



April 17, 2006

**VIA OVERNIGHT COURIER**

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**VIA OVERNIGHT COURIER**

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RE: Comments on Proposed Coarse Particulate Matter NAAQS  
Docket ID. No. EPA-HQ-DAR-2001-0017

Dear Administrator Johnson and Acting Administrator Wehrum:

I am writing to you on behalf of the National Cattlemen's Beef Association ("NCBA") and the National Mining Association ("NMA") to comment on EPA's proposed revisions to the Particulate Matter ("PM") National Ambient Air Quality Standards ("NAAQS") 71 Fed. Reg. 2620-2708 (Jan. 17, 2006) and several related EPA actions.



## 1.0 INTRODUCTION

These comments address the issue of whether the ambient monitoring data for  $PM_{10-2.5}$  used in the epidemiologic studies on which EPA relies for support of the proposed  $PM_{10-2.5}$  NAAQS are adequately representative of the exposure of those suffering various morbidity or mortality effects to serve as the basis for any conclusion of that the exposure and the effects are associated. The conclusions reached are that ambient monitors for  $PM_{10-2.5}$  are representative of only limited areas around the monitor, and thus are not representative of the large urban areas for which the epidemiologic data are collected. This limitation, along with limitations of the sampling methods employed in some studies renders the ambient air basis for the epidemiologic results incorrect and inappropriate. See Part I below.

These comments also address whether a  $PM_{10-2.5}$  nationwide concentration level equivalent to the 1987  $PM_{10}$  24-hour concentration level can be validly and accurately derived. The conclusion reached is that no single, or even approximately equivalent,  $PM_{10-2.5}$  concentration level can be derived, due to the wide variation in the fine and coarse PM fractions of  $PM_{10}$  in different parts of the nation. Simply put, 150 micrograms of  $PM_{10}$  may be composed of 80-90% fine or combustion PM and 10-20% of dust or coarse PM sources in a humid, populated urban area. Because little, if any, of the particulate matter in these areas is from dust or coarse PM sources, the resultant  $PM_{10-2.5}$  concentration could be 15-30  $\mu\text{g}/\text{m}^3$ . On the other hand, 150  $\mu\text{g}/\text{m}^3$  of  $PM_{10}$  may be composed of 80-90% dust or coarse PM and 10-20% of fine or combustion PM, thus having a  $PM_{10-2.5}$  concentration of 120-135  $\mu\text{g}/\text{m}^3$ , in an arid or desert area with few, if any, combustion sources. Clearly, 15  $\mu\text{g}/\text{m}^3$  cannot be characterized as equivalent to 135  $\mu\text{g}/\text{m}^3$ . As discussed below, real data demonstrates this lack of possible equivalence of any single  $PM_{10-2.5}$  value, or reasonable range of such values, to the 1987  $PM_{10}$  standard. As a result, it is not possible, using reasonable existing data and methods to establish a "level of protection equivalent to the 1987  $PM_{10}$  standard," see Part II below.

## **PART I: Validity of PM<sub>10-2.5</sub> Measurements in Epidemiology Studies**

### **2.0 AREA OF INFLUENCE OF PM<sub>10-2.5</sub> EMISSIONS<sup>1</sup>**

The area of influence of a source of coarse particles can be determined through air quality modeling analysis. The EPA model, Industrial Source Complex (ISC), has been used to generate the areas of influence of different sources of particulate matter. ISC was selected because it has the most sophisticated methods of handling particles in the Guideline on Air Quality Models (40 CFR Part 51, Appendix W). This model's treatment of the deposition of coarse particulate matter is the state-of-the science, based on empirical work, including tracer and other studies, performed by Batelle Northwest [Horst, 1984]. There are three physical processes by which particles are removed from the air:

1. Gravitational Settling: While very fine PM, such as combustion PM, may remain suspended for considerable distances due to Brownian motion, the larger particles that characterize dust and coarse PM falls out of the atmosphere over relatively short distances, due in part to gravitational settling. The weight of a particle determines its settling velocity. Because the weight of particles in the coarse size range is relatively small, some of those engaged in statistical/epidemiological studies apparently believe that particles in the coarse range remain aloft for long distances. This is not correct!
2. Turbulent Settling: When coarse particles originate at ground level, as is the case with surface mining, cattle and agricultural operations, or otherwise move close to or come in contact with the ground or vegetation, they are in large part turbulently deposited on the ground. This effect was demonstrated by Batelle Northwest in classic field experiments and incorporated into ISC. *Id.* It is responsible for most of the deposition of coarse particles from surface mining, cattle operations (such as hooves on pen surfaces, and removing and applying manure to croplands) and

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<sup>1</sup> This analysis uses the convention that PM<sub>x</sub> means all particulate matter in the size below or included in the range specified in the subscript. Where reference is made to a single size particle, the value will be quoted in microns.

agricultural operations (such as tilling), as well as wind-blown dust, and dust from earth-moving and construction, or entrainment on dirt roads.

3. Precipitation Scavenging: Any actual precipitation removes particulates of all sizes from the air. In addition, high relative humidity increases particle sizes due to agglomeration and the addition of water vapor to particles, such that deposition is substantially more likely.

Using gravitational and turbulent settling (no precipitation scavenging), the distances from a source of airborne concentrations of particles can be calculated. Figure 1 shows the distances calculated by ISC for deposition of particles in the 10-2.5- $\mu\text{m}$  size range. It shows that particles deposit out rapidly with distance from a ground-level source, with the larger particles falling out much more rapidly than the smaller particles. The shaded area between the upper line (which depicts particles of uniform 2.5 microns in diameter, i.e. the lower bound of the  $\text{PM}_{10-2.5}$  range) and the lower line (which depicts particles of uniform 10 microns in diameter) depicts the range of concentration of particles between 2.5 microns and 10 microns. Each particle size was modeled with a 1 gram/second emission rate, i.e., the same mass. The 10-micron particles are deposited closest to the source and thus, have the lowest concentrations. Larger particles than 10 microns will deposit even sooner (the unshaded area below the 10-micron line). The 2.5-micron particles will deposit further away from the source. Particles smaller than 2.5 microns, will deposit at even longer distances.

Within 400 meters (1,312 feet,  $\frac{1}{4}$  of a mile) of the source, the concentrations of 10-micron particles fall to  $1/100^{\text{th}}$  of the nearby concentrations. Similarly, the 5-micron particle concentrations fall to  $1/100^{\text{th}}$  of the concentrations within 500 meters (1,640 feet,  $1/3$  of a mile) and the 2.5 micron particles fall to  $1/100^{\text{th}}$  of the concentration within 1,000 meters (3,280 feet,  $5/8$ 's of a miles). Between 100 meters and 200 meters the concentration of the range of particles from 10 microns to 2.5 microns drops from  $1,500 \mu\text{g}/\text{m}^3$  to  $300 \mu\text{g}/\text{m}^3$ , and at 300 meters drops to  $120 \mu\text{g}/\text{m}^3$ , at 400 meters to  $90 \mu\text{g}/\text{m}^3$ , at 500 meters to  $60 \mu\text{g}/\text{m}^3$  and at 1,000 meters to  $20 \mu\text{g}/\text{m}^3$ , demonstrating the enormous spatial variation in exposure of people to  $\text{PM}_{10-2.5}$  living within a very short distance of a coarse PM source, as well as the effective maximum distance of

**any** exposure from the source. This demonstration reflects what is so easily observed with dust sources, namely that their plumes fall out rapidly over a relatively short distance, i.e. coarse PM sources are local and do not have impact over substantial distances. For an elevated source (10 meters high effective point of injection), the distances are shown in Figure 2. The concentrations are lower, but they are also nearly completely gone by 1,000 meters downwind. The purpose of Figure 2 is to show that even if cattle, tractors or trucks on dirt roads were to kick their dust up to over 30 feet, it would still effectively dissipate within 1,000 meters to *de minimis* concentrations. If all of the dust were released at 10m, the concentration at 1,000 meters would fall to a minimal fraction of the level at the source.

Another important result demonstrated by modeling is that the particle size distribution of PM<sub>10-2.5</sub> changes as the plume moves downwind. Because the 10-micron and 5-micron particles initially disappear in these 500 meters of a ground level source (Figure 1), what remains in the air are only particles closer to 2.5 microns in size. Thus, health effects at distances more than 500 meters are more likely to be from that fraction of particles which may be indistinguishable from "fine particles". The reverse is also true; coarse particles are deposited at even shorter distances and their influence on potential health effects is found at even smaller distances from sources.

Figure 3 is a depiction of a hypothetical metropolitan area approximately 10 miles (17, 600 meters) square with a population of 1 million people (10,000 per square mile). It shows a city-center monitoring station, and the effective area of coarse PM sources impacting that monitoring, with a remote monitoring station 3 miles north of the central monitoring station. The shaded circle around the monitoring stations reflects the maximum area of impact from coarse PM sources on the monitoring site, i.e., the travel distance from the source to the monitoring station. While coarse PM plumes would fall within only a fraction of half of the circles at most, if one assumes that all of the people within 1,000 meters of the central monitoring station were exposed to the maximum level of the source, the monitoring stations would still only represent less than 2% of those exposed in the metropolitan area, i.e., those with morbidity or mortality that might be reflected in epidemiological statistics.

A recent study (WGA, 2001) of PM<sub>10</sub> and PM<sub>2.5</sub> air quality prepared for the Western Governor's Association, highlights these issues for fugitive dust sources. The study's first

“finding” is that “only a fraction of suspended particles are regionally transportable. Ground-level emissions of mechanically generated particles are likely removed near the source.” The WGA study showed the attenuation of particles as a function of time rather than distance. This figure is provided here as Figure 4 from studies in a stirred tank. For particles of 10 microns in diameter, half of them are removed after about 3.5 minutes and less than 10% remain after 12 minutes. In order to translate these results to distances, the time is multiplied by the wind speed. At a wind speed of 1 meter per second (approximately 2.2 miles per hour), half of the 10-micron particles are deposited in 210 meters (700 feet) and 90% are deposited within 720 meters (2,400 feet or ½ miles). Half of the 2.5-micron particles released at 1 meter are deposited within 1 hour (3,600 meters, 2-¼ miles) and 90% are deposited in ~3 hours (10,800 meters, 6.7 miles).

The WGA study also shows from measured data that PM<sub>10</sub> (all particles less than 10 microns) is reduced to 10% of its original concentration within 45 meters of unpaved roads. Another study (Etyemezian, 2004) shows significant concentration reductions at 50 meters from an unpaved roadway. EPA has recognized (FR 71, No 10, pg 2625) that “coarse particles generally deposit rapidly on the ground or other surfaces and are not readily transported across urban or broader areas.”

### **3.0 AREA OF INFLUENCE OF PM<sub>10</sub> – PM<sub>2.5</sub> MONITOR**

The corollary to the above results for emissions sources is that ambient monitors for coarse particles are only representative of sources within a limited area of the monitor. For ground-level sources, this area is less than 1/3 of a mile and for elevated sources, not more than 2/3's of a mile.

Given the above, it is safe to say that PM<sub>10-2.5</sub> monitors reflect only the sources within a small area of the monitor. They clearly do not reflect entire urban areas or even the area serviced by a single hospital or medical service center.

Current EPA regulations specify the criteria for the “spatial averaging” of PM<sub>2.5</sub> across urban areas. Specifically, annual concentrations of PM<sub>2.5</sub> at multiple monitoring stations must be ± 20% to qualify for spatial averaging for purposes of determining compliance with the NAAQS for PM<sub>2.5</sub>. Additionally, the correlation of daily site pairs, i.e., up and down variations of two or more sites to be included in the spatial average, must be greater than 60% (R > 0.60) 40 CFR

Part 58, Appendix D, Section 2.8.1.6.1. EPA has now proposed in Appendix N that the definition of spatial averaging be tightened to  $\pm 10\%$  and a correlation of 90% ( $R > 0.90$ ).

If we apply the "spatial averaging" criteria to  $PM_{10-2.5}$ , that would help to show the limited area of influence for monitors for  $PM_{10-2.5}$ , (40 CFR Part 50 Appendix N has no such requirement). As an example of the "spatial averaging" of  $PM_{10-2.5}$ , Salt Lake City has 4 monitors where  $PM_{10-2.5}$  ( $PM_{10}$  minus  $PM_{2.5}$ ) has been measured in the last 6 years. The results are:

$PM_{10-2.5}$ ( $\mu\text{g}/\text{m}^3$ )		
	Average	Data Points
Hawthorne	16.9	2139
Cottonwood	17.7	741
North Salt Lake	29.0	670
Magna	13.4	164
Averaged	19.25	

In the case of Salt Lake City, two of the four sites fall outside of the old  $\pm 20\%$  criteria and only one site meets the  $\pm 10\%$  criteria. Clearly, these sites represent four different  $PM_{10-2.5}$  exposure scenarios and none of them represent the situation to which the majority of residents would be exposed. These sites may reflect a particular local source or the lack of one, and there may be major sources between monitoring sites that are not reflected at all. In short EPA's criteria for relatively uniform distribution over large distances in urban areas cannot apply to  $PM_{10-2.5}$  because this data cannot meet the criteria. The criteria assumes a uniformity and spatial distribution that physically does not and cannot exist for coarse PM from ground-level or low-level coarse PM sources.

#### 4.0 REPRESENTATIVENESS OF PM<sub>10-2.5</sub> DATA FOR THE EPIDEMIOLOGIC STUDIES USED TO JUSTIFY THE PROPOSED NAAQS

One of the “important uncertainties”, (FR 71, No 10, pg 2654) which remains in developing a “thoracic course particle exposure” NAAQS is the representativeness of the monitored PM<sub>10-2.5</sub> data used in the epidemiologic studies. The following analysis of the data used in the epidemiologic studies is meant to be a demonstration of the lack of spatial averaging and the limited area of the influence of monitoring data for PM<sub>10-2.5</sub>. This analysis is aided by an EPA memorandum (Ross, 2005) which provides some of the data needed.

First, there are eastern urban areas which are dominated by fine particles and then western areas that are dominated by coarse particles.

- A. Six-City Study (St. Louis) – The epidemiologic study (Harvard Six-City Study) used PM<sub>10-2.5</sub> data from one location in the “southeast section” of the city. The average concentration for the respiratory symptoms study in 1986 was 12.6 µg/m<sup>3</sup> measured by dichotomous samples. EPA (Ross, 2005) provided PM<sub>10-2.5</sub> concentration data from 2001 – 2003 for three St. Louis area sites where the 3-year average was 10.1, 14.9 and 22.2 µg/m<sup>3</sup> respectively. The mean of these three monitors is 15.7 µg/m<sup>3</sup>. Only one of these monitors is ± 20% or ± 10% of the mean. Therefore, these monitors do not meet the criteria for spatial averaging. That means that each monitor is measuring its own nearby environment and nearby sources of coarse particulate matter and not measuring an urban average appropriate for epidemiologic studies.
  
- B. Six City Study (Steubenville) – The epidemiologic study used one downtown location and the 2-year average of PM<sub>10-2.5</sub> by dichotomous sample was 16.2 µg/m<sup>3</sup>. EPA’s analysis (Ross, 2005) shows five monitors; again 3-year averages for 2001 – 2003 are presented. They range from 10.7 to 14.7 µg/m<sup>3</sup>. While all of the monitors are within the ± 20% criteria only two are within the ± 10% criteria.

- C. Detroit – The data used for the epidemiologic comparison was from two dichotomous samplers in Windsor, Ontario, i.e., health affects in Michigan were evaluated with samples from across the river in Canada. These PM<sub>10-2.5</sub> monitors averaged 13.3µg/m<sup>3</sup> over a 3-year period (1992-1994). Table B-1 of Ross, 2005, is reproduced as follows:

**Table B-1: Annual Mean PM<sub>10-2.5</sub> Concentrations from Monitors in Wayne County, Michigan and Windsor, Ontario (in µg/m<sup>3</sup>)**

Site Name	1999	2000	2001	2002	2003
Windsor (RDG dichot)	9.7	11.1	8.6	4.5	7.1
Livonia	8.7	6.8	8.5	No data	No data
Allen Park	15.3	11.0	11.7	5.7	8.2
West Fort	21.6	18.6	23.5	18.0	11.6
Dearborn	21.8	19.8	18.0	20.0	30.4
<b>Area Average</b>	<b>15.4</b>	<b>13.5</b>	<b>14.1</b>	<b>12.1</b>	<b>14.3</b>

No matter the year, it is clear that the spatial averaging among these monitors is not met. There are years when two sites may be close together, but no more than one site is ever close to the ± 20% or ± 10% criteria. EPA also provided correlations of matched data. Those correlations were reported as 0.40 – 0.76. None of the monitors met the proposed correlation criteria for spatial averaging and only one met the current criteria. Thus each monitor responds to the nearby sources of PM<sub>10-2.5</sub> and only represents its own area of Detroit or Windsor.

Again, there is considerable variability over the urban area and it does not meet the EPA criteria for “spatial averaging”. The measurement data cannot support the health effects analysis.

- D. Coachella Valley – This study looked at cardiovascular mortality in residents of the valley (generally Palm Springs and Indio). The original study (1989-1998)

used beta gauge measurements of  $PM_{10}$  and  $PM_{2.5}$  at Indio and found the coarse fraction by the difference method, i.e. subtraction of  $PM_{2.5}$  from  $PM_{10}$ , at Indio and then predicted values for Palm Springs, more than 20 miles away where it evaluated possible associations. The EPA review used the 2001-2003 average which showed a threefold difference between the two sites;  $45.5 \mu\text{g}/\text{m}^3$  at Indio and  $15.5 \mu\text{g}/\text{m}^3$  at Palm Springs. EPA ascribes the difference to fugitive dust. Clearly the residents in different parts of the valley are subjected to widely different concentrations depending upon their locations. This is the nature of fugitive dust exposures which cannot be determined by two monitors for the entire valley.

- E. Phoenix (Ross, 2005) – EPA demonstrates that the concentrations of  $PM_{10}$  across the Phoenix area differed by a factor of two in 2003 ( $35 \mu\text{g}/\text{m}^3$  on the north side and  $62 \mu\text{g}/\text{m}^3$  to the “south”). EPA (Ross, 2005) suggests that since the data used for the epidemiological study was midway between the two extremes ( $46 \mu\text{g}/\text{m}^3$  at West Phoenix) that it represents an average of the Phoenix area but that conclusion violates EPA’s own definition of a proper “spatial average” of  $\pm 20\%$ , much less  $\pm 10\%$ . The large difference between the averages at West Phoenix and the JLG supersite (which are in close proximity) also argues specifically that exposures vary across the city (West Phoenix is 30 – 80% higher than the JPL supersite depending upon the year). Evidently, as demonstrated above, a few monitors cannot possibly represent the exposure to  $PM_{10-2.5}$  of even a small fraction of the population for a metropolitan area such as Phoenix extending over far more than 100 square miles and certainly no single monitor is representative of population exposures across the urban area.

Individual exposures in Phoenix will evidently vary substantially depending upon exposure location.

- F. Seattle – In this study, the authors tried to account for the variations by using a weighted average, weighted toward residential sites. But using a weighted

average only hides the dissimilarity of even the annual average measurements. They are, as in the other cities, not valid for "spatial averaging". The mean concentration at one site ( $9.3 \mu\text{g}/\text{m}^3$ ) was almost twice the mean concentration at another site ( $17.1 \mu\text{g}/\text{m}^3$ ) during the years of the epidemiologic study. Additionally, more than 70% of the  $\text{PM}_{2.5}$  measurements and up to 30% of the  $\text{PM}_{10}$  measurements were missing. For one of the sites used in the average, the data were estimated from nephelometer data, clearly an extremely inaccurate procedure. These measurements are clearly so compromised that the health effects are suspect.

#### **5.0 MEASUREMENT OF $\text{PM}_{10-2.5}$**

The direct measurement of  $\text{PM}_{10-2.5}$  is not currently done at any regulatory Federal Reference Method ("FRM") monitoring site because the FRM methods do not include its direct measurement.  $\text{PM}_{10-2.5}$  is determined indirectly by subtracting separate  $\text{PM}_{2.5}$  measurements from  $\text{PM}_{10}$  measurements. This is an indirect evaluation and leads to the problems which occur with any subtraction of small weights. The Salt Lake City data includes negative results which mean that  $\text{PM}_{2.5}$  is greater than  $\text{PM}_{10}$  which is of course impossible (see Table 1). These are measurement errors for times when there is very little or no  $\text{PM}_{10-2.5}$  in the atmosphere. The magnitude of some of these errors ( $-36.8 \mu\text{g}/\text{m}^3$ ) exceed the total levels of exposure in some epidemiological studies, and cannot be dismissed as insignificant. Indeed, they may well be determinative or predicted association or non-association.

EPA must rely on this measurement technique for its retrospective analysis of all the epidemiologic studies (Ross, 2005). This reliance is clearly less than definitive. Why must EPA provide a retrospective analysis for the epidemiologic studies? Because those studies were designed under the assumption that one or two monitors would be representative of ambient air quality for the urban area under study, and because these studies were designed to evaluate small particles ( $\text{PM}_{2.5}$ ) which may not vary much over an urban area, they are incorrectly designed for  $\text{PM}_{10-2.5}$ .

## 6.0 CORRELATIONS OF PM<sub>10-2.5</sub> DATA

EPA's discussions (Ross, 2005) of whether the PM<sub>10-2.5</sub> data it relies upon has consistent annual concentrations begs the question. EPA should have focused on the maximum 24-hour concentrations. The differences in maximum 24-hour concentrations between sites in any urban area are substantially larger than the differences in annual average concentrations. It is curious that EPA focused on the annual average PM<sub>10-2.5</sub>. EPA has asserted conversely that it is only the highest 24-hour concentrations in the data sets that are relevant to the epidemiologic associations being measured.

EPA relies instead on the correlation of concentrations at different sites to bolster its argument that the sites in an urban area are represented by the annual or long-term averages measured. Correlations do not address the maximum 24-hour concentrations. This test, in essence, assumes that 24-hour average concentrations go up and down at the same time. One might ask what that really means for PM<sub>10-2.5</sub>. If multiple (or only two monitors in many cases described by EPA) monitoring sites go up and down at the same time, it generally means a widespread air pollution episode which is highly dependant upon the meteorology during the episode. The meteorological circumstances of the episodes are crucial to the particulate matter content of the air.

Low wind speed stagnation conditions produce fine particles resulting from the atmospheric chemistry of increased ozone concentrations, including the formation of sulfates and nitrates. Low wind speeds result in less turbulence and increased ability of fine particles to remain airborne. PM<sub>2.5</sub> particles would increase significantly in concentration in such circumstances. This also may be true for particles slightly greater than PM<sub>2.5</sub>, that result from growth of combustion-related particles by aging in stagnant, foggy atmospheres i.e., those above the cut point of the PM<sub>2.5</sub> monitor or collections device. Those slightly greater than PM<sub>2.5</sub> particles would be measured as coarse particles by the measurement methods employed but are not truly "coarse particles" and are not due to fugitive dust sources.

If the correlations between monitors occur at higher wind speeds or are not associated with stagnation episodes, then it is likely that the particles are truly coarse particles and would tend toward the higher end of the range of PM<sub>10</sub> to PM<sub>2.5</sub>. Correlations against wind speed, low

concentrations of other pollutants (like  $PM_{2.5}$ ) and low humidity might be used to ascertain concentrations which identify a different particle distribution.

Even as it is, EPA's correlations are not as strong as one might expect, i.e., they range from 0.40 to 0.80 depending on the city involved (Ross, 2005). The eastern cities tend to have higher correlations, suggesting again that smaller particles play a role.

A recent study (Geller, 2004) in Los Angeles evaluated the correlations between  $PM_{10-2.5}$  and  $PM_{2.5}$  at four different sites. The  $R^2$  values were 0.11, 0.49, 0.14 and 0.16, well below any criteria for spatial averaging. These evaluations demonstrate that the sources of these two particle sizes are different and that use of one to estimate the other is not appropriate.

## **7.0 EXPOSURE ANALYSIS**

None of the studies which have suggested a link between  $PM_{10-2.5}$  and health effects provide any semblance of a true exposure assessment. One might concede that fine PM is sufficiently ubiquitous that an exposure assessment is not necessary. That would be the case if the "spatial average" of multiple  $PM_{2.5}$  monitors in an urban area were  $\pm 10\%$  and a correlation of 90% or greater for all monitors **and** that one could assume that the fine PM penetrated indoors, resulting in exposures equivalent to those measured outdoors. Then, one might be able to assume that one or two ambient monitors might be representative of exposures to these small particles.

Such a concession is not possible with  $PM_{10-2.5}$  because of the strong variations in concentrations with exposure locations. A large number of factors contribute to actual exposures. Chief among these is the difference between indoor and outdoor exposures. Since people generally spend less than 10% of their time outdoors, it is important to know what portion of the outdoor concentration of  $PM_{10-2.5}$  appears indoors. The following table from a study in Seattle (one of the cities discussed above) shows the percentage of time spent outdoors (Allen, 2004). Additionally, that study represents a comprehensive exposure analysis.

Location	% Time Spent	Exposure $\mu\text{g}/\text{m}^3$		% Exposure
	Mean (SD)	GM (GSD)	AM (SD)	Mean (SD)
Healthy Subjects (5 Monitoring Events; N = 35 subject-Days)				
Indoors at home	84.7 (10.1)	7.3 (2.6)	10.9 (12.8)	79.5 (15.4)
Outdoors at home	1.0 (1.4)	18.4 (1.7)	26.9 (24.6)	2.4 (4.0)
In transit	4.1 (3.0)	10.1 (2.6)	17.2 (36.6)	5.8 (4.5)
At work	0.0 (0.0)	---	---	---
Outdoors away from home	1.4 (2.8)	12.1 (1.5)	13.2 (6.4)	1.6 (3.3)
Indoors away from home	8.8 (6.4)	9.2 (2.7)	14.7 (17.6)	10.6 (10.1)

A recent study (Larnat, 2006) in Los Angeles shows clearly the significant reduction in indoor concentrations of  $\text{PM}_{10-2.5}$  compared with outdoor  $\text{PM}_{10-2.5}$  concentrations. Average reductions were 45% during the afternoon and evening, 70% in the morning and 89% overnight. Indeed, EPA concedes that coarse PM generally does not penetrate from outdoors to indoors.

Indoor/outdoor reductions are not the only ones that occur with larger particles. They are subject to deposition from a large number of surface obstacles which increase with atmospheric turbulence but also provide impaction surfaces. Many of these are intentionally designed to result in such reductions; fences, wind breaks, rows of houses, and tall buildings all reduce the ability of  $\text{PM}_{10-2.5}$  particles to travel even the distances presented in the modeling above (Section 2.0).

## **Part II: Equivalence**

### **8.0 INTRODUCTION**

Is the proposed 24-hour average NAAQS of  $70 \mu\text{g}/\text{m}^3$  for  $\text{PM}_{10-2.5}$  equivalent to the 1987  $\text{PM}_{10}$  NAAQS of  $150 \mu\text{g}/\text{m}^3$ ? In providing an analysis of this question, it is also important to keep in mind the “form of the standard”, i.e.

The  $\text{PM}_{10-2.5}$  NAAQS, proposed, is that 98% of the measurements over three years will be below the standard. This means that if:

1. Measurements are made 365 days a year, the 22<sup>nd</sup> highest measurements must be below  $75 \mu\text{g}/\text{m}^3$  ( $1095 \times 0.02 = 21.9$ )
2. Measurements are made every 3<sup>rd</sup> day (as required for  $\text{PM}_{2.5}$  compliance), the 8<sup>th</sup> highest concentration must be below  $75 \mu\text{g}/\text{m}^3$  ( $1095 \div 3 \times 0.02 = 7.3$ )
3. Measurements are made every 6<sup>th</sup> day; the 4<sup>th</sup> high concentration must be below  $75 \mu\text{g}/\text{m}^3$  ( $1095 \div 6 \times 0.02 = 3.65$ )

The 1987  $\text{PM}_{10}$  NAAQS was remanded to EPA by the court and fell back to the form that provides the 2<sup>nd</sup> highest value in any year should be below  $150 \mu\text{g}/\text{m}^3$

### Utah

Co-located  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  data for eight sites in Utah have been evaluated for equivalence (Sands, 2006). The results are presented in Table 1 on the next page. They show a number of important aspects to the problem of measuring and analyzing both compliance with the proposed NAAQS and equivalence.

Second, the minimum concentrations (MIN  $\text{PM}_c$ ) highlight the problems of subtracting  $\text{PM}_{2.5}$  from  $\text{PM}_{10}$ . The minimum values in Salt Lake County are significant. They equal the magnitude of the concentrations for which a health effect is alleged. There are a total of fourteen days where  $\text{PM}_{2.5}$  illogically exceeds  $\text{PM}_{10}$ .

One site (North Salt Lake) is calculated to have trouble meeting the proposed NAAQS because the percentage of measurements in the last three years above  $70 \mu\text{g}/\text{m}^3$  is 2.62%. The equivalent concentrations for these sites are listed in the next to the last column. They are all well above  $70 \mu\text{g}/\text{m}^3$  and are 74 to 90% higher than the proposed  $\text{PM}_{10-2.5}$  NAAQS.

### Wyoming

Analysis of data from a mining location in northeastern Wyoming (Schaefer, 2006), which currently shows compliance with the  $\text{PM}_{10}$  NAAQS, shows 13.2% (a total of 43 days monitored every 3<sup>rd</sup> day) of concentrations of  $\text{PM}_{10-2.5}$  in three years, exceed the proposed NAAQS. These data are shown in Figure 5. Thus, a specific fugitive dust monitoring location shows that the proposed NAAQS is significantly more stringent than the current NAAQS. An

Table 1

Summary Results of Preliminary PM<sub>c</sub> Analysis Using Co-located PM<sub>10</sub> and PM<sub>2.5</sub> Data from Monitoring Sites in the State of Utah

County	Station Name	Dates Analyzed	Max PM <sub>c</sub>	Min PM <sub>c</sub>	Ave PM <sub>c</sub>	All time # Days (PM <sub>2.5</sub> > PM <sub>10</sub> )	All time # Days (PM <sub>c</sub> > 70)	Past 3 years # Days (PM <sub>c</sub> > 70)	# Colocated Data Pts	All time % of Data Having PM <sub>c</sub> > 70	Past 3 Years % of Data Having PM <sub>c</sub> > 70	PM <sub>c</sub> Std "Equivalent" to PM <sub>10</sub> Std of 150 <sup>2</sup>
Salt Lake County	Hawthorne - HW	1/1/98 to 12/31/04	323.6	-13.8	16.9	6	9	7	2139	0.42%	0.71%	127
Salt Lake County	Cottonwood -CW	1/1/98 to 12/31/04	125	-36.8	17.7	4	1	1	741	0.13%	0.28%	129
Salt Lake County	North Salt Lake - N2	1/1/99 to 12/31/04	143.8	-6.9	29.0	1	26	10	670	3.88%	2.92%	122
Salt Lake County	Magna -MG	7/1/03 to 12/31/04	76.9	-20.4	13.4	3	1	NA	164	0.61%	NA	131
Utah County	Lindon -LN	1/1/98 to 12/31/04	133.2	0	20.4	0	12	5	1963	0.61%	0.68%	132
Utah County	North Provo -NP	1/1/98 to 12/31/04	59.3	0.1	15.6	0	0	0	712	0.00%	0.00%	NA
Cache County	Logan - L4	1/1/00 to 12/31/04	83.3	0	14.9	0	2	1	539	0.37%	0.30%	132
Weber County	Ogden#2 - O2	1/1/02 to 12/31/04	80.6	0.2	0	0	1	1	340	0.29%	0.29%	133

<sup>1</sup>Percentages greater than 2% may indicate problems meeting a 3-year average of the annual 98th percentile 24-hour average PM<sub>10.2.5</sub>. No data handling conventions were applied in preliminary analysis.

<sup>2</sup>Based on days with PM<sub>c</sub> > 70 µg/m<sup>3</sup>. Preliminary analysis of Utah data indicates a new PM<sub>10.2.5</sub> indicator set at 70 µg/m<sup>3</sup> would be much more restrictive than the current PM<sub>10</sub> standards.

equivalent concentration for  $PM_{10-2.5}$  is estimated at  $85 \mu\text{g}/\text{m}^3$ . This is 76% more stringent than the current  $PM_{10}$  standard. The “form of the standard” whether “expected exceedance” (second high value), 99<sup>th</sup> percentile, or 98<sup>th</sup> percentile makes no difference to the results at this monitor;  $70 \mu\text{g}/\text{m}^3$  of  $PM_{10-2.5}$  is a substantially more stringent standard than  $150 \mu\text{g}/\text{m}^3$  of  $PM_{10}$ .

Figure 6 shows the percentage of  $PM_{10-2.5}$  in the total  $PM_{10}$  measurement for each day of the 5-year record. When  $PM_{10}$  concentrations are greater than  $50 \mu\text{g}/\text{m}^3$ , the average  $PM_{10-2.5}$  portion of the total concentration is 90.3% and thus, the  $PM_{2.5}$  is less than 10% of the total concentration. The average  $PM_{2.5}$  percentage of the total is 19% including  $PM_{10}$  concentrations less than  $50 \mu\text{g}/\text{m}^3$ . The figure reveals an extremely important point about fugitive dust sources. For the maximum concentrations, which will determine the 98% percentile compliance with the proposed NAAQS, the percentage of  $PM_{10-2.5}$  is always extremely high. In Figure 7 (Schmidt, 2005), EPA showed the ratios of  $PM_{2.5}$  to  $PM_{10}$  by region of the country. Those ratios average about 30%  $PM_{2.5}$  in the “Southwest” to 70%  $PM_{2.5}$  in the “Northeast” and “Industrial Midwest”. The extremes are important in any 24-hour average NAAQS. In the last four regions, they are less than 25%  $PM_{2.5}$  and in the “Northeast” they are equal, i.e., all the  $PM_{10}$  and  $PM_{2.5}$ .

#### EPA Data

EPA’s (Schmidt, 2005) evaluation of equivalence is provided by “region” of the country. Figure 8 is a reproduction of the analysis of equivalence. It is clear that there is no uniformly equivalent concentration to the proposed NAAQS of  $PM_{10-2.5}$  at the 98<sup>th</sup> percentile (PMC\_DV\_98) to the current NAAQS of  $PM_{10}$  expected exceedance (PMT\_DV\_EE). The range of the averages is from a ratio of 0.31 ( $46.5 \mu\text{g}/\text{m}^3$  equivalent to  $150 \mu\text{g}/\text{m}^3$  in the east to a ratio of 56 ( $84 \mu\text{g}/\text{m}^3$  equivalent to  $150 \mu\text{g}/\text{m}^3$ ) in the upper midwest. The 95<sup>th</sup> percentile of the measured ratios is shown at the ends of the whisker. For the southwest, this goes as high as a ratio of 0.87 ( $130.5 \mu\text{g}/\text{m}^3$  equivalence to  $150 \mu\text{g}/\text{m}^3$ ). This figure shows that setting the ratio at 0.47 ( $70 \mu\text{g}/\text{m}^3$ ) for the proposed NAAQS is arbitrary. The scatter is too large (ratios of 0.12 to 0.87). Four of these EPA selected regions have data which show that the average “equivalent” concentration (ratio of 0.42) is higher than the current NAAQS and for the other three “regions”, is lower. It should be noted that when the form of the standard is the 99<sup>th</sup> percentile, the range of ratios is 0.14 to 0.93 (Schmidt, 2005) and is therefore, not much different than for the 98<sup>th</sup>

percentile. Under the 99<sup>th</sup> percentile form of the standard, five of the seven "regions" would have averages which lead to a more stringent standard. From this data, it is clear that there is no "equivalent" PM<sub>10-2.5</sub> concentration. The concept of "equivalence" which EPA uses cannot be supported by the data.

## 9.0 CONCLUSIONS

### Part I

1. The area of influence of a source of PM<sub>10-2.5</sub> is less than 1,000 meters and less than 500 meters (~ 1/3<sup>rd</sup> mile) for the particles greater than 5 microns in diameter. The impact of roadway is no more than 50 meters (164 feet).
2. The air quality represented by a PM<sub>10-2.5</sub> monitor can be no more than a distance of 1,000 meters.
3. Monitors for PM<sub>10-2.5</sub> do not represent urban areas for which the epidemiologic studies cited to support the proposed NAAQS were performed. Those few, in most cases one, monitor only represent PM<sub>10-2.5</sub> air quality within the 1,000-meter radius of their location, not the entire urban area.
4. An ambient monitor for PM<sub>10-2.5</sub> does not represent the total exposure of an individual to coarse particles. A total exposure assessment must be part of any study of health effects.
5. EPA continues to employ an indirect method of measuring PM<sub>10-2.5</sub> by using the difference between PM<sub>10</sub> and PM<sub>2.5</sub> monitored results. This method is incorrect and not technically acceptable.

### Part II

1. Data from sites dominated by fugitive dust sources demonstrates that the proposed NAAQS is significantly more stringent than the current PM<sub>10</sub> NAAQS.
2. Data on the PM<sub>10-2.5</sub> fraction of total PM<sub>10</sub> from fugitive dust sources shows that 90% or more of the PM<sub>10</sub> is PM<sub>10-2.5</sub> especially at the maximum daily values. EPA's use of long-term average ratios of PM<sub>10-2.5</sub> to PM<sub>10</sub> (47%), hide the fact that most sources of

PM<sub>10-2.5</sub> will be much more likely to exceed the proposed NAAQS than the current NAAQS. The data presented provide examples of this fact.

3. There is no universal equivalent for PM<sub>10-2.5</sub> to the current PM<sub>10</sub> NAAQS. The “equivalence” ranges from 12% to 87% of the current NAAQS.

## 10.0 REFERENCES

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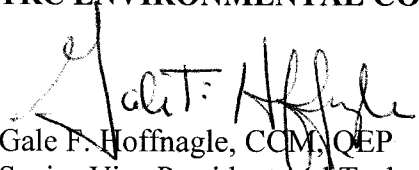
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April 17, 2006

Page 20

If you have any questions on these requests, please contact me at (860) 298-6247 or <mailto:ghoffnagle@trcsolutions.com>.

Sincerely,

**TRC ENVIRONMENTAL CORPORATION**

  
Gale F. Hoffnagle, CCM, QEP  
Senior Vice President and Technical Director

GFH/jeh

cc: Dr. Erika Sasser (via overnight courier)  
Mail Code: C539-01  
Air Quality Strategies and Standards Division  
US EPA  
Research Triangle Park, NC 27711

# FIGURES

FIGURE 1. Concentrations of Coarse Particles vs Downwind Distance (Groundlevel Source)

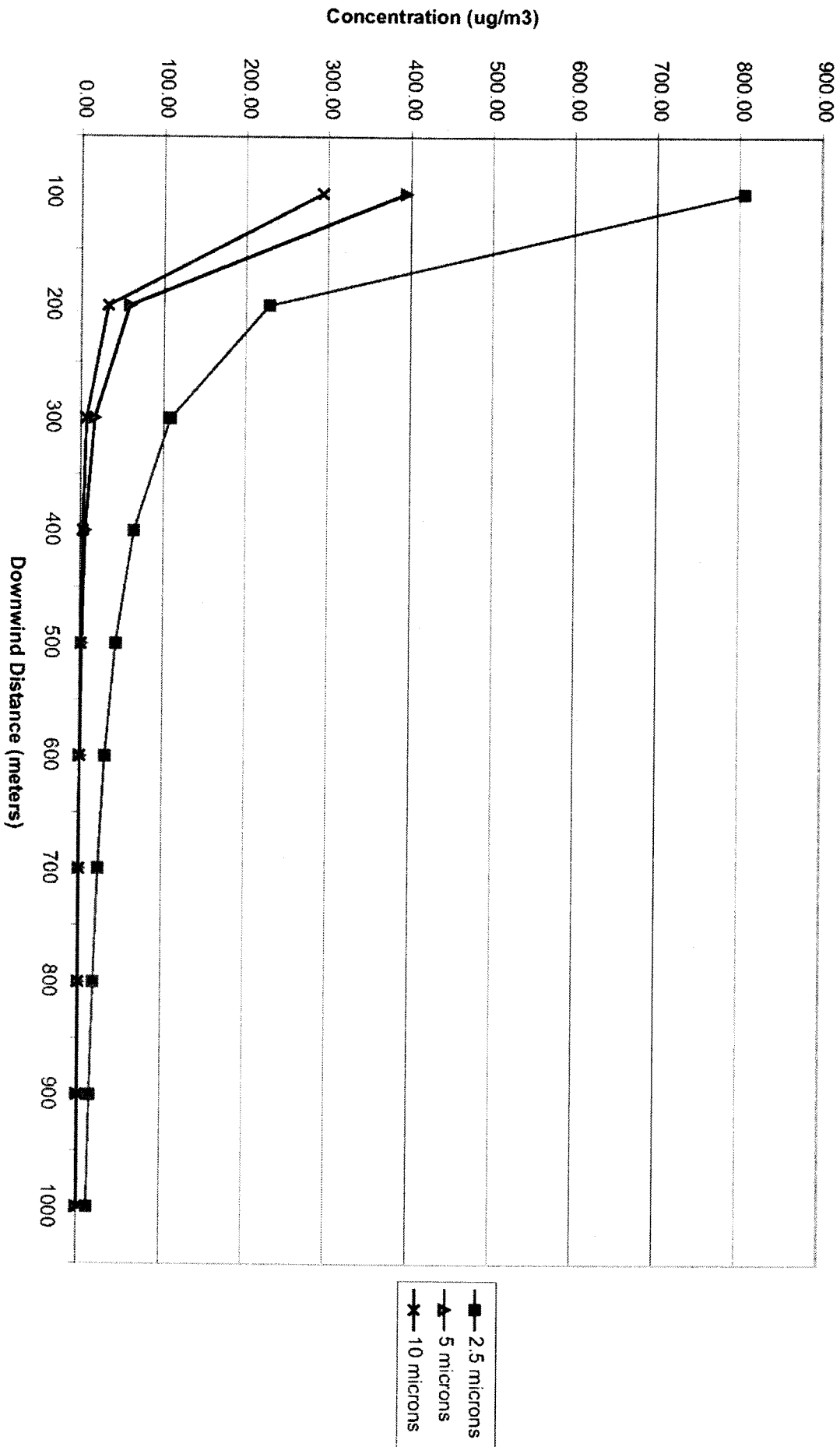
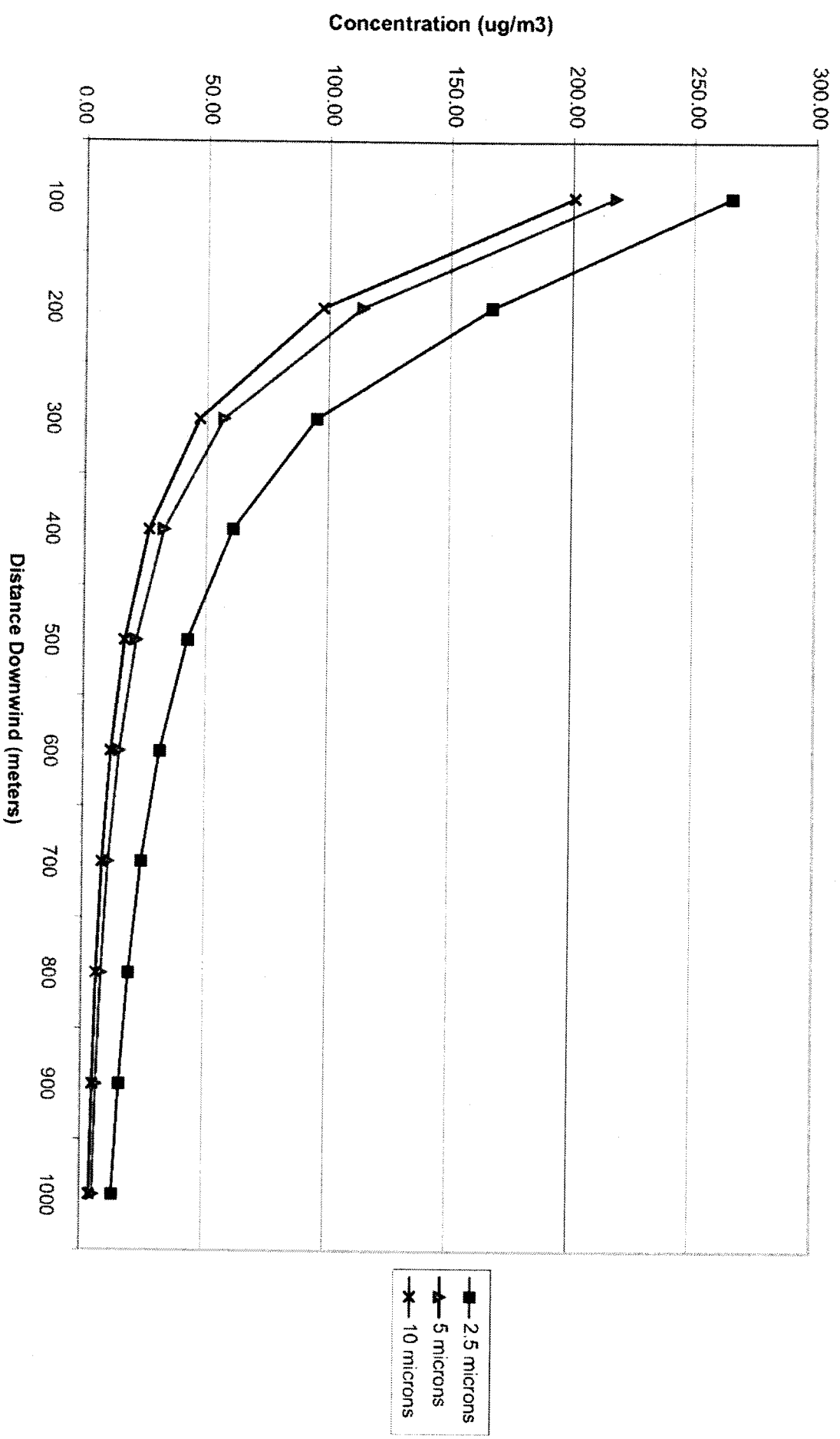


FIGURE 2. Coarse Particle Concentration vs Distance (10 Meter High Source)



**FIGURE 3. Area of Influence of PM<sub>10-2.5</sub> Monitors in a Hypothetical Urban Area**

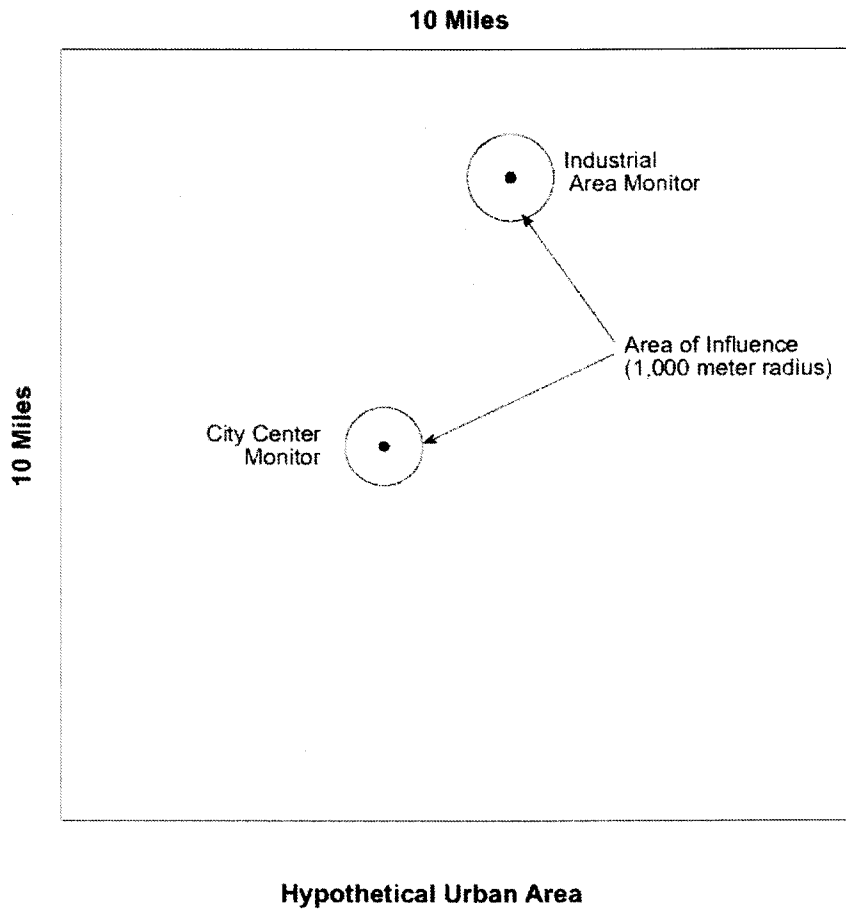


FIGURE 4. (from WGA, 2001)

Figure 2-2. Attenuation of PM<sub>10</sub> and PM<sub>2.5</sub> mass concentrations with time and vertical mixing volume (adapted from Watson and Chow, 2000). Assumes stirred tank model of Hinds (1999) in which particles are homogeneously redistributed throughout the mixed layer at each time step.

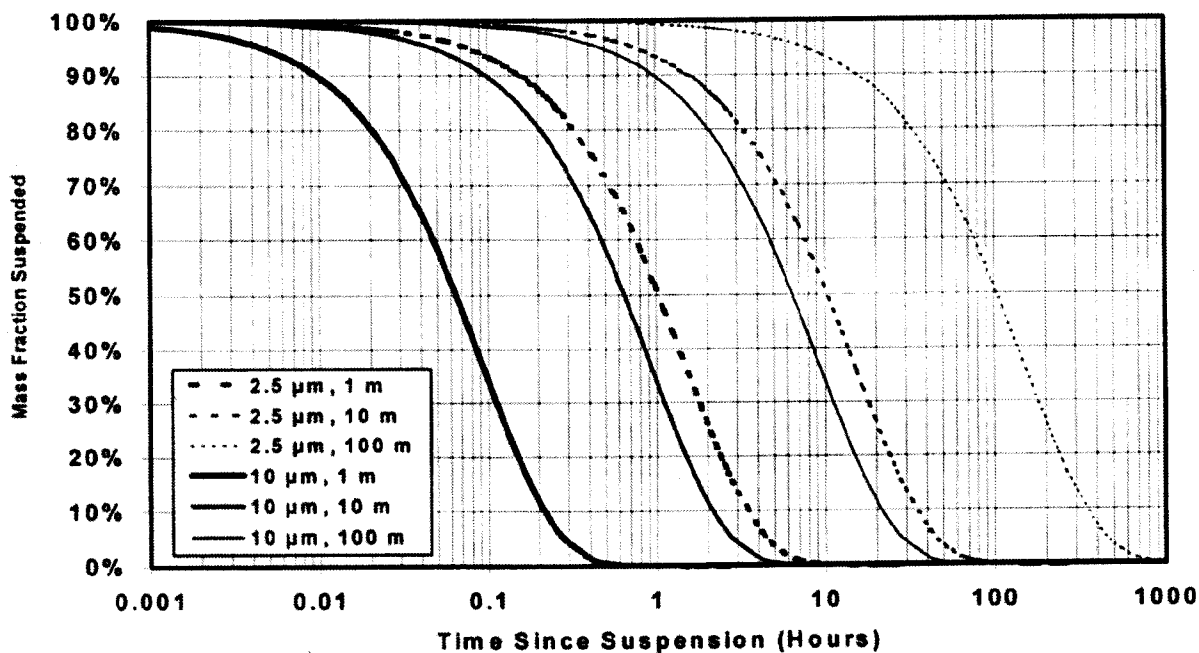


FIGURE 5.

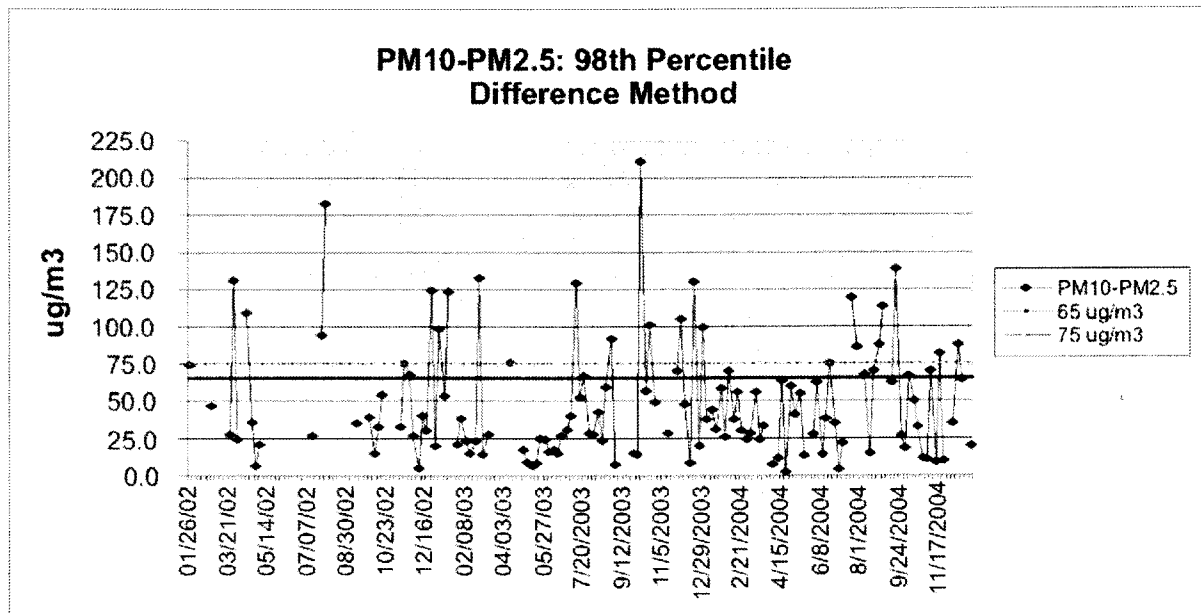
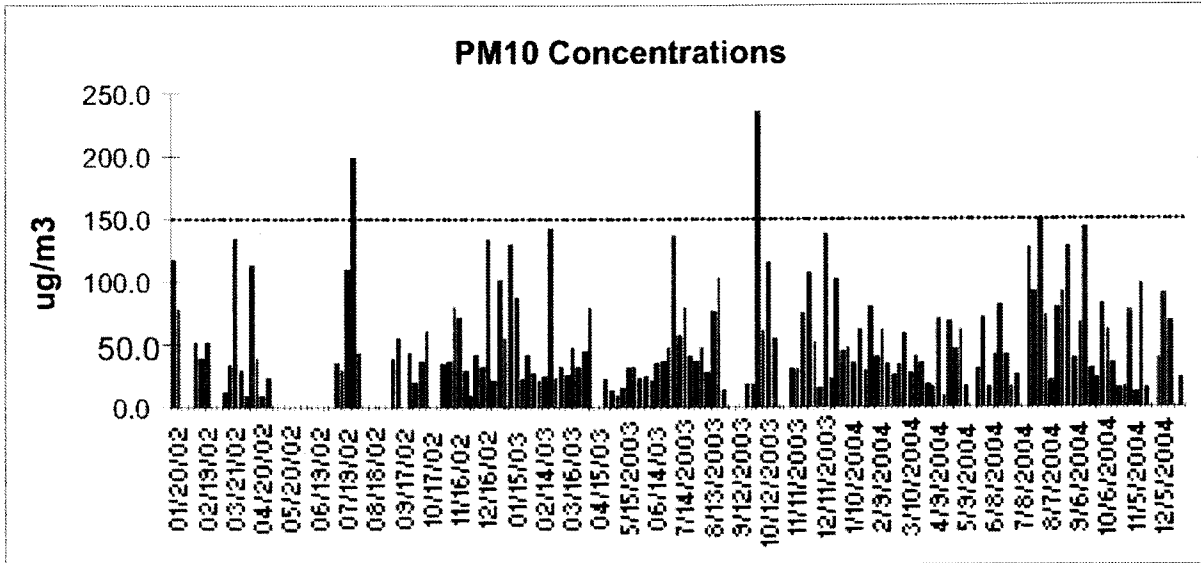


FIGURE 6.

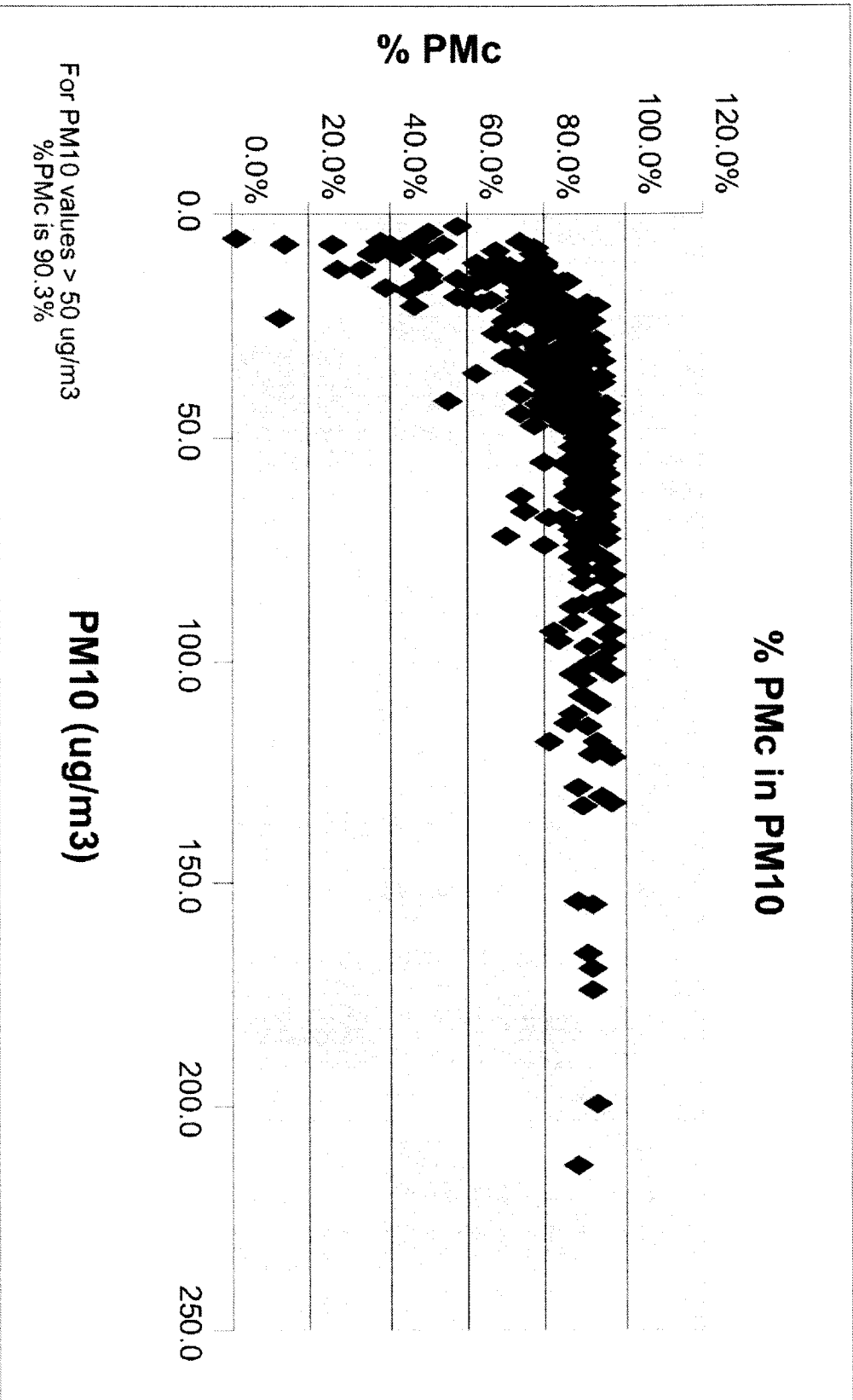


Figure 7

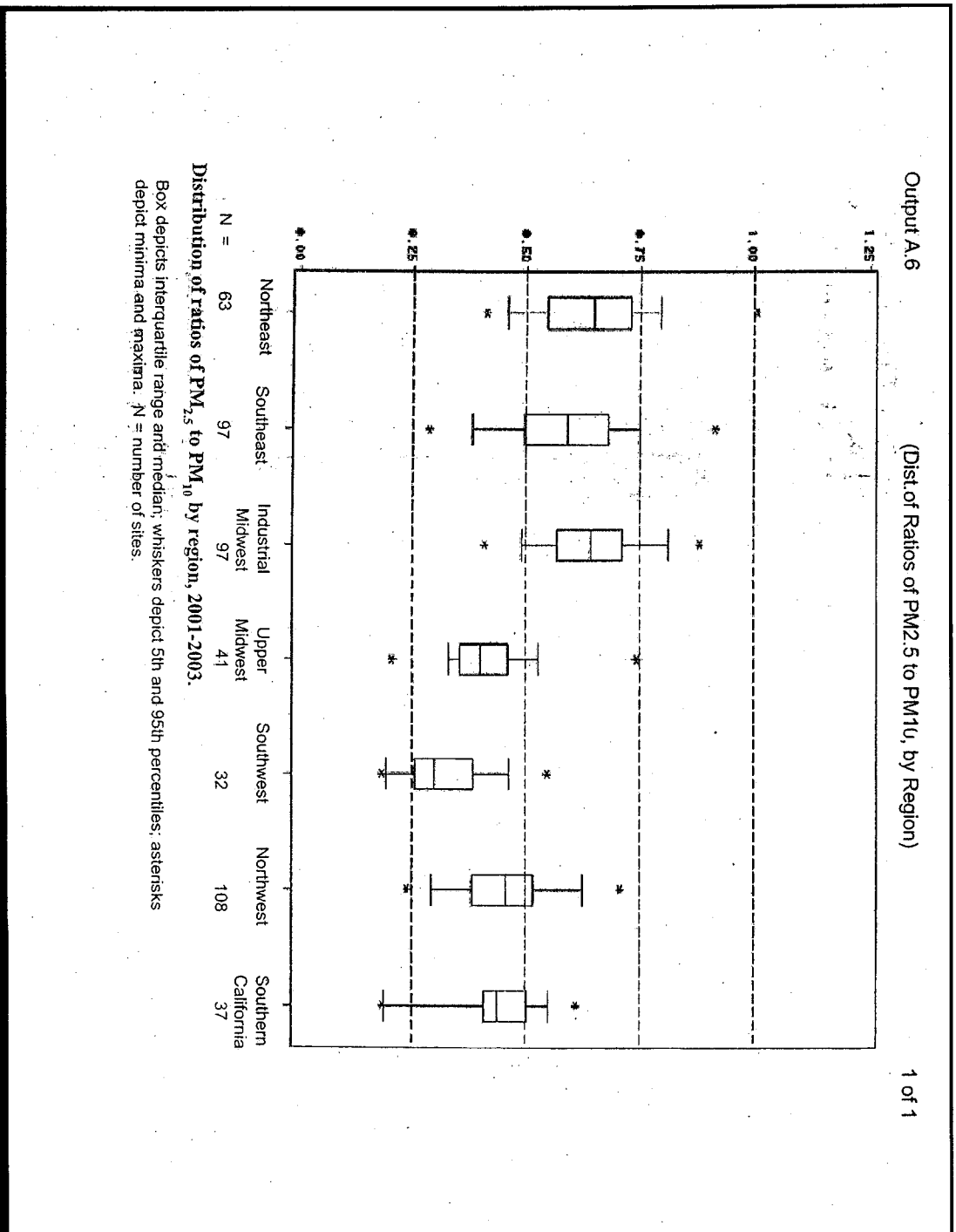


Figure 8

Output A:7 (PM10-2.5 Equivalence to PM10 NAAQS)

10 of 19

