

DATE: April 15, 2011

TO: Dispersion Modeling Team  
Permit Writers  
Compliance Staff

FROM: John Roth – Leader, Stationary Source Modeling Team

SUBJECT: PM<sub>2.5</sub> Regional Background Concentrations<sup>1</sup>

FILE REF: 4560

## INTRODUCTION

In September 2008 WDNR Air Management updated the regional background concentrations used in assessing the impact of permitted emissions on air quality. These concentrations are added to the modeled concentrations of the air pollutant(s) emitted by the source(s) to estimate the total air quality impact at a given location. Regional background values help in assessing the total impact on human health by examining all sources of air contaminants, including those sources that are not modeled but are within the region. Examples of sources not modeled include other point sources, mobile sources, and fugitive emissions sources.

This update provides regional background concentrations for particulate matter with aerodynamic diameter of less than 2.5 micrometers (PM<sub>2.5</sub>) using substantially the same methodology as in September 2008 {Appendix}.

## BACKGROUND CONCENTRATION DETERMINATION

The September 2008 backgrounds were developed for two population based subsets of Wisconsin. Cities or villages with population of 25 000 people or higher were grouped in the 'high' category, while the remainder of the state is in the 'low' category. Higher regional backgrounds are expected to occur in the more developed (residential, industrial, & transportation) areas.

The PM<sub>2.5</sub> regional backgrounds were calculated by separating the monitors into the same two geographic categories and taking the mean of the 2001-06 data. The monitoring objective of each monitor is driven by the area immediately adjacent to the station while PM<sub>2.5</sub> is more regional in nature. There may be several different ways to group the monitoring data, but using the previously defined geographic areas is more consistent.

The 98<sup>th</sup> percentile daily concentration and the annual concentration from each station that captured at least 75% of the yearly data were compiled. Since there are proposed nonattainment areas that will function under different regulations, any monitoring station that had a 98<sup>th</sup> percentile daily concentration over 35.0 ug/m<sup>3</sup> was discarded. The remaining data in each category was averaged and the result rounded to one decimal place.

For the nonattainment counties of Milwaukee, Racine, and Waukesha, these background values do not apply.

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<sup>1</sup> This document is intended solely as guidance and does not contain any mandatory requirements except where requirements found in statute or administrative rule are referenced. This guidance does not establish or affect legal rights or obligations and is not finally determinative of any of the issues addressed. This guidance does not create any rights enforceable by any party in litigation with the State of Wisconsin or the Department of Natural Resources. Any regulatory decisions made by the Department of Natural Resources in any matter addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.

The table below presents the regional background concentrations for Wisconsin derived from these methods.

<b>Wisconsin Regional Background Concentrations</b> (All Concentrations in $\mu\text{g}/\text{m}^3$ )			
Pollutant	Time Period	High Value	Low Value
TSP	24 Hour	58.9	39.7
PM <sub>10</sub>	24 Hour	47.0	29.4
	Annual	19.9	10.1
PM <sub>2.5</sub>	24 Hour	28.9	25.6
	Annual	10.2	8.7
Pb	Quarterly	0.02	0.01
SO <sub>2</sub>	3 Hour	43.2	11.8
	24 Hour	30.5	11.2
	Annual	8.6	5.4
NO <sub>x</sub>	Annual	24.1	8.0
CO	1 Hour	1,362.7	950.5
	8 Hour	1,191.2	904.7

<b>Higher Regional Background Areas in Wisconsin</b>	
Main City	Additional Incorporated (City or Village) Areas
Superior	-
Eau Claire	Altoona
Wausau	Schofield
La Crosse	Onalaska
Green Bay	Ashwaubenon, Allouez, De Pere
Appleton	Menasha, Neenah, Little Chute, Kimberly, Combined Locks, Kaukauna
Manitowoc	Two Rivers
Oshkosh	-
Fond du Lac	North Fond du Lac
Sheboygan	-
West Bend	-
Madison	Middleton, Shorewood Hills, McFarland, Maple Bluff, Sun Prairie, Monona, Fitchburg
Janesville	-
Beloit	-
Kenosha	Pleasant Prairie
Racine	Elmwood Park
<b>Milwaukee</b>	<b><i>St. Francis, Cudahy, South Milwaukee, Oak Creek, Franklin, Greenfield, Greendale, Hales Corners, West Allis, West Milwaukee, Wauwatosa, Shorewood, Glendale, Whitefish Bay, Brown Deer, Fox Point, River Hills, Bayside, Menomonee Falls, Butler, Lannon, Brookfield, Elm Grove, New Berlin, Muskego, Waukesha, Germantown, Mequon, Theinsville</i></b>

**Note:** For locations within Milwaukee, Racine, or Waukesha Counties, these backgrounds do not apply.

**APPENDIX**

**September 2008 Memorandum**

DATE: September 15, 2008

FILE REF: 4560

TO: Dispersion Modeling Team  
Permit Writers  
Compliance Staff

FROM: John Roth – Leader, Stationary Source Modeling Team

SUBJECT: Regional Background Concentrations<sup>2</sup>**INTRODUCTION**

Beginning in January 2007, WDNR Air Management staff met with consultants, industry representatives, attorneys, and other interested parties to solicit ideas and discuss options for streamlining the ambient air quality assessments that are performed in conjunction with issuing air pollution control permits. Thirty-two people participated in the meetings, including representatives from the United States Environmental Protection Agency (USEPA), Wisconsin Manufacturers and Commerce (WMC), Wisconsin Paper Council (WPC), Sierra Club, several industries, and several law firms. This work group was formed as part of the Department's Air Permit Improvement Initiative.

One major issue that was discussed with this group was regional background concentrations. These concentrations are added to the modeled concentrations of the air pollutant(s) emitted by the source(s) to estimate the total air quality impact at a given location. Regional background values help in assessing the total impact on human health by examining all sources of air contaminants, including those sources that are not modeled but are within the region. Examples of sources not modeled include other point sources, mobile sources, and fugitive emissions sources.

**GEOGRAPHIC AREAS**

Historically, regional background concentrations for each pollutant for which modeling is conducted were established for each county in Wisconsin. Ambient air quality monitors do not exist in each county, so representative values from neighboring counties were assigned to counties without monitors. A sub-group of consultants and DNR staff was formed from the larger group mentioned above, to assess the validity of that approach and to determine if changes were needed. Since many counties in Wisconsin have one or two large cities with the bulk of the county being suburban, agricultural, or rural, the group decided that regional background concentrations should be determined for cities or villages, rather than being determined for counties. The group recommended that higher background concentrations be set for areas with greater populations and industries and lower background concentrations be set for other areas.

All cities and villages in Wisconsin were examined using the year 2000 U.S. Census data to determine the proper population threshold to distinguish high background concentration areas from low background concentration areas. Cities and villages with populations of 5 000, 10 000, 15 000, 20 000, and 25 000 residents were identified. Many small cities and villages have populations of 1 000 to 5 000 residents. Using their collective knowledge and professional judgment, the group concluded that these smaller cities and villages (i.e. with a population of 5 000 or less) generally have less industry, fewer residential emissions, and less traffic, so higher background concentrations would not be appropriate.

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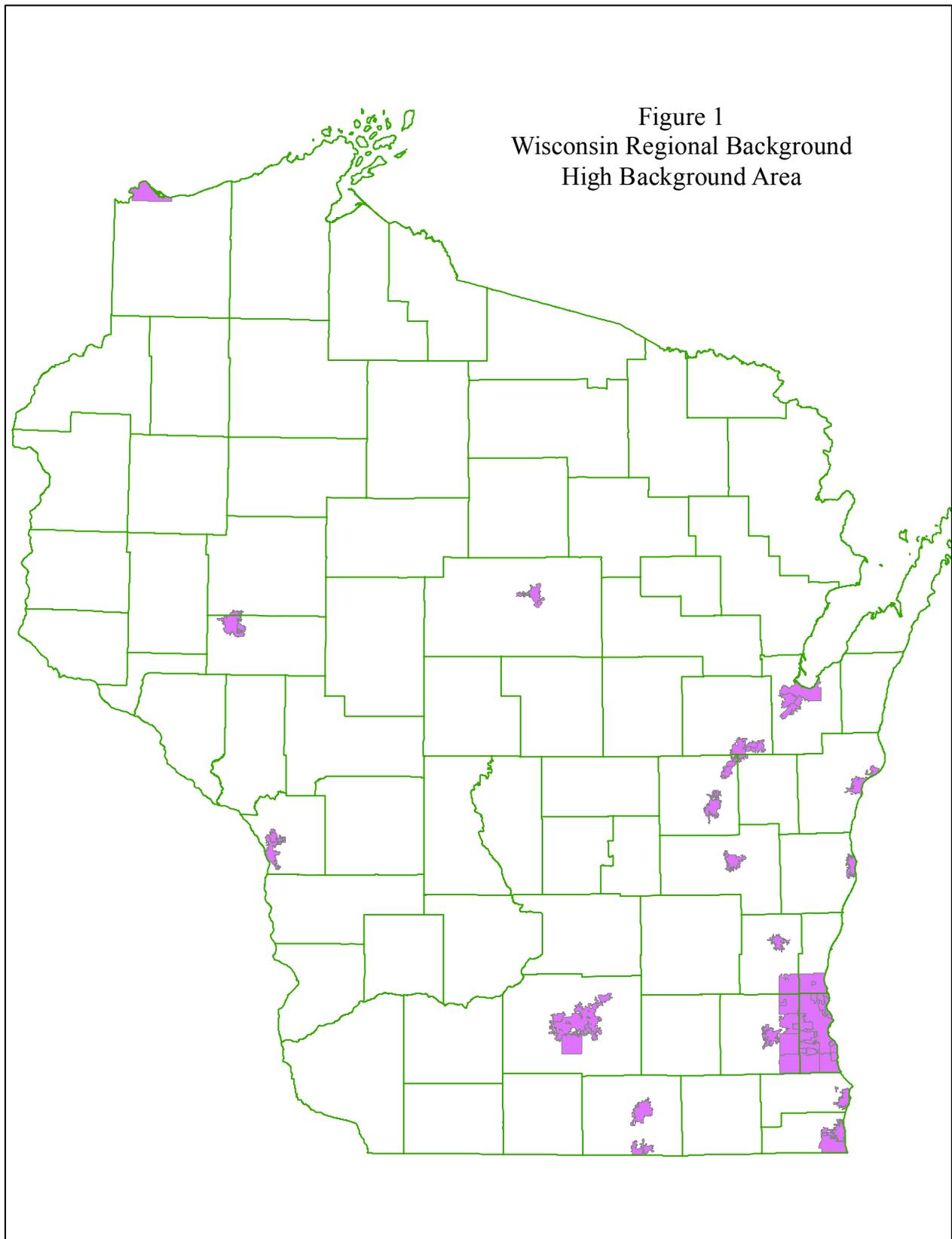
<sup>2</sup> This document is intended solely as guidance and does not contain any mandatory requirements except where requirements found in statute or administrative rule are referenced. This guidance does not establish or affect legal rights or obligations and is not finally determinative of any of the issues addressed. This guidance does not create any rights enforceable by any party in litigation with the State of Wisconsin or the Department of Natural Resources. Any regulatory decisions made by the Department of Natural Resources in any matter addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.

Other areas such as Wisconsin Rapids, Stevens Point, and Marshfield have populations in the 15 000 to 20 000 resident range. The group concluded, again through a combination of their practical experience and professional judgment, that while these cities have industrial development, these industries are often comprised of one or two large facilities that can be, and often are, modeled together. The group also determined that the current regional background concentrations used for these cities (i.e. 15 000 to 20 000 population) is lower than the higher background concentrations being considered, so moving those cities and villages into a higher background concentration category would not be justified.

Using a 25 000 population threshold, the city of Superior would be in the higher background category, as would the city of Fond du Lac, but the cities of Stevens Point, Marshfield, and Wisconsin Rapids would be in the lower background concentration category. This approach is consistent with the current regional background concentrations that are being used in these cities, and also captures the more industrial areas of the State into the higher regional background category.

Many of the larger cities in Wisconsin have neighboring suburbs that, when combined, are considered one metropolitan area. Legally and administratively, these cities and villages are separate entities but for the purposes of regional background concentrations these areas should be considered as one contiguous region. The year 2000 U.S. Census data was again consulted and a list was created of all cities and villages immediately adjacent to a larger city or village (i.e. one with population of 25 000 people or more). For the purposes of this document, if the population density of the neighboring city or village is more than half the population density of the main city or village, then it is considered 'part' of the main city or village. Also, if the larger city or village surrounds another city or village, the surrounded entity was considered 'part' of the main city or village. This total area was then assigned the higher regional background concentration. Using this method, the following map and table were developed to show in what areas the higher background concentration should be used and in what areas the lower concentration should be used.

Figure 1 below shows the higher regional background areas (shaded) in Wisconsin.



Cities and villages can change their boundaries (e.g. through annexation), so Figure 1 above is not an official indicator of the proper background concentrations to use. Table 1 below lists all the areas where the higher background concentrations should be used. If a given area expands due to annexation or incorporation, the higher background concentration values would apply to the additional (i.e. annexed, incorporated) area.

<b>TABLE 1</b>	
<b>Higher Regional Background Areas in Wisconsin</b>	
Main City	Additional Incorporated (City or Village) Areas
Superior	-
Eau Claire	Altoona
Wausau	Schofield
La Crosse	Onalaska
Green Bay	Ashwaubenon, Allouez, De Pere
Appleton	Menasha, Neenah, Little Chute, Kimberly, Combined Locks, Kaukauna
Manitowoc	Two Rivers
Oshkosh	-
Fond du Lac	North Fond du Lac
Sheboygan	-
West Bend	-
Madison	Middleton, Shorewood Hills, McFarland, Maple Bluff, Sun Prairie, Monona, Fitchburg
Janesville	-
Beloit	-
Kenosha	Pleasant Prairie
Racine	Elmwood Park
Milwaukee	St. Francis, Cudahy, South Milwaukee, Oak Creek, Franklin, Greenfield, Greendale, Hales Corners, West Allis, West Milwaukee, Wauwatosa, Shorewood, Glendale, Whitefish Bay, Brown Deer, Fox Point, River Hills, Bayside, Menomonee Falls, Butler, Lannon, Brookfield, Elm Grove, New Berlin, Muskego, Germantown, Mequon, Theisville, Waukesha

**Notes**

- The designated areas are based on the corporate boundaries of the city or village, not the ZIP code.
- If the emission sources of a facility are located within the corporate boundaries of an area listed in the table, the higher background concentrations should be used.
- If emission sources for a modeling analysis lay both inside and outside of an area listed in the table, the higher background concentrations should be used.

## **BACKGROUND CONCENTRATION DETERMINATION**

The work group also focused on the values used to calculate the regional background values. Previously, short-term (24-hour or less) regional background concentrations were derived from readings from individual ambient air quality monitors, using arithmetic means of three to five years of second-highest values. This method was developed years ago since the second-highest readings from a monitor were recorded and the data was easily obtained. The group concluded that these values are conservative and may not represent normal or actual background conditions within a given geographic area. Therefore, for the short-term standards, an examination of other metrics (such as the 90<sup>th</sup>, 95<sup>th</sup>, or 98<sup>th</sup> percentile of the ranked data) was performed.

Data from the years 2001 through 2006 was obtained from WDNR monitoring staff. The data was both in raw format and in statistical summary tables. The land use in the general vicinity of the monitor was provided with the data, as well as the pertinent statistics (number of observations, ranked percentiles, maximum values). In addition, WDNR monitoring staff also identified each monitor by its main monitoring objective, such as 'population exposure', 'highest concentration', and 'regional transport'.

For each pollutant, the 90<sup>th</sup>, 95<sup>th</sup>, and 98<sup>th</sup> percentile short-term values for each monitor with more than 75% data capture in one year were entered into a spreadsheet. The annual value for each monitor meeting the 75% data capture threshold was also entered. The data was organized into the monitoring objective categories of 'population exposure' and 'general/background', and into the land use categories of 'urban residential', 'suburban residential', and 'urban commercial' where applicable. In reviewing the data it was noted that many of the monitor locations were actually close to industrial facilities, regardless of the land use data category.

Due to the fact that many of the monitors were specially located close to industrial facilities, the monitored values will be higher than the concentrations in the surrounding area especially for particulate matter and carbon monoxide. Therefore, in determining the higher background concentration for the short-term TSP standard the group concluded that values should be derived from the arithmetic mean of the 95<sup>th</sup> percentile data from the 'population exposure' category. The 95<sup>th</sup> percentile was selected for these pollutants because the group concluded that the 95<sup>th</sup> percentile values eliminated more of the high concentrations that are related to a specific industrial source while still being conservative. For the short-term PM<sub>10</sub>, SO<sub>2</sub>, and CO standards the group concluded that the higher background values should be derived from the arithmetic mean of the 98<sup>th</sup> percentile data from the 'population exposure' category. The 98<sup>th</sup> percentile was selected for these pollutants because the values are equivalent to the second-highest concentrations historically used. Using the mean of multiple years of data for the monitor categories provide a representative estimate of the impact to the general population. For the annual background concentrations for PM<sub>10</sub> and SO<sub>2</sub>, the arithmetic mean of the annual impacts from the same monitors was calculated.

For the lower background concentration areas the short-term values for TSP were derived from the mean of the 95<sup>th</sup> percentile data from the 'general/background' category, while the values for CO were derived from the mean of the 95<sup>th</sup> percentile of the 'population exposure' category (there are no 'general/background' monitor locations for CO). For the short-term PM<sub>10</sub> and SO<sub>2</sub> standards the group concluded that the lower background values should be derived from the arithmetic mean of the 98<sup>th</sup> percentile data from the 'general/background' category. Using the mean of multiple years of data for the monitor categories provide a representative estimate of the general concentrations. For the annual background concentrations for PM<sub>10</sub> and SO<sub>2</sub>, the arithmetic mean of the annual impacts from the same monitors was calculated.

This procedure worked for TSP, PM<sub>10</sub>, SO<sub>2</sub>, and CO, but due to the lack of monitoring data for NO<sub>x</sub>, a slightly different method was applied to derive an annual background concentration for NO<sub>x</sub>. One year of data was available for a rural location, and two years of data were available for two locations in the City of Milwaukee. The four Milwaukee data points largely dominated this five-value mean. So five additional data values were obtained from partial years of data collected during the ozone season at sites in Dodge County. The overall average of all NO<sub>x</sub> data values was used for the higher background areas, while the single rural data point was used for the lower background areas.

Wisconsin has limited monitoring for lead (Pb), so the Monitoring Section was consulted and based on their professional judgment revised regional background concentrations were established.

Table 2 below presents the regional background concentrations for Wisconsin derived from these methods.

<b>TABLE 2</b> <b>Wisconsin Regional Background Concentrations</b> (All Concentrations in $\mu\text{g}/\text{m}^3$ )			
Pollutant	Time Period	High Value*	Low Value**
TSP	24 Hour	58.9	39.7
PM <sub>10</sub>	24 Hour	47.0	29.4
	Annual	19.9	10.1
Pb	Quarterly	0.02	0.01
SO <sub>2</sub>	3 Hour	43.2	11.8
	24 Hour	30.5	11.2
	Annual	8.6	5.4
NO <sub>x</sub>	Annual	24.1	8.0
CO	1 Hour	1,362.7	950.5
	8 Hour	1,191.2	904.7

\* Values to be used in higher background concentration areas identified in Table 1

\*\* Values to be used in lower background concentration areas (i.e. areas not listed in Table 1)

### **REGIONAL BACKGROUND IMPLEMENTATION**

These regional background concentration values will likely not be updated for several years. Budget constraints have limited the ambient monitoring network to ozone and PM<sub>2.5</sub>, and most of the TSP, PM<sub>10</sub>, SO<sub>2</sub>, and CO monitors have been removed. In the year 2016, the monitoring data through 2015 will be assessed to determine if sufficient values exist to warrant revising the background concentrations. If there is little available monitoring data, or if there are small changes in the values, background concentrations will remain unchanged.

After the 2010 U.S. Census, WDNR will review the population of the cities and villages of Wisconsin to determine if additional areas need to be included into the high background category. This review will take place in 2012, or whenever the revised Census data is readily available.

If the implementation of the PM<sub>2.5</sub> standards requires them, regional background concentration values will be determined, using the same procedures identified in this memo, for the other criteria pollutants

The background concentrations listed in Table 2 will be the values used for air dispersion modeling. WDNR will no longer consider requests for alternate regional background concentrations, unless the source has installed an ambient monitor in an appropriate location and has a minimum of two (2) full years of data. If the source has this data, WDNR will work with the source to develop source-specific background concentrations.