ArcGIS (Esri) to plot each footprint and to determine the boundaries for each land use within a given footprint. Images created during the Footprint processing portion of the method were loaded into ArcGIS. The receptor (i.e. PM_{10} monitor) on each footprint was geo-rectified to match the physical location of the monitor station of interest and the scale of the footprints were adjusted to match that of the land use data layer. New polygons were created to outline the footprint boundary. When necessary, these polygons were clipped to insure the extent of the footprint did not exceed the distance a parcel of air could travel in an hour. The land use polygon was then clipped to the boundary of the individual footprint polygons to create a land use polygon unique to each footprint polygon. Land use areas and road lengths were then calculated in ArcGIS. Road width was utilized to estimate road area for unpaved and paved roadways.

Statistical Optimization of EFs

The final step of the emission factor back calculation process involves data consolidation and statistical optimization in order to estimate the EFs for each land use. For each footprint, the total area of each land use type was summed in ArcGIS. After calculating the total land use area for each footprint, the data was compiled in MS Excel. For the optimization process each land use must be contained within at least one unique footprint.

Following the consolidation of data, the emissions from the total footprint must be calculated from the field PM_{10} average concentrations for the period of interest. Daily average emissions at the station are calculated using the following equation:

$$E = \frac{A_{FP} * H_M * C}{907{,}184{,}740{,}000}$$

where E is the average emissions captured by the station [tons], A_{FP} is the area of the emissions origination footprint [m^2], H_M is the atmospheric mixing height [m], C is the average hourly measured PM_{10} concentration [$\mu g/m^3$], and 907,184,740,000 is the conversion factor from micrograms to tons. Once this has been calculated for each footprint, an E_{80} or E_{90} can be calculated so 80% or 90% of the total emissions can be attributed to the 80% or 90% footprint (percentage is dependant on which footprint size reasonably fit within the boundaries of the Footprint model boundaries):

$$E_{80} = 0.8 * E \text{ or } E_{90} = 0.9 * E$$

The final step requires the use of statistical optimization in order to simultaneously back calculate all 9 EFs for each wind speed/diurnal temporal grouping. In order to complete this process, the Excel Addin - Solver was utilized to apply the Newton Method. Solver

was set up to simultaneously calculate all EFs and the difference between the calculated PM10 concentrations using those EFs for each footprint and the field measured PM10 concentrations for each footprint (this value is known as the Error). Solver was then instructed to minimize the sum of the individual Errors squared for all footprints. Using this method, Solver determined the most appropriate EF values for each land use across all footprints in order to minimize Error using the equation:

$$\sum_{x=a}^{o} A_x * EF_x + \varepsilon$$

where A_x is a given land use Area, EF_x is the estimated Emission Factor of land use x, and ε is the Error associated with the footprint of interest.

After the creation of individual EFs for all land uses at all wind speeds for the 3 periods of the day, wind blown EFs were determined by subtracting low wind EFs (i.e. 0-3 mph winds) from all higher wind speed emission factors (i.e. 3-6, 6-9, 9-12, 12-15, 15-18, and 18+ mph) for all 9 land uses during each of the 3 temporal periods of the day (0-700, 800-1500, and 1600-2300 hours). By doing so, activity driven emissions could be separated from wind blown emissions in order to adequately calculate EFs which were only dependant on emissions originating from windblown PM_{10} entrainment.

Design Day Modeling

Due to time constraints, modeling using AERMOD could not be performed to test the validity of the back calculated EFs. Therefore, a simplified model was utilized to test the accuracy of the estimated EFs. Model validity was tested using the EFs estimated for each land use by the EFBC method and applying the appropriate EFs to each hour of the design day. Since PM_{10} entrainment originating from stagnation activities were unknown, estimated EFs created prior to the wind blown correction were utilized in this testing in order to account for unknown stagnation emissions as well. Testing was achieved by using the meteorological data for each hour of the January 1st proposed PCH design day to create 24 unique emission origination footprints using the EdiRe Footprint program. These footprints represented the estimated origination area of 90% of the emissions impacting the station for a given hour of the design day. These 24 footprints were used in the same method described on the "*ArcGIS Data Integration*" section to determine the total land use area contributing emissions for each hour of the day. Each hour was modeled separately, multiplying EFs by the corresponding land use area to determine the emissions from each land use type and then summing all land use emissions for the hour. Total emissions were then converted to PM_{10} atmospheric concentrations to compare to monitor measured concentrations on the design day by modifying the equation:

$$E = \frac{A_{FP} * H_M * C}{907{,}184{,}740{,}000}$$

to calculate for C, whereby:

$$C = \frac{907{,}184{,}740{,}000 * E}{A_{FP} * H_M}$$

The variables *A* and *H* were based on the hourly measurements specific to the design day being tested. Hourly calculated concentrations were then compared to PM_{10} concentrations measured at the monitor for the design day.

RESULTS

EF Estimation

The EFBC method relies upon adequate characterization and classification of emission contributing lands into discrete categories. For the purposes of the initial test of this method, land uses were classified into 9 categories. Table 1 gives a description of each of these Land Use (LU) codes. These LU codes will be used in subsequent graphs and tables.

Table 1: Land use code categories

Landuse Code	**Description**
A	Developed Urban Lands
B	Developed Rural Lands (low density residential)
C	Paved Roads
D	Unpaved Roads
E	Cleared Areas
F	Construction Area
G	CAFOs and Dairies
H	Desert Shrubland
I&J	Fallow and Active Crop Fields

For the purposes of creating the necessary EFs for all land uses during the PCH January 1, 2008 design day, nine wind speed/period of day combinations were required. Table 2 shows these combinations. For instance, on January 1stfor 000-700 hours winds speeds between 0-3 mph and 3-6 mph were registered at the PCH monitor, but no wind speeds higher than this were registered during this timeframe. Therefore, EFs were developed for these 2 wind speed bins, but not for any higher wind speeds for this time of day. Altogether, Table 2 gives 80 estimated EFs for 9 LUs as determined using the EFBC methodology. These EFs were estimated during the winter period of 2008 (Dec 21 – Mar 20). These EFs have not been corrected to remove stagnation, activity driven emissions. An emission factor for land use G (CAFOs and Dairies) could not be determined for the winter of 2008 for wind speeds over 18 mph at a 10m height between the hours of 1600 and 2300 due to lack of available data. This EF was not necessary to test the PCH 1/1/2008 proposed design day.

Table 2: Estimated EFs [tons/m^2/hr] for different wind speeds and times of the day for the winter months of 2008. These EFs were calculated using the EF back calculation (EFBC) model. These EFs include emissions originating from stagnation activities.

LU ID	A	B	C	D	E	F	G	H	I&J
0-3mph 000-700hrs	5.45E-10	1.87E-10	1.18E-10	3.14E-11	2.07E-10	6.43E-10	2.45E-09	7.68E-10	1.37E-09
0-3mph 800-1500hrs	6.70E-09	2.94E-10	3.13E-08	5.73E-11	7.13E-11	2.89E-08	4.84E-10	2.58E-10	2.33E-09
0-3mph 1600-2300hrs	2.10E-10	1.41E-10	5.09E-11	7.12E-11	1.59E-10	5.32E-11	6.44E-08	6.86E-10	6.39E-09
3-6mph 000-700hrs	1.44E-09	1.36E-09	3.53E-10	1.60E-10	1.21E-09	2.34E-10	1.62E-10	1.97E-09	2.00E-09
3-6mph 800-1500hrs	1.32E-09	9.49E-10	1.73E-10	7.34E-11	1.84E-10	1.88E-10	2.35E-09	5.25E-10	1.63E-09
15-18mph 800-1500hrs	7.39E-07	4.57E-07	1.04E-07	4.23E-08	2.29E-08	8.48E-09	1.57E-09	7.58E-07	3.28E-08
15-18mph 1600-2300hrs	1.65E-07	1.45E-07	3.70E-08	9.63E-09	3.40E-08	5.67E-08	2.02E-09	1.75E-07	1.80E-07
18+mph 800-1500hrs	5.93E-07	1.09E-06	1.87E-07	1.12E-07	5.13E-07	1.21E-08	4.36E-10	2.07E-06	1.21E-06
18+mph 1600-2300hrs	1.35E-08	1.11E-07	2.33E-07	1.67E-07	3.95E-06	1.48E-06	NA	6.60E-08	2.36E-07

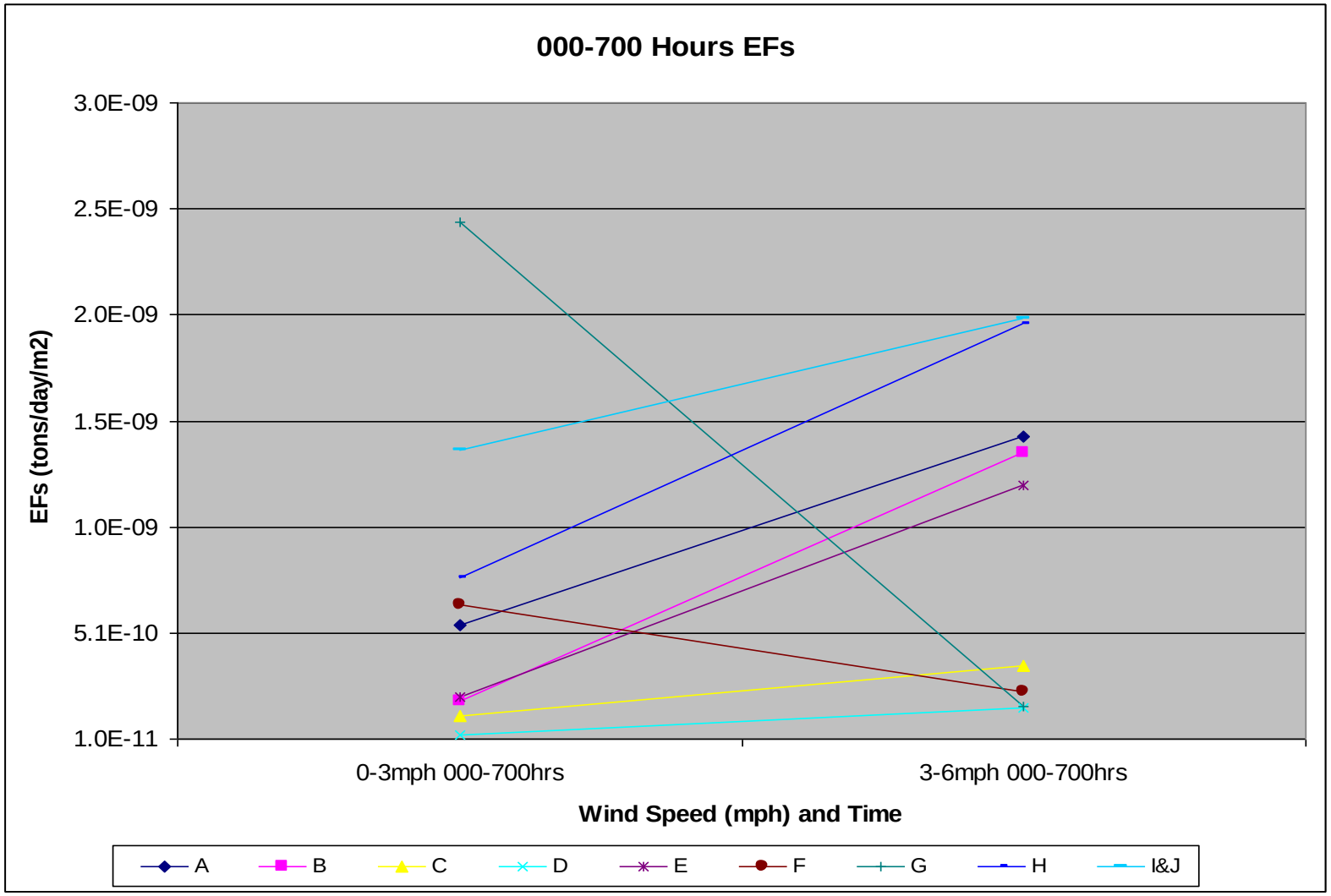

Figure 1: Estimated Winter Emission Factors [tons/m2/hour] for all land uses between 0-700 hours for the wind speed categories of 0-3 mph and 3-6 mph. Wind speeds were adjusted for a 10m height.

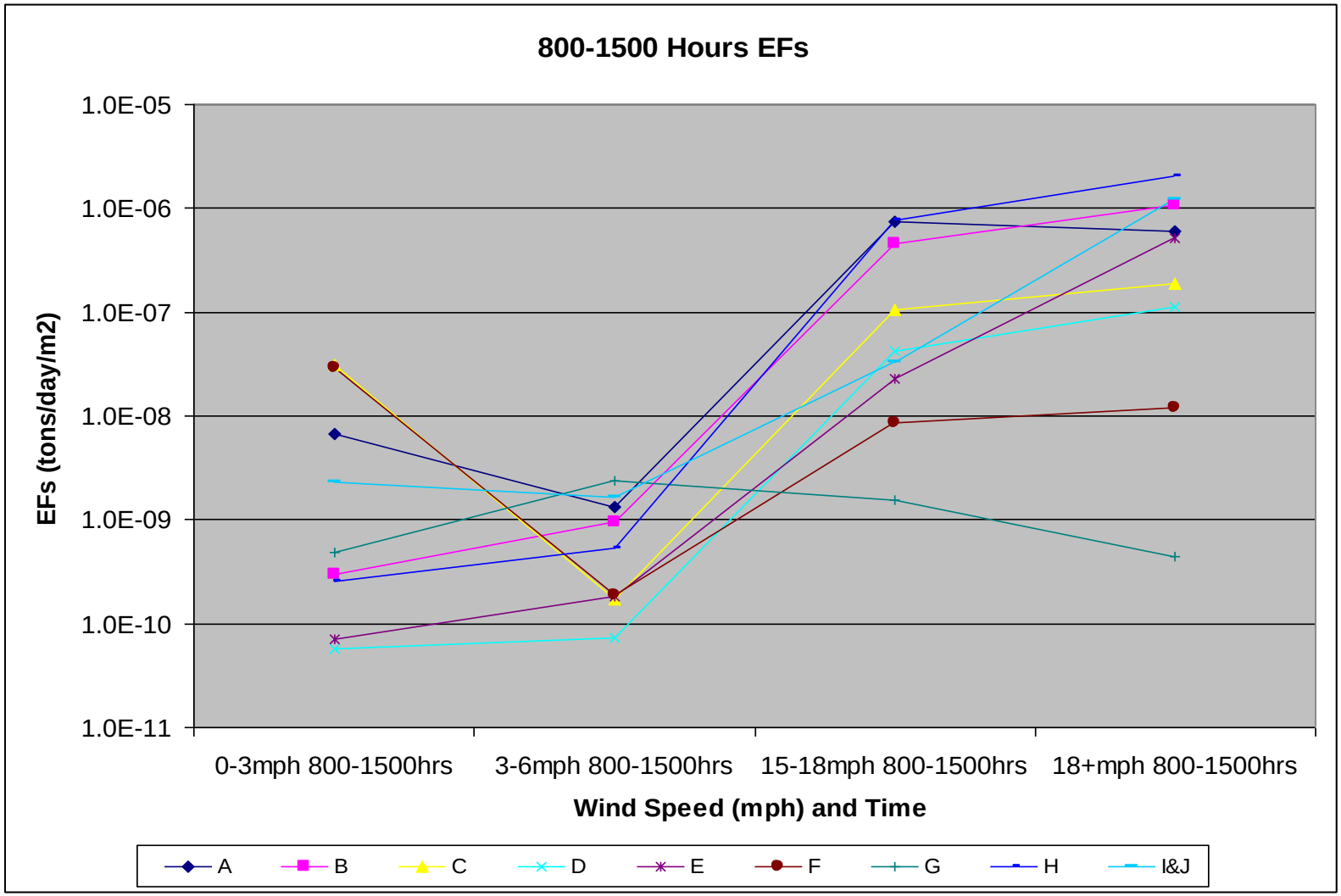

Figure 2: Estimated Winter Emission Factors [tons/m2/hour] for all land uses between 800-1500 hours for the wind speed categories of 0-3 mph, 3-6 mph, 15-18 mph, and 18+ mph. Wind speeds were adjusted for a 10m height.

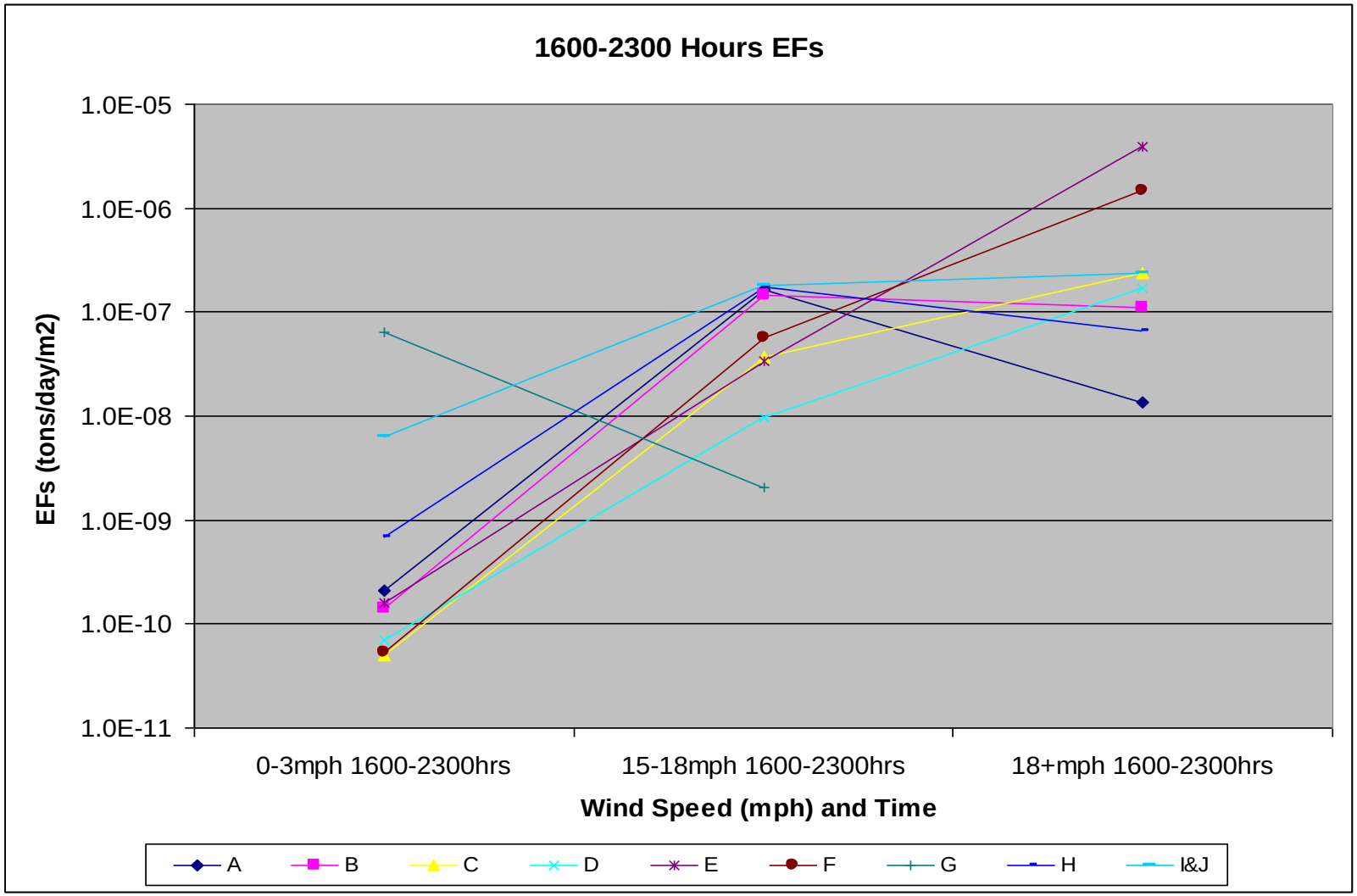

Figure 3: Estimated Winter Emission Factors [tons/m2/hour] for all land uses between 1600-2300 hours for the wind speed categories of 0-3 mph, 15-18 mph, and 18+ mph. Wind speeds were adjusted for a 10m height.

Figures 1-3 show how these estimated EFs change with varying wind speeds for the three periods of the day for which they were calculated (0-700 hours, 800-1500 hours, and 1600-2300hours). CAFOs and Dairies (Land Use type G) is the only land use which showed decreasing emission rates with increasing wind speeds. This could be attributed to cattle movement patterns. As wind speeds increase, especially into extreme speeds such as 15+ mph, cattle may be less likely to move around which would reduce mechanical entrainment not related to windblown emissions. During the early and late hours of the day, Croplands and CAFOs have the highest EFs under stagnation conditions, likely due to the increased activity on these lands in comparison to other land uses at the same time of day. During the mid-hours of the day, construction areas, paved roads, and urban developed lands have much higher stagnation related emission rates. This is also attributable to the increased activity on these lands during the middle portion of the day for winter months.

The next step in the windblown EF estimation process was to correct the EFs listed above for stagnation, activity driven emissions. In order to do so, EFs for wind speeds less than 3 mph were subtracted from wind speeds greater than 3 mph. In this way, windblown EFs were created through the removal of activity driven emissions. Land uses which exhibited decreasing emission factors with increasing wind speeds were assumed to have negligible emissions originating from wind and were thus given wind blown EFs of 0 tons/m^2/hour. Table 3 presents wind blown EFs after correcting for stagnation, activity driven emissions.

For the early hours of the day (000-700 hours) low speeds (i.e. 0-3 mph) exhibited the highest windblown EFs for Desert Shrublands, Developed Rural Lands, and Cleared Areas followed by Developed Urban Lands and Crop Fields. The first 3 land use types are likely to have large reservoirs for PM_{10} entrainment with the possibility of being highly disturbed. Developed Urban Lands and a majority of Crop Fields are going to have a high degree of land coverage to reduce emission factors.

For all hours of the day, as wind speeds increase Desert Shrubland EFs increase with the exception of the late hours of the day. As wind speeds transition from 15-18 mph to 18+ mph Desert Shrubland EFs decrease slightly which could be an artifact of reservoir depletion in the late hours of the day. In fact, 3 of the 4 instances where EFs decreased when transitioning from 15-18 mph to 18+ mph for a given land use occurred in the later hours of the day (1600-2300 hours), indicating reservoir depletion may in fact be playing a significant role. Cleared Areas and Crop Fields showed drastic increases in EFs during the middle of the day (800-1500 hours) with increasing wind speed, while in the late hours of the day (1600-2300 hours) Unpaved Roads, Cleared Areas, and Construction Areas showed the greatest increases in emission factors with increasing wind speed. Developed Urban and Rural Lands had consistently high EFs as did Paved Roads. The elevated Developed Urban Lands and Paved Road EFs were surprising due to the degree to which these land uses have coverage to reduce the reservoir size.

Table 3: Estimated wind blown EFs [tons/m^2/hr] for different wind speeds and times of the day for the winter months of 2008. These EFs were calculated using the EF back calculation model, and were corrected to remove stagnation activities.

LU ID	A	B	C	D	E	F	G	H	I&J
3-6mph 000-700hrs	8.91E-10	1.17E-09	2.35E-10	1.28E-10	1.00E-09	0.00E+00	0.00E+00	1.20E-09	6.26E-10
3-6mph 800-1500hrs	0.00E+00	6.55E-10	0.00E+00	1.61E-11	1.13E-10	0.00E+00	1.86E-09	2.66E-10	0.00E+00
15-18mph 800-1500hrs	7.32E-07	4.57E-07	7.28E-08	4.22E-08	2.29E-08	0.00E+00	1.08E-09	7.58E-07	3.05E-08
15-18mph 1600-2300hrs	1.65E-07	1.45E-07	3.69E-08	9.56E-09	3.39E-08	5.67E-08	0.00E+00	1.75E-07	1.74E-07
18+mph 800-1500hrs	5.86E-07	1.09E-06	1.55E-07	1.12E-07	5.13E-07	0.00E+00	0.00E+00	2.07E-06	1.21E-06
18+mph 1600-2300hrs	1.33E-08	1.11E-07	2.33E-07	1.67E-07	3.95E-06	1.48E-06	0.00E+00	6.53E-08	2.30E-07

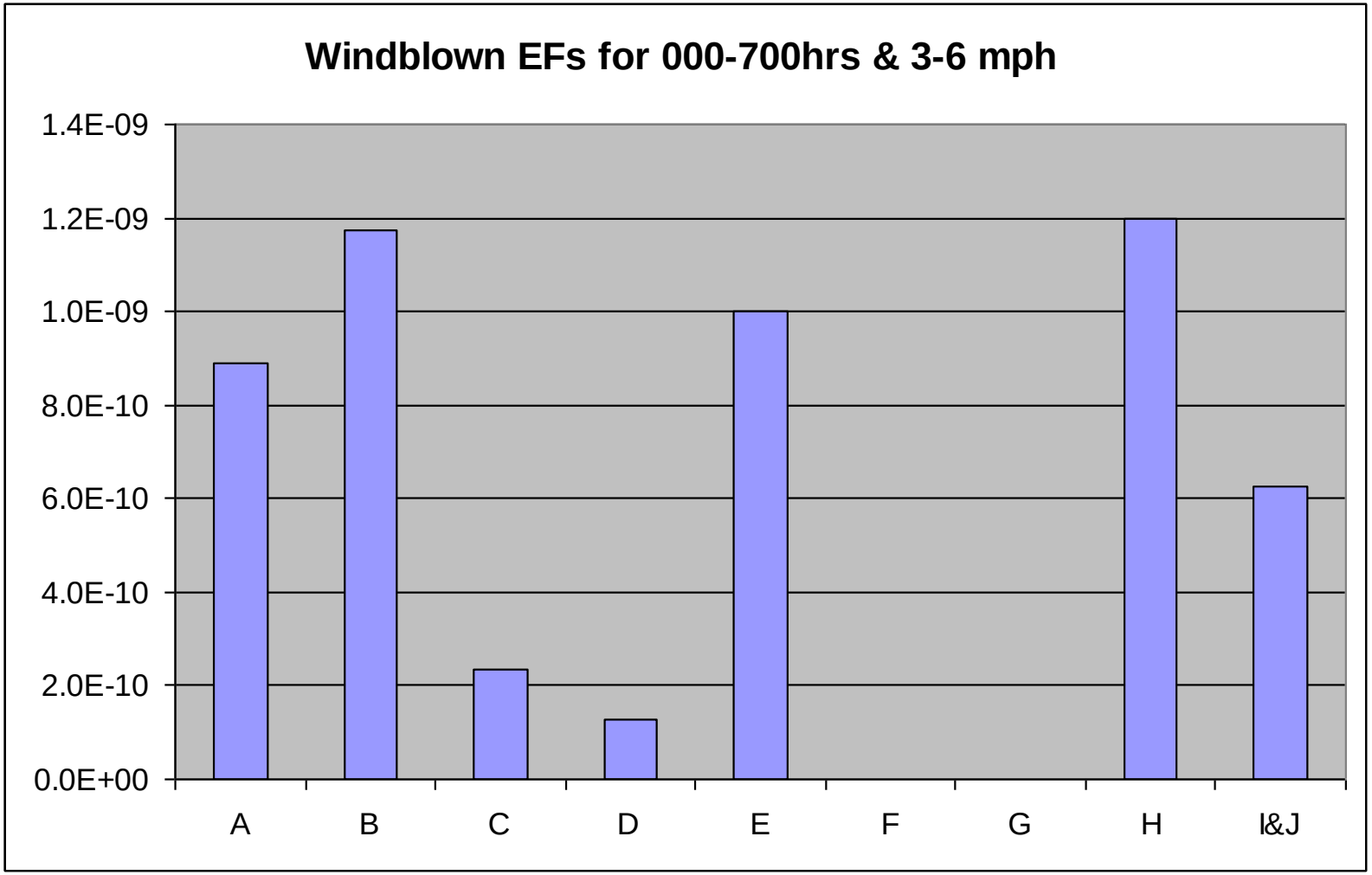

Figure 4: Estimated Winter Windblown Emission Factors [tons/m2/hour] for all land uses between 0-700 hours for the wind speed category of 3-6 mph. Wind speeds were adjusted for a 10m height. These EFs were corrected for stagnation, activity driven emissions.

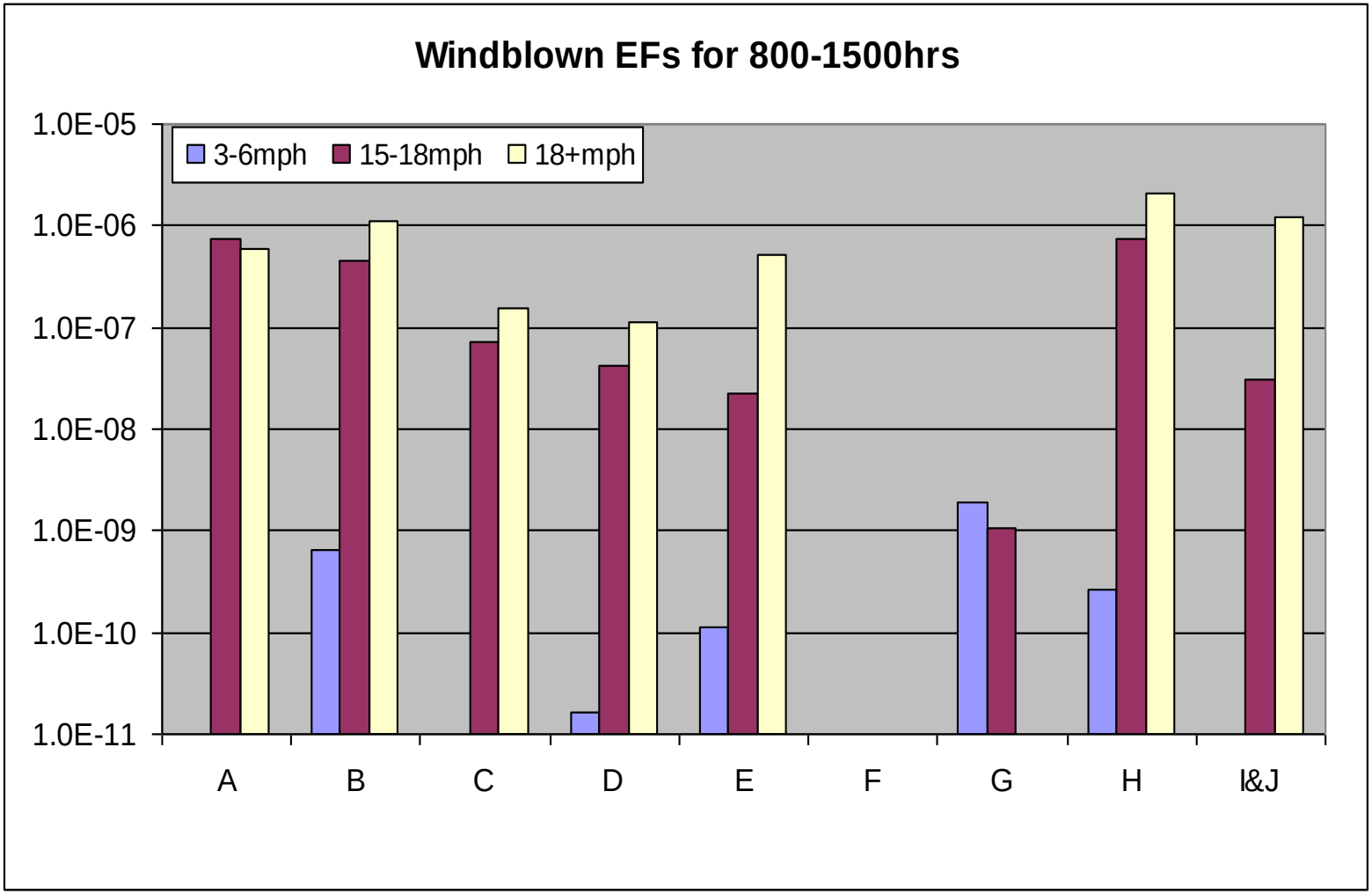

Figure 5: Estimated Winter Windblown Emission Factors [tons/m2/hour] for all land uses between 800-1500 hours for the wind speed categories of 3-6 mph, 15-18 mph, and 18+ mph. Wind speeds were adjusted for a 10m height. These EFs were corrected for stagnation, activity driven emissions.

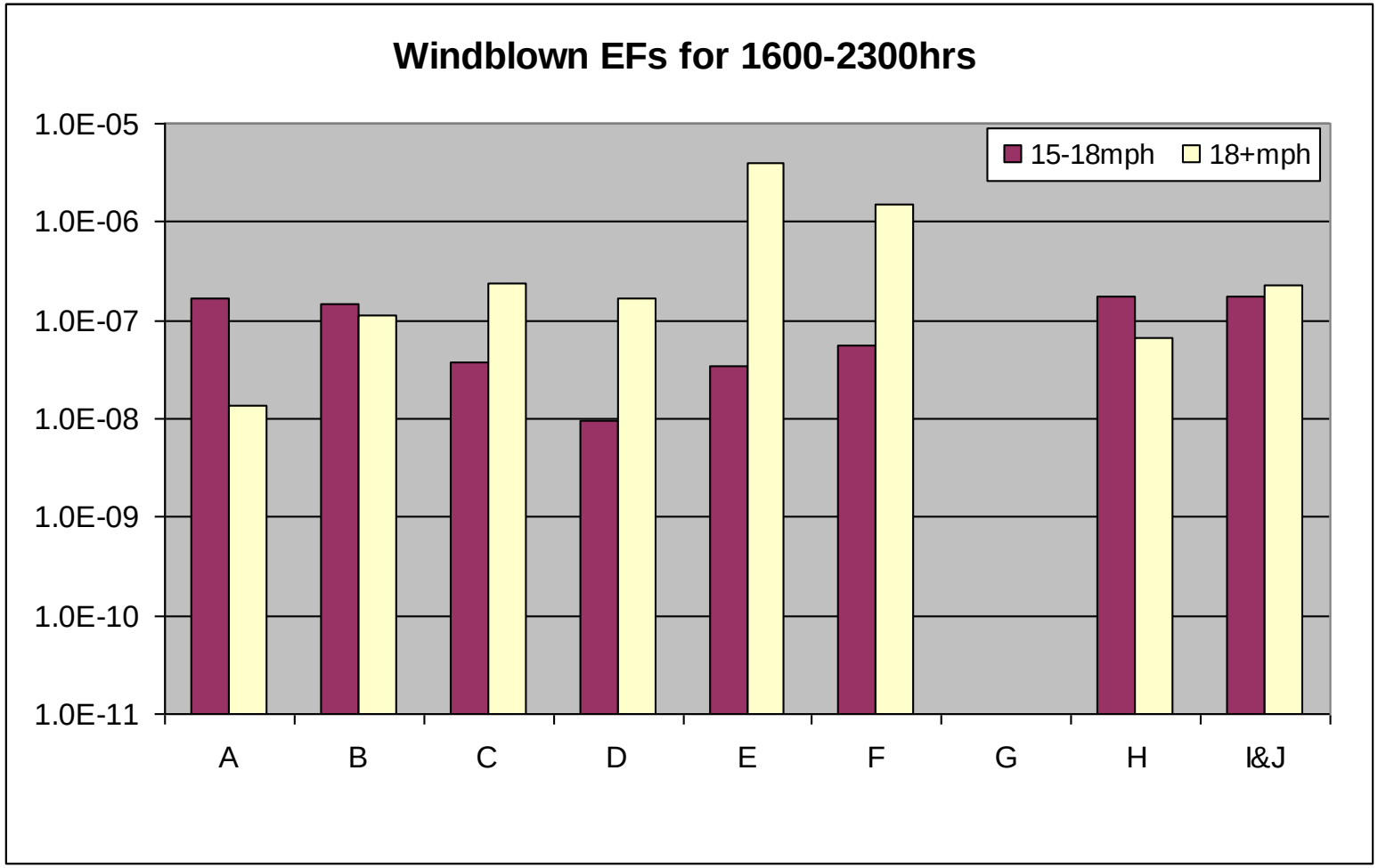

Figure 6: Estimated Winter Windblown Emission Factors [tons/m2/hour] for all land uses between 1600-2300 hours for the wind speed categories of 15-18 mph and 18+ mph. Wind speeds were adjusted for a 10m height. These EFs were corrected for stagnation, activity driven emissions.

EF estimation Variability and Error

The EF back calculation method attempts to minimize data variability by grouping similar wind speeds, wind directions, hours of the day, and only utilizing data from the season of interest on dates where rainfall was less than 2 mm. However, natural variability will still occur in emissions data due to soil texture variability within the modeled region; reservoir depletion over consecutive high wind hours; variability in soil moisture over the modeled region; variability in stagnation, activity related emissions; etc. This variability is reflected in Table 3. Table 3 presents the error matrix which calculates the percent error for each footprint when back calculating the EFs for each wind speed/diurnal temporal grouping (separated by rows in the table). This error was calculated using the following equation:

$$\%\varepsilon = \frac{\left(E - |\varepsilon|\right)}{E}$$

where E is the field measured emissions [tons/hour] and $|\varepsilon|$ is the absolute value of the error from the previously mentioned equation:

$$\sum_{x=a}^{o} A_x * EF_x + \varepsilon$$

The variability in this error accentuates the variability which can be seen in field measured PM10 concentrations under similar meteorological conditions.

Table 3: This error matrix shows the percent errors associated with each footprint during the back calculation portion for determining EFs. Positive errors indicate that the measured field PM10 concentrations are larger than the errors for that footprint during statistical optimization. Negative errors indicate that the measured field PM10 concentrations are larger than the errors for that footprint during statistical optimization. Strongly negative values show poor correlation resulting from highly variable data. Only 8 footprints were calculated for the last row of data since CAFOs and Dairies were not found to contribute during any hours with these meteorological characteristics.

EF Back Calculation Error Matrix (%)									
	1	2	3	4	5	6	7	8	9
0-3mph 000-700hrs	72	102	-51	-63	105	119	23	-131	124
0-3mph 800-1500hrs	198	179	197	156	198	198	98	95	100
0-3mph 1600-2300hrs	-108	25	-245	-704	-573	124	116	71	-25
3-6mph 000-700hrs	83	88	-239	-66	69	70	91	100	88
3-6mph 800-1500hrs	116	98	23	124	15	100	-149	-140	100
15-18mph 800-1500hrs	86	-335	-1862	-251	-1594	-575	-2297	-890	-3447
15-18mph 1600-2300hrs	-449	-191	34	-125	-155	-2937	-523	-322	-252
18+mph 800-1500hrs	48	-3601	93	-3519	-2673	-1240	-3693	-1543	-33
18+mph 1600-2300hrs	-133	40	-388	-333	100	-1	-2755	-17271	

Design Day Modeling

The estimated EFs for the winter of 2008 presented in Table 2 were used to test how well total hourly estimated PM10 concentrations using a simplified modeling approach would compare to field measured PM10 concentrations for the Pinal County Housing design day of January 1, 2008. Wind blown EFs could not be used since activity driven emissions from the January 1st design day had not yet been determined. Therefore, uncorrected emission factors (i.e. EFs which account for stagnation, activity driven emissions as well as wind blown emissions) were utilized in testing the model performance against field measured PM10 concentrations. Figure 7 presents this comparison and shows fairly good model results against field measured values. Modeled peak PM10 concentrations are delayed by 3 hours in comparison to field measured data; however, the overall trend is captured and for most hours of the day there is only a small amount of error between field measured and model estimated PM_{10} atmospheric concentrations. The average hourly error throughout the day is 97%, as calculated by the equation:

$$\%Difference = \frac{\left|C_{Model} - C_{Measured}\right|}{C_{Measured}}$$

Where C_{Model} is the PM_{10} concentration which was modeled (µg/m^3) and $C_{Measured}$ is the PM_{10} concentration (µg/m^3) measured at the monitor for that hour of the design day. The model performed very well at the daily scale. PCAQD reported a 24 hour PM_{10} concentration for PCH on 1/1/2008 of 264.9 µg/m^3 and the model predicted a 24 hour average concentration of 260.4 µg/m^3. The estimated 24 hour average was calculated by averaging each of the individual 24 hourly estimated PM_{10} concentrations, where:

$$C_{24} = \frac{\sum_{h=100}^{2400} C_h}{24}$$

C_{24} is the average 24 hour concentration (µg/m^3) and C_h (µg/m^3) is the estimated PM_{10} concentration for each of the 24 estimated hourly concentrations.

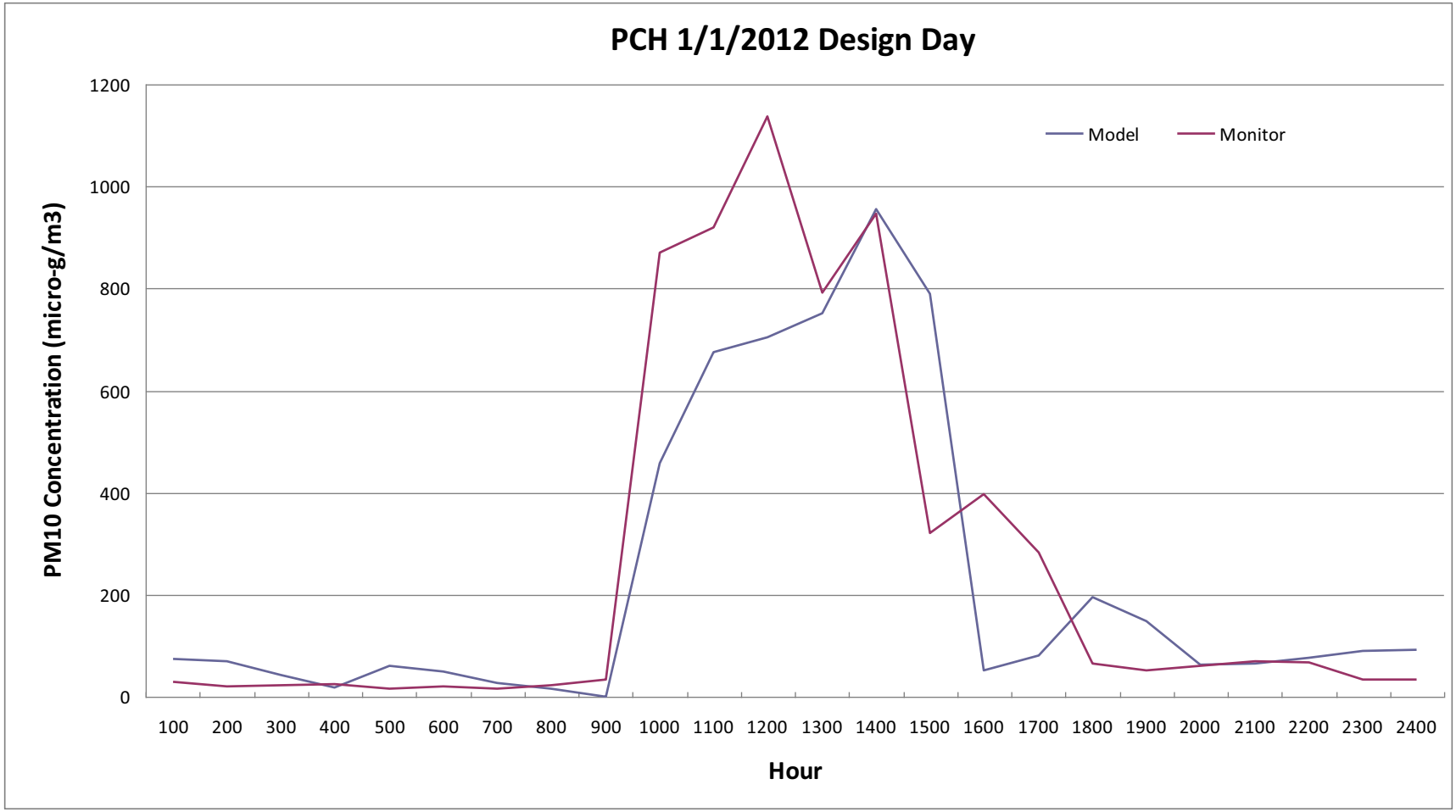

Figure 7: A comparison of field measured PM10 concentrations (Monitor) against PM10 concentrations predicted using EFs estimated by the back calculation method (Model) for each hour of the 1/1/2008 PCH design day.

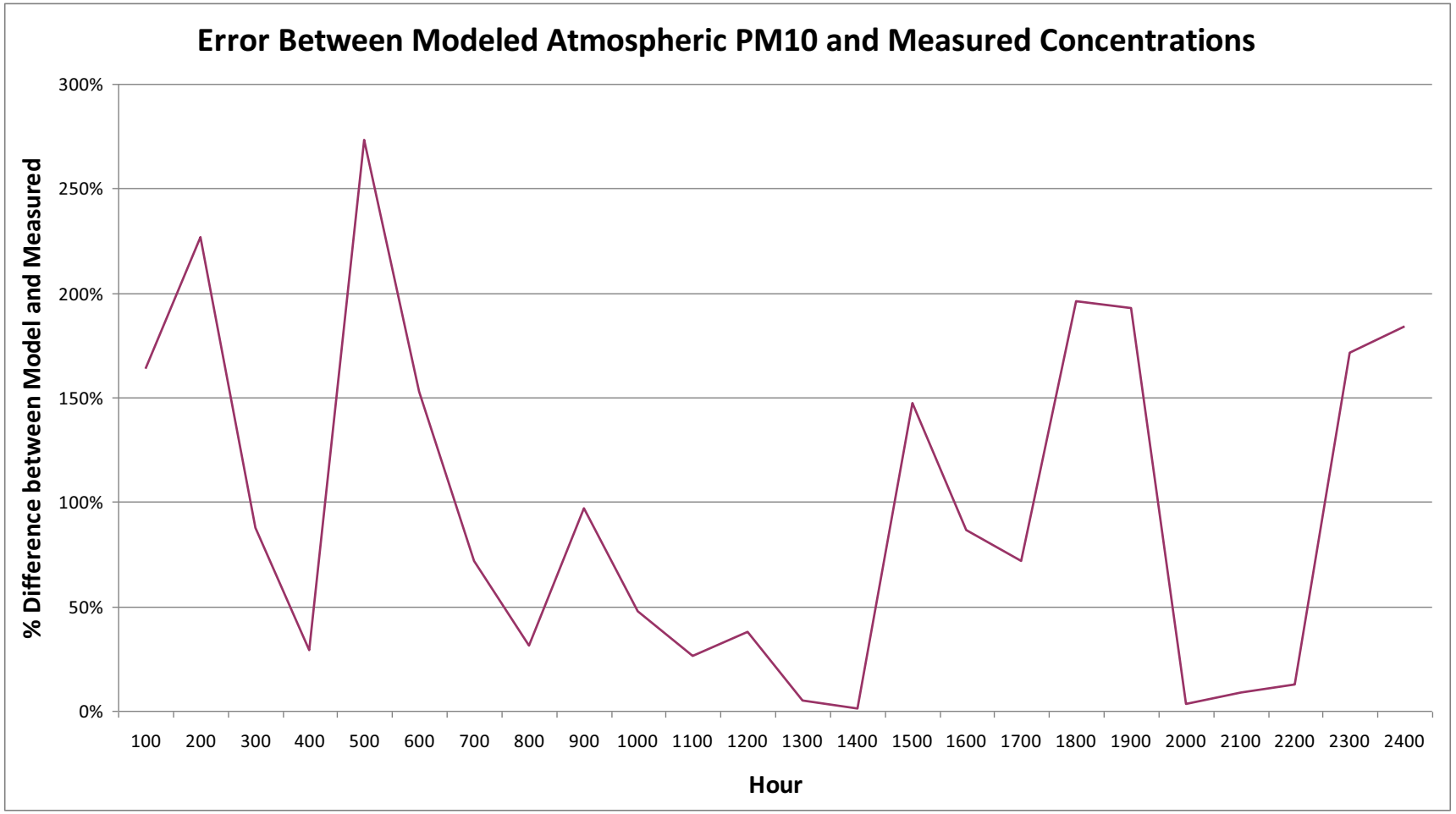

Figure 8: Calculated Difference between modeled and measured atmospheric PM_{10} concentrations for each hour of the PCH 1/1/2008 design day.

DISCUSSION

The EF Back Calculation Method utilizes field measured PM10 concentrations and meteorological data in an attempt to accurately estimate EFs for a variety of land use types within a given area. The estimated EFs using this method are specific to the area for which the model is run. This is preferential to literature reported EFs which may be calculated in an environment uniquely different from the modeled area. Pinal County is a region of high soil disturbance, low annual rainfall, and low surface friction due to a lack of vegetative cover. For these reasons, EFs specific to the region were needed and the EFBC method was employed. In this document, the methodology behind the EF back calculation method is presented. In addition, the resulting estimated EFs from a test run were utilized in a simplified model to gauge the accuracy of these EFs for one of the design days proposed for modeling in the Pinal County State Implementation Plan. The EFBC method provided some individual EFs which were counter intuitive, such as EFs from paved and unpaved roads being comparable. These issues could be due to statistical optimization problems with these land use types due to the small relative area they exhibit in relation to other land use types used in the model. This could also be due to incorrect characterization of land uses, requiring a review of the land use classification layers used for the model. Despite these issues, when the EFBC estimated EFs were modeled for the PCH January 1, 2008 design day, the results exhibited good agreement with field measured PM_{10} concentrations at the hourly scale and excellent agreement at the daily scale (i.e. 24 hour average PM_{10} concentrations) using a simplified modeling approach. Further work will need to be done to test validity of these estimated EFs in an EPA approved model such as AERMOD. The use of AERMOD will provide a different modeling domain than that used in the simplified modeling approach presented in this paper as well as account for deposition and dispersion effects on the modeling domain not directly accounted for in the simplified approach presented above. However, the preliminary results presented in the model above using EFs estimated by the EFBC method indicate this method represents a reasonable way to estimate area specific EFs from field measured meteorological and PM10 concentration data for PM_{10} concentration modeling. While WRAP or AP-42 regionally or nationally based EF values and equations present more generalized values, this method allows the user to specify the land use types of interest and develop EFs originating from locally sampled data.

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Kljun, N.; Kormann, R.; Rotach, M.W.; Meixner, F.X. Comparison of the Lagrangian Footprint Model LPDM-B with an Analytical Footprint Model. 2003. *Boundary-Layer Meteorology*, 106: 349-355.

Kormann, R.; Meixner, F.X. An Analytical Footprint Model for Non-neutral Stratification. 2001. *Boundary-Layer Meteorology*, 99: 207-224.

Appendix J

MAG 2012 Five Percent Plan for PM10 for the
Maricopa County Nonattainment Area
May 2012

INVENTORY DEVELOPMENT

Under a rollback modeling scheme, reductions of emissions that impact the monitor are assumed to result in an equal reduction in monitor concentrations. As such, both base case (2007) low and high wind inventories must be developed along with control case (2012) low and high wind inventories. This following describes in detail how the 2007 base year and 2012 control/attainment year high and low wind inventories were developed. Details on how the base and attainment year inventories are developed for the entire nonattainment area are presented in Chapters II and III of this TSD.

High Wind Inventories

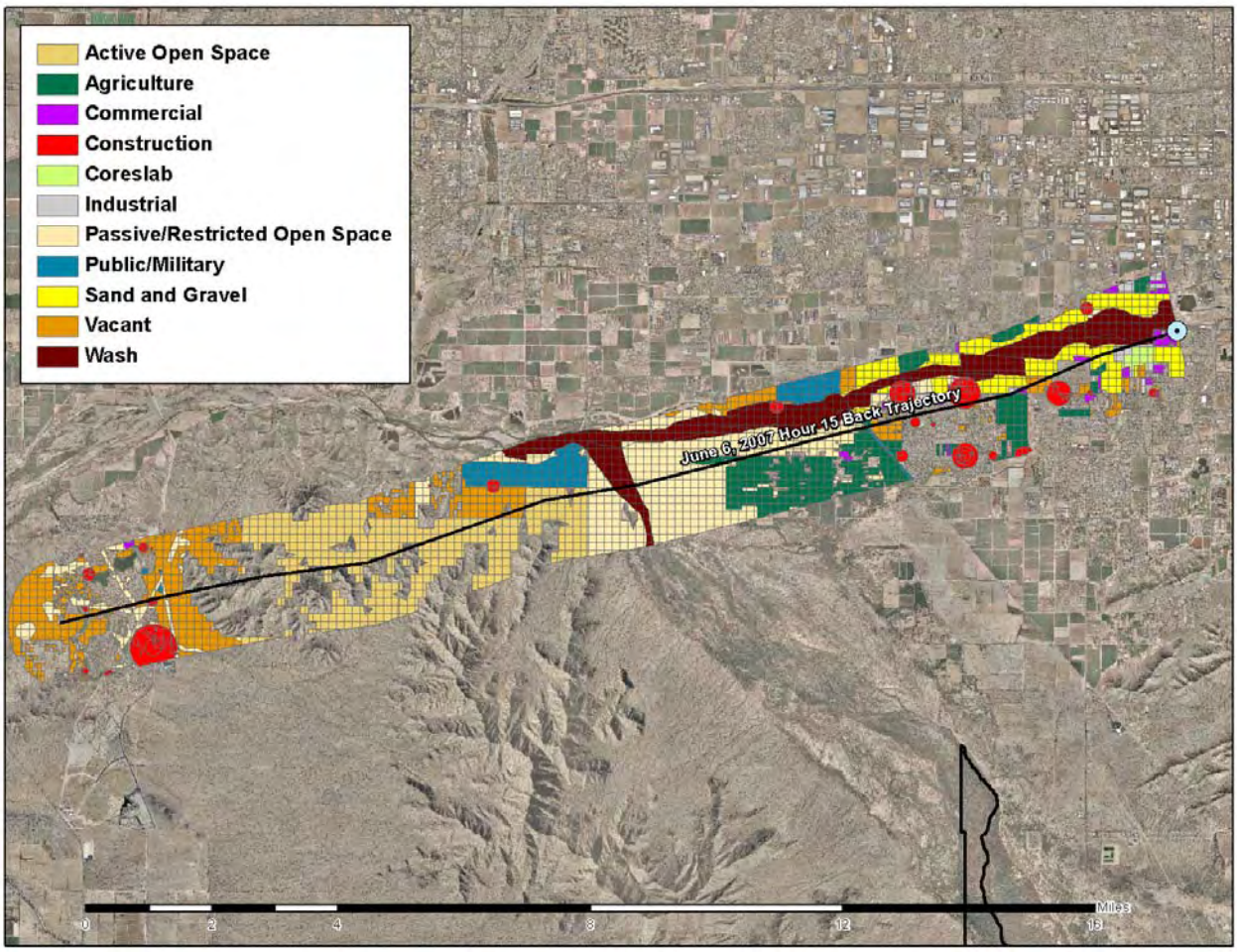
For the high wind hours, hourly windblown PM-10 emissions are calculated based upon the land uses that fall within each of the hourly high wind domains. Land use data, with the exception of construction data, comes from the MAG information services and represents land use patterns as of 2009. Land use is held constant between calculation of 2007 and 2012 year inventories. A detailed write-up of how the land use data is created is included in the 2008 PM-10 Periodic Emissions Inventory as an Appendix to the windblown dust section. Construction data was provided by the Maricopa County Air Quality Department for the year 2007. To be conservative this data is also held constant through 2012 even though there is substantially less construction occurring due to the economic recession. Windblown PM-10 emissions for the subject land uses are calculated per the methodology described in the 2008 PM-10 Periodic Emissions Inventory (Appendix A, Exhibit 1). As an example, emissions from the West 43rd Avenue monitor hour 15 high wind domain (June 6, 2007 design day) are explained below. All of the hourly high wind emissions are calculated in the same manner shown in this example.

Initially, through the use of ArcGIS, the land uses subject to windblown dust emissions within the high wind domain are identified. For the hour 15 example, 11 unique land uses within the high wind domain are subject to windblown dust as shown in Figure V-16. They include the land uses of Active Open Space (i.e., parks), Agriculture, Commercial, Construction, Coreslab (a large combination of sand and gravel and industrial facility), Industrial, Passive/Restricted Open Space (i.e., preserves), Public/Military Space (i.e., jails, bases), Sand and Gravel facilities, Vacant, and Dry Washes. These land uses are chosen because either all or some of their acreage is bare soil from which windblown dust can be generated. Land uses such as residential or golf courses are not included as land uses subject to windblown dust since none (or a very limited amount) of the acreage associated with these land uses is bare soil. Land uses on the steep slopes of mountain preserves are also excluded as the surface roughness of the slope severely limits the production of windblown dust.

After the land uses are identified, a 10-acre fishnet grid is applied to the land uses, so that no individual land use parcel is larger than ten acres. This allows for calculating the distance from each parcel boundary to the modeled monitor; which is West 43rd Avenue in this example. The distance of the parcel to the monitor is necessary in order to apply

the distance weighting factor to the calculated emissions as discussed earlier in this chapter.

Figure V-16
Land Uses Capable of Producing Windblown Dust Within the Hour 15, West 43rd Avenue Monitor, High Wind Domain (June 6, 2007)



To be conservative, all but four of the land uses shown above are assumed to have 100% of their acreage capable of emitting windblown dust. The land uses of Commercial, Coreslab, Industrial and Public/Military are exempted from this assumption because these land uses are known to have a mix of large buildings and paved parking lots/access roads in addition to areas of bare soil. Over 2500 aerial photographs of these types of parcels in the Salt River area were evaluated to determine the average percentage of bare soil present on each of these land uses. The results of that analysis are listed in Table V-22. To be conservative, the mean value was chosen to represent the average percentage of bare soil on these land uses, as this value was higher than the median in all cases. Note that Coreslab is considered an industrial parcel, and as such is assigned the average of 24% for the amount of bare soil present.

Table V-22
Results of Aerial Photography Analysis of Percentage of Bare Soil on Land Uses with Both Bare and Covered Surfaces

Land Use	Mean	Median	Std. Deviation
Commercial	26%	20%	23%
Industrial	24%	17%	21%
Public/Military	35%	21%	35%

After the land uses within the high wind domain have been classified and selected, the process for calculating windblown emissions from these land uses can begin. The 2008 PM-10 Periodic Emissions Inventory developed emission factors for two classes of bare soil: disturbed and stable. Disturbed soils emit at a much higher rate than stabilized soils because there is more loose soil available to be entrained by the wind. As wind speeds increase, both disturbed and stable soils emit at higher rates, as the extra energy from the wind entrains more material from both surfaces. Thus, the main elements needed to calculate windblown PM-10 emissions are the number of acres of bare soil, the wind speeds over that soil, and the percentage of the acres that are disturbed or stable.

Table V-23 displays the emission factors by wind speed bins as developed in the 2008 Periodic Emissions Inventory. These emission factors were developed based upon local testing of Arizona soils. The units of the emission factors are tons per acre per five-minute, as the input wind speed data for most of the high wind domains is a five-minute average wind speed.

Table V-23
Windblown PM-10 Emission Factors (tons /acre-five-minute) by 10-Meter Wind Speed Bin and Soil Stabilization

Soil Stabilization	Wind Speed 12-15 mph	Wind Speed 15-20 mph	Wind Speed 20-25 mph	Wind Speed 25-30 mph	Wind Speed 30-35 mph
Disturbed	5.44E-05	1.69E-04	5.14E-04	1.24E-03	2.57E-03
Stable	1.10E-05	2.93E-05	7.68E-05	1.64E-04	3.10E-04

Continuing with the use of the hour 15, West 43rd Avenue, high wind domain example, the hourly average wind speed for that hour was 18.1 mph. An examination of the five-minute wind speed data for that hour reveals that ten of the five minute periods had wind speeds between 15-20 mph and two of the five minute periods had wind speeds between 20-25 mph. This means that the emissions factors from only two wind speed bins (15-20 and 20-25) will be used to calculate emissions for this hour.

At this point, the amount of acreage by land use and the five minute wind speeds have been determined for the example high wind domain. The one variable that is left to be

determined is how much of the land use acreage is disturbed or stable. A direct measurement of this variable is not possible, as stabilization rates change over time with meteorological and anthropogenic activities unique to each individual parcel. Therefore, a surrogate variable is needed to assume an average disturbance level for each land use subject to producing windblown dust. As discussed in Chapter Five of the main plan and the 2008 PM-10 Periodic Emissions Inventory, rule effectiveness has been chosen as the surrogate for the disturbance levels of bare soils. As an example, a rule effectiveness of 80% would assume that 80% of the acreage is stable and 20% is disturbed. Maricopa County Air Quality Department performed rule effectiveness studies for three fugitive dust rules: Rule 310, earthmoving activities, Rule 310.01, open and vacant areas, and Rule 316, sand and gravel sites. These studies were done on an annual basis and are shown in Table V-24. The values for calendar years 2007, 2008 and 2010 were all derived per the methodology listed in the 2008 PM-10 Periodic Emissions Inventory. The increases in rule effectiveness through time is a direct result of the implementation of the control measures in this plan. The value for 2012 is the assumed value achieved as a result of the control measures in this plan projected out through 2012 (See Chapter Five of main plan for more explanation).

Table V-24
Calendar Year Rule Effectiveness Rates as Surrogates for Soil Disturbance Rates

Rule	2007	2008	2010	2012
310	76%	90%	94%	94%
310.01	85%	95%	96%	97%
316	40%	65%	73%	73%

The 11 land uses identified earlier in Figure V-16 are thus assigned disturbance rates based upon the rule effectiveness rates in Table V-24. Rule 310 serves as a surrogate value for construction land uses, Rule 316 serves as a surrogate for sand and gravel land uses, and Rule 310.01 serves as a surrogate for all remaining land uses. Rule 310.01 directly regulates all open areas and industrial/commercial areas that are permitted or un-permitted. The only land use under which Rule 310.01 does not regulate is agriculture. However, because there are no quantitative rule effectiveness or disturbance rates studies available that are applicable to agricultural land, Rule 310.01 disturbance rates are assumed to apply, as was assumed in the 2008 PM-10 Periodic Emissions Inventory. It is important to point out however, that because there are no benefits for agricultural land taken as part of the attainment demonstration or the five percent reductions, the assumed 2007 rule 310.01 effectiveness rate of 85% is held constant through 2012, meaning windblown dust emissions from agricultural lands in 2012 are the same as in 2007. All other land uses besides agriculture experience a reduction in emissions between 2007 and 2012 as a result of the benefit of increased rule effectiveness; which is pragmatically translating as an assumption of less disturbed soil in the windblown dust inventory.

Now that all of the required elements (acreage, percent disturbed, and wind speeds) have been determined, the elements are simply multiplied in order to obtain PM-10 windblown dust emissions for each land use within the high wind domain. An example equation using data from the hour 15 example high wind domain is shown below to detail how high wind emissions are calculated:

Example for calculating base year (2007) windblown dust emissions from Commercial land uses:

(1) Land use * % acreage * 15-20 mph wind * % Stable * Stable 15-20 mph = Stable Emissions
Acreage of bare soil speed periods emission factor
(250.2) * (26%) * (10) * (85%) * (2.93E-05) = 1.62E-02 Tons

+

(2) Land use * % acreage * 20-25 mph wind * % Stable * Stable 20-25 mph = Stable Emissions
Acreage of bare soil speed periods emission factor
(250.2) * (26%) * (2) * (85%) * (7.68E-05) = 8.49E-03 Tons

+

(3) Land use * % acreage * 15-20 mph wind * % Disturbed * Disturbed 15-20 mph = Disturbed Emissions
Acreage of bare soil speed periods emission factor
(250.2) * (26%) * (10) * (15%) * (1.69E-04) = 1.65E-02 Tons

+

(4) Land use * % acreage * 20-25 mph wind * % Disturbed * Disturbed 20-25 mph = Disturbed Emissions
Acreage of bare soil speed periods emission factor
(250.2) * (26%) * (2) * (15%) * (5.14E-04) = 1.00E-02 Tons

Sum of above equations (1 through 4) = 5.12E-02 Tons of PM-10 emissions from Commercial land uses.

This process is repeated for all land uses and then summed to calculate total PM-10 emissions from all land uses within the high wind domain. The only difference between 2007 and 2012 year emissions is that the disturbance rates change based upon gains in rule effectiveness, thus the reductions in emissions between 2007 and 2012 are solely attributable to increases in rule effectiveness.

The emissions that are calculated per the steps above, represent maximum potential PM-10 emissions from windblown dust. As explained in the 2008 PM-10 Periodic Emissions Inventory, a whole host of other factors including supply limitations, surface roughness, soil moisture content, vegetative cover, soil texture, etc. and would likely limit the PM-10 emissions from windblown dust to levels below what is calculated in each of the high wind domains. The 2008 PM-10 Emissions Inventory corrects for these limiters by standardizing PM-10 emissions as compared to concentrations seen at the monitor under high wind conditions. This helps to ensure the scale of the emissions estimate is not too

large. However, this step is not necessary for high wind emission inventories prepared for use in an attainment demonstration, as what is important in this rollback modeling is the difference between 2007 and 2012 emissions, not the scale of those emissions as compared to low wind emission sources. Since both 2007 and 2012 high wind emissions are calculated in the same way, the difference between the two inventories provides the reductions needed to model attainment at the monitors. The unit and scale of the inventories thus do not matter, only that the methodology is the same between the base and controlled inventories in order to claim the benefits of the measures in this plan as applied to the modeled concentrations.

Once high wind PM-10 emissions have been calculated for the land uses, one final step is required to prepare the emissions for attainment modeling. The calculated emissions for each land use parcel are divided by the distance (feet) from the modeled monitor. As discussed in an earlier section in this chapter, distance weighting is applied to this emissions in order to account for their diminishing impact on monitor concentrations with distance. The best weighting function was determined to be a simple inverse distance ratio (1/d) through analysis of dispersion behavior provided by sample AERMOD model runs (see earlier sections on source weighting and temporary monitor insights).

Tables V-25 through V-31 provide the results of the high wind emissions inventories for the high wind domains of each modeled monitor, based upon the process outlined above. They list both the calculated emissions and the inverse-distance weighted emissions for the base and controlled year inventories.

Table V-25
Base Case 2007 and Controlled 2012 High Wind PM-10 Emissions Inventories for May 4, 2007 Design Day at the West 43rd Avenue Monitor

High Wind Hour	Un-weighted Emissions (tons)		Distance-Weighted Emissions (tons/feet from monitor)		% Reduction of Weighted Emissions
	2007	2012	2007	2012	
12	3.05	2.09	2.872E-04	1.900E-04	33.8%
13	9.49	6.36	6.529E-04	4.245E-04	35.0%
14	9.94	6.67	6.866E-04	4.454E-04	35.1%
15	13.94	9.19	8.721E-04	5.581E-04	36.0%
16	13.36	8.81	8.921E-04	5.699E-04	36.1%
17	19.01	12.39	1.190E-03	7.505E-04	36.9%
18	11.84	7.86	7.837E-04	5.033E-04	35.8%
19	6.58	4.44	5.158E-04	3.364E-04	34.8%
21	4.02	2.72	3.236E-04	2.129E-04	34.2%
22	6.63	4.48	5.104E-04	3.330E-04	34.8%
Total	97.86	65.02	6.714E-03	4.324E-03	35.6%

Table V-26
Base Case 2007 and Controlled 2012 High Wind PM-10 Emissions Inventories for June 6, 2007 Design Day at the Central Phoenix Monitor

High Wind Hour	Un-weighted Emissions (tons)		Distance-Weighted Emissions (tons/feet from monitor)		% Reduction of Weighted Emissions
	2007	2012	2007	2012	
0	1.90	1.32	7.549E-05	5.230E-05	30.7%
1	0.99	0.74	5.184E-05	3.687E-05	28.9%
6	1.69	1.18	6.873E-05	4.797E-05	30.2%
7	0.99	0.74	5.254E-05	3.730E-05	29.0%
10	0.88	0.64	4.939E-05	3.485E-05	29.4%
11	2.01	1.41	7.319E-05	5.123E-05	30.0%
12	4.01	2.91	1.706E-04	1.166E-04	31.7%
13	7.52	5.04	2.448E-04	1.625E-04	33.6%
14	7.28	4.96	2.265E-04	1.520E-04	32.9%
15	4.33	3.04	1.657E-04	1.121E-04	32.3%
16	4.27	3.13	1.737E-04	1.192E-04	31.4%
17	2.29	1.60	8.494E-05	5.855E-05	31.1%
18	2.21	1.55	7.971E-05	5.545E-05	30.4%
Total	40.39	28.25	1.517E-03	1.037E-03	31.7%

Table V-27
Base Case 2007 and Controlled 2012 High Wind PM-10 Emissions Inventories for June 6, 2007 Design Day at the Durango Complex Monitor

High Wind Hour	Un-weighted Emissions (tons)		Distance-Weighted Emissions (tons/feet from monitor)		% Reduction of Weighted Emissions
	2007	2012	2007	2012	
11	1.99	1.37	1.340E-04	9.011E-05	32.8%
12	3.69	2.55	2.267E-04	1.543E-04	31.9%
13	3.12	2.15	1.876E-04	1.281E-04	31.7%
14	8.02	5.49	4.672E-04	3.093E-04	33.8%
15	9.84	7.07	4.992E-04	3.379E-04	32.3%
16	5.62	3.79	3.247E-04	2.160E-04	33.5%
17	2.47	1.72	1.619E-04	1.110E-04	31.4%
Total	34.74	24.13	2.001E-03	1.347E-03	32.7%

Table V-28
Base Case 2007 and Controlled 2012 High Wind PM-10 Emissions Inventories for June 6, 2007 Design Day at the Greenwood Monitor

High Wind Hour	Un-weighted Emissions (tons)		Distance-Weighted Emissions (tons/feet from monitor)		% Reduction of Weighted Emissions
	2007	2012	2007	2012	
12	1.05	0.77	5.872E-05	4.191E-05	28.6%
13	1.03	0.80	6.482E-05	4.701E-05	27.5%
14	3.03	2.16	1.618E-04	1.110E-04	31.4%
15	2.34	1.75	1.266E-04	8.868E-05	30.0%
Total	7.45	5.49	4.119E-04	2.886E-04	29.9%

Table V-29
Base Case 2007 and Controlled 2012 High Wind PM-10 Emissions Inventories for June 6, 2007 Design Day at the Higley Monitor

High Wind Hour	Un-weighted Emissions (tons)		Distance-Weighted Emissions (tons/feet from monitor)		% Reduction of Weighted Emissions
	2007	2012	2007	2012	
10	0.74	0.55	6.103E-05	4.481E-05	26.6%
11	3.00	2.05	1.944E-04	1.330E-04	31.6%
12	2.15	1.54	1.805E-04	1.270E-04	29.6%
13	2.41	1.69	1.824E-04	1.268E-04	30.4%
14	5.61	3.83	2.282E-04	1.553E-04	31.9%
15	5.70	3.98	2.113E-04	1.442E-04	31.8%
16	5.65	3.90	2.065E-04	1.403E-04	32.1%
17	1.50	1.11	6.687E-05	4.791E-05	28.4%
Total	26.76	18.64	1.331E-03	9.195E-04	30.9%

Table V-30
Base Case 2007 and Controlled 2012 High Wind PM-10 Emissions Inventories for June 6, 2007 Design Day at the West Phoenix Monitor

High Wind Hour	Un-weighted Emissions (tons)		Distance-Weighted Emissions (tons/feet from monitor)		% Reduction of Weighted Emissions
	2007	2012	2007	2012	
11	0.65	0.53	2.164E-05	1.680E-05	22.4%
12	1.78	1.33	5.329E-05	3.930E-05	26.2%
13	3.35	2.45	8.177E-05	5.933E-05	27.4%
14	4.27	3.08	1.123E-04	8.105E-05	27.8%
15	1.63	1.21	4.623E-05	3.396E-05	26.5%
Total	11.67	8.60	3.152E-04	2.304E-04	26.9%

Table V-31
Base Case 2007 and Controlled 2012 High Wind PM-10 Emissions Inventories for June 6, 2007 Design Day at the West 43rd Avenue Monitor

High Wind Hour	Un-weighted Emissions (tons)		Distance-Weighted Emissions (tons/feet from monitor)		% Reduction of Weighted Emissions
	2007	2012	2007	2012	
0	2.29	1.59	2.064E-04	1.388E-04	32.8%
5	3.31	2.29	2.894E-04	1.924E-04	33.5%
6	5.05	3.43	4.359E-04	2.860E-04	34.4%
10	3.44	2.38	2.835E-04	1.898E-04	33.1%
11	6.67	4.51	4.937E-04	3.237E-04	34.4%
12	6.02	4.06	5.697E-04	3.704E-04	35.0%
13	5.66	3.82	4.721E-04	3.088E-04	34.6%
14	9.67	6.48	6.830E-04	4.425E-04	35.2%
15	13.99	9.12	9.717E-04	6.168E-04	36.5%
16	9.67	6.48	6.630E-04	4.304E-04	35.1%
17	5.10	3.45	4.285E-04	2.812E-04	34.4%
18	4.94	3.34	3.857E-04	2.526E-04	34.5%
Total	75.81	50.97	5.883E-03	3.833E-03	34.8%