WDNR Dispersion Modeling Guidelines

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List of Acronyms

AAS – Ambient Air Standards
AERMIC – American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee
AERMOD – AERmic MODel
AQRV – Air Quality Related Values
BACT – Best Available Control Technology
BPIPPRM – Building Profile Input Program for PRiMe
CFR – Code of Federal Regulations
CO – Carbon Monoxide
FCP – Forest County Potowatomi
FID – Federal ID
HAP – Hazardous Air Pollutant
LAER – Lowest Achievable Emission Rate
NAAQS – National Ambient Air Quality Standard
NAD – North American Datum
NED – National Elevation Dataset
NO_X – Nitrogen Oxides
NWS – National Weather Service
Pb - Lead
$PM_{2.5}$ – Particulate Matter less than 2.5 microns in diameter
PM_{10} – Particulate Matter less than 10 microns in diameter
PSD – Prevention of Significant Deterioration
SCRAM – Support Center for Regulatory Atmospheric Modeling
SIL – Significant Impact Level
SO_2 – Sulfur Dioxide
SRP – Scientific Review Panel
SSMT – Stationary Source Modeling Team
TSP – Total Suspended Particulate
USEPA – United States Environmental Protection Agency
USGS – United States Geological Survey
UTM – Universal Transverse Mercator
VOC – Volatile Organic Compounds
WDNR – Wisconsin Department of Natural Resources

1. Introduction

Dispersion modeling is a complex process requiring guidance in order to define proper procedures. This document is intended to illustrate and explain various methodologies and guidelines concerning the atmospheric dispersion modeling performed by the Wisconsin Department of Natural Resources (WDNR). All modeling completed in the State of Wisconsin for use by WDNR should be conducted in accordance with these procedures as well as guidance contained in the Guideline on Air Quality Models, EPA document 40 CFR part 51, Appendix W.

A model is a mathematical simulation, designed to predict what can or will happen in real-world scenarios. Atmospheric dispersion modeling is useful in predicting the impact a particular facility will have with respect to a given pollutant. The major benefit of dispersion modeling is that it is an inexpensive way to assess the impact of a source. This information is vital in assessing a facility's compliance with respect to the National and State Ambient Air Quality Standards (NAAQS) and increments as well as the various Hazardous Air Pollutant (HAP) standards, both federal and state.

Dispersion modeling incorporates information about a facility, such as source parameters, facility layout information, and emission rates, along with meteorological data, in order to predict concentrations of pollutants in the vicinity of the facility. The point of highest impact is determined through the use of a receptor grid that is set up by the modeler. The pollutant concentration at the point of highest impact is added to a previously determined background concentration and then is compared to the corresponding ambient air quality standard.

For a wide range of regulatory applications in all types of terrain, including where building downwash is important, the recommended atmospheric dispersion model is AERMOD (the AERMIC Model).

2. Purpose of Modeling

Air quality dispersion modeling is performed to assess the impact of an air pollution source on the surrounding environment. The impact is quantified by predicting the concentration of the pollutant at ground level and then comparing that result to a reference level. The most commonly used reference for comparison is the NAAQS. These standards were developed by the United States Environmental Protection Agency (USEPA) to protect human health and welfare. Each standard is defined in terms of pollutant, averaging time, and a level where health is protected with an adequate margin of safety (primary standard) or a level necessary to protect public welfare from unknown or anticipated effects (secondary standard). The following Table 2.1 lists the current state and federal NAAQS (except ozone, which is not listed because air quality modeling is not done for ozone precursors, such as VOCs):

Table 2.1
National Ambient Air Quality Standards
Concentrations in µg/m^3

		Primary	Secondary
Total Suspended Particulates (TSP)*	24 hour	-	150.0
Particulate Matter < 10µ (PM_{10})	Annual	50.0	50.0
	24 hour	150.0	150.0
Particulate Matter < 2.5µ ($PM_{2.5}$)	Annual 24 hour	15.0 35.0	15.0 35.0
Sulfur Dioxide (SO_2)	Annual	80.0	-
	24 hour	365.0	-
	3 hour	-	1300.0
Nitrogen Oxide (NO_x)	Annual	100.0	100.0
Carbon Monoxide (CO)	8 hour	10000.0	10000.0
	1 hour	40000.0	40000.0
Lead (Pb)	Calendar Quarter	1.5	1.5

*Total Suspended Particulate (TSP) is a standard maintained by the State of Wisconsin (not a federal NAAQS).

According to WDNR regulations, the 24-hour PM_{10} standard is met when, "The expected number of days per calendar year with a 24-hour average concentration above 150 µg/m^3… is equal to or less than one." {s. NR 404.04(8)(b)(2), Wis. Adm. Code} For a dispersion modeling analysis containing five years of data, this means the sixth highest value over the five years, when added to the appropriate background concentration, must be below the air quality standard.

Wisconsin also maintains a 24-hour TSP standard that uses the highest of the five year's second-highest concentrations from the dispersion model to demonstrate compliance. Statistically, the high second high is the worst possible case of the sixth highest over five years, and since the standards for PM_{10} and TSP are both 150.0 µg/m^3, one analysis for PM, using TSP emission rates and the highest, second-highest concentrations, can be conducted and the same modeled impact used for both pollutants.

In May 2008, USEPA issued their final rule regarding $PM_{2.5}$. The standards are published here, but source specific modeling for $PM_{2.5}$ is not being done for regulatory purposes in the State of Wisconsin at this time. Early in 2008, DNR staff and industry representatives met to discuss the difficulties associated with modeling for $PM_{2.5}$ at this time. The industry group collaborated to produce a paper indicating that test methods for determining $PM_{2.5}$ emissions are not sophisticated enough to accurately measure $PM_{2.5}$ emissions. Further, USEPA has indicated that more information regarding $PM_{2.5}$ emission limits and modeling will be forthcoming and that Wisconsin may continue to use the PM_{10} surrogacy approach regarding $PM_{2.5}$. WDNR will use the surrogacy approach until accurate test methods have been developed to measure $PM_{2.5}$ and USEPA indicates that the surrogacy approach is no longer valid.

The other short-term (1, 3, 8, or 24 hour) standards are met when the highest of the five-year's second-highest modeled concentrations (plus background) are at or below the standard. The annual standards are met when the highest yearly impact plus background is at or below the standard.

In addition to the NAAQS, the State of Wisconsin has developed Ambient Air Standards (AAS) for hazardous air pollutants (HAPs) listed in Chapter NR 445, Wis. Adm. Code. To demonstrate compliance with the NR 445 ambient air standards, the first-highest modeled impact is compared to the AAS. Air pollution sources in Wisconsin must attain and maintain all air quality standards for HAPs.

Aside from dispersion modeling, a facility may demonstrate compliance with the air quality standards by directly sampling the air using an air quality monitor. Monitoring is the most direct method to measure the amount of pollutants in the air, but it has limitations. Monitoring is time consuming, labor intensive, costly, not predictive, and there are difficulties associated with siting monitors.

Dispersion modeling, on the other hand, is not subject to the same limitations as monitoring. Atmospheric dispersion modeling can be used for pre-construction sources to determine the potential impact a facility would have. Modeling studies can be completed relatively quickly and cost-effectively.

While monitoring does have the advantage of providing direct measurements of the ambient air, the values are for a limited number of points. As meteorological conditions change, the monitor may or may not record the maximum impact. It is also important to note that monitoring results may provide data about a number of sources, not just the one in question. A monitor cannot easily differentiate whether a particular molecule of a pollutant comes from one source or another. Modeling, however, can be done to assess the impact from one source alone. In addition, while the model results are not direct measurements, they are based on algorithms that have been verified against real-world data, such as tracer gas studies or other ambient air monitoring.

The WDNR uses dispersion modeling to assess compliance with ambient air quality standards when conducting air construction and operation permit reviews, air compliance inspections, air complaint investigations, and air spill investigations. Dispersion modeling analyses are also used to estimate risk, to prepare environmental assessments and impact statements, to develop air regulations and to select site locations for ambient air monitors.

3. When to Model

3.1 General

Air dispersion modeling is used for a variety of purposes. Generally, sources are modeled when they are applying for an air permit (construction, operation, or operation permit renewal) and must demonstrate the attainment of NAAQS, PSD Increments, and Wisconsin's ch. NR 445 and TSP standards. In addition, modeling is used to calculate ambient pollution concentrations in risk assessments or when the WDNR receives a complaint. The model results are useful in identifying the source of the emissions and in assessing the impact of the emissions from the facility being complained about.

3.2 Previous Modeling

In a memo dated October 7, 1998 (Refined Air Quality Dispersion Modeling Policy), WDNR stated that prior air quality modeling results could be used for operation permit applications when the facility has previously received an air quality permit which addresses all the same pollutants and sources in the current application, and the same physical stack parameters and emission limits will apply in the new operation permit. The memo also went on to state that if a new dispersion model is released by the USEPA that supersedes the model used in the prior analysis, the modeler and permit engineer should discuss the differences and ramifications of a new model with the company. For more information regarding the release of AERMOD and its applicability to specific permit types, see the AERMOD transition memo.

4. How to Model

The first step in air dispersion modeling for a source is first to determine the type of model that is needed. There are two basic types of dispersion models used at the WDNR. The first type is classified as a screening model, while the second type is referred to as a refined model. The classification is based on the consideration of meteorological conditions and receptor placement. Screening models search through a limited number of meteorological conditions to determine which conditions will give the highest concentration. The calculations of concentrations are only made along the plume centerline. A refined model uses historical meteorological data to give a more realistic estimate of ground level concentrations. In addition, refined models allow for calculations of concentration in two dimensions.

Screening models allow for quick analysis of impacts from a single stationary source. Since the worst-case dispersion estimates are used in the concentration calculations, screening models are generally very conservative. With that in mind, if the screening model results are below regulatory standards, the need for the more time-consuming refined modeling may be eliminated. The WDNR currently uses SCREEN3.

Refined modeling uses meteorological data gathered at or near the specified location in order to calculate pollutant concentrations surrounding a source. The concentration calculations in a refined model are done on an hourly basis using a meteorological file supplied by the user.

The meteorological variables that should be defined in the refined model include wind speed and direction, atmospheric stability, and temperature, among others. The meteorological data must meet EPA guidelines for data capture, data quality, and the inclusion of upper air data. The WDNR keeps a preprocessed set of meteorological data accessible for use with refined modeling.

On November 9, 2005 USEPA promulgated a formal change to the Guideline on Air Quality Models (40 CFR part 51, Appendix W), introducing AERMOD as the recommended atmospheric dispersion model, to become effective on December 9, 2005. On December 7, 2005, WDNR issued an AERMOD transition memo, addressing the use of AERMOD for each permit type for which modeling may be conducted.

(Guidance concerning the use of refined models will follow the section regarding screening models.)

4.1 Screening Modeling

4.1.1 Restrictions and Limitations

The first step in using a screening model is to determine whether it is appropriate for the current project. If any of the following statements are true, a refined modeling analysis should be completed.

1. The source is a PSD source (as described in ch. NR 405, Wis. Adm. Code).

2. The source is not vented to the atmosphere through a stack (see s. NR 400.02(147), Wis. Adm. Code, for definition of "stack").

3. The source is located within 5000 meters (3 miles) of a PM, SO_2, NO_x, or CO nonattainment area. The EPA recommendations for $PM_{2.5}$ designations were made and scheduled to go into effect in December 2008, but are currently being reconsidered.

4. The pollutant does not have an Ambient Air Standard (AAS) listed in Table A of ch. NR 445, Wis. Adm. Code.

5. The source is located in an area with significant topographical relief.

If a screening model is used and any of the following are true, a refined modeling analysis should be completed.

1. The pollutant is lead, and the predicted 24-hour concentration (when calculated by the SCREEN model and multiplied by the 0.4 conversion factor) exceeds 1.3 $\mu g/m^3$.

2. The source is a new source located in a baseline PSD county for the pollutant considered, and the concentration as calculated by SCREEN is greater than the Significant Impact Level (SIL) in Table 4.1, below:

Table 4.1
PSD Significant Impact Levels
Concentrations in $\mu g/m^3$

Pollutant	Time Period	Concentration
PM10	24 hour Annual	5.0 1.0
SO2	3 hour 24 hour Annual	25.0 5.0 1.0
NOx	Annual	1.0

4.1.2 SCREEN Model Input Information

The following tasks should be completed before the SCREEN model can be run:

1. Compile a list of the parameters for each stack (if there is more than one stack for the pollutant, see number two below). The required parameters are:

   Stack Height (m)
   Normal Stack Gas Exit Velocity (m/s or ACFM)
   Stack Inside Diameter (m)
   Normal Stack Gas Exit Temperature (K)
   Emission Rates (g/s)

2. If the facility has more than one stack for a particular pollutant, each stack should be modeled separately and the maximum concentrations summed together for comparison to the appropriate standards. If the total exceeds any standard, a refined analysis should be performed.

3. Determine if the source is in a RURAL or URBAN area, as defined by USEPA. The only URBAN location in Wisconsin under EPA guidelines is the central city of Milwaukee.

4. Building heights in the vicinity of the facility need to be examined to determine if the plume is affected by downwash. Building heights must be considered in relation to the building's width to determine the most significant building. To determine the controlling building, compute the effective building index (H_e) for each structure on the facility property.

   $$H_e = H_b + 1.5(L_b)$$

   Where: H_e is the effective building index
   H_b is the actual building height
   L_b is the lesser of the building height or maximum width (usually the diagonal)

   A structure influences stack dispersion if it is within a distance of five times the building height. The structure with the largest H_e is considered the controlling building. Determine the building height, the minimum building width, and the maximum building width for the controlling building. Enter the controlling building height and lateral dimensions into SCREEN3.

5. The receptors should extend beyond the point of maximum impact, so when using the automated distance array, the minimum distance should be 50 meters and the maximum distance 5000 meters.

4.1.3 Output Analysis

The maximum concentration is found in the output file created by the SCREEN model. This concentration is the maximum in a one-hour period, so it must be converted to the proper averaging period. Use the conversion factors in the following Table 4.3 (as determined by US EPA) to convert to the time period of interest:

Table 4.3
SCREEN Output Conversion Factors

To Convert to	Multiply Concentration by
3 hour	0.9
8 hour	0.7
24 hour	0.4
Annual	0.08

If lead (Pb) is being modeled, compute the 24-hour concentration using the conversion factor above. If the predicted concentration is less than or equal to 1.3 $\mu g/m^3$, no further modeling for Pb is required. If the value is higher than this, the modeling for all pollutants should be referred to the Stationary Source Modeling Team.

The total concentration is calculated by adding the screening model output to the appropriate background concentration. This calculation is not performed for HAPs, as currently there are no regional background values for HAPs, so the modeled concentration is directly compared to the standards in ch. NR 445.

4.2 Refined Modeling

The current model recommended for regulatory use is AERMOD. AERMOD handles many sources with hundreds of receptors, uses real-world preprocessed meteorological data, and accounts for building effects and terrain. When refined modeling is performed, the most current version of AERMOD found on the Support Center for Regulatory Atmospheric Modeling (SCRAM) website should be used. Any questions as to model selection should be directed to a WDNR modeler.

4.2.1 Required Information

A variety of information is needed in order to perform air quality dispersion modeling with AERMOD. When a WDNR permit writer requests modeling, the first step is to complete a modeling request form. The form, when completed, provides the modeler with all of the necessary information to complete the modeling in a timely fashion. Once the modeler has received the modeling request form and necessary information, a completeness check will be done. Within three business days, the modeler will examine the request to let the permit reviewer know if all the necessary information has been provided. In addition, the modeler will attempt to provide an approximate date of project completion.

Section 4.2.2 identifies information that is necessary for setting up and running a refined modeling analysis using AERMOD. The information is mostly applicable to permit writers at WDNR, but is presented here so that external customers understand all the information necessary for a modeling analysis.

If an applicant is performing their own modeling, they may wish to consult with WDNR prior to submittal. The consultation can include meteorological data selection and any other concerns the applicant may have. The consultation can occur via phone call or email to the appropriate regional contact, or the applicant may wish to submit a modeling protocol for WDNR review.

The accuracy and validity of the information supplied for modeling is important because it reduces multiple iterations of model runs. AERMOD can take a long time, up to several days, to execute.

To illustrate the procedures for air modeling and to provide insight into the impact of multiple modeling iterations, an example of a typical modeling project is provided here.

A dispersion modeling project is received on a Monday morning. The project contains four stacks and is located in a county with a PSD baseline. A search of the inventory uncovers two additional facilities (20 additional sources) that have to be included in the model run. Both neighboring facilities were previously modeled, but with a different dispersion model and both met the increment and NAAQS standards.

First, the three facilities are located relative to each other using aerial photographs. Sometimes the facility has been constructed prior to the photo so it is easy to find, other times the facility is located by cross streets, rail lines, etc. Second, the relative coordinates for each of the facilities are converted into UTM using on-line digital topographic maps. Most of the on-line topographic maps are over 30 years old, so many facilities and their associated roads do not appear, which can make this task difficult.

Next, the source parameters are converted from English to metric units and typed or copied into the input file, along with the source locations in UTM.

Then each of the three facilities is run through the Building Profile Input Program for PRIME (BPIPPRM). The applicant's building is measured by hand and the data is converted into UTM coordinates. The building coordinates are entered into the BPIPPRM input file. Additionally, the other two facilities that were modeled previously need to be entered into the BPIPPRM input file. Sometimes the old BPIP files are readily available and the conversion into UTM coordinates can be done easily. Other times, the old files are not available and all the building coordinates need to be remeasured.

The next step in the modeling process is to set up a receptor grid with 25-meter spacing around the facility. Generally, relative coordinates are used initially, to establish ambient air versus the company plot plan, and then converted into UTM. This data is input to an AERMAP input file along with the terrain domain, and the NED file that is used to extract elevations.

The final step is to assess what meteorological data to use. There are 22 data sets available in Wisconsin covering most of the different climate and land-use characteristics. Both the location of the facility and the surrounding land-use play a role in the station selection, and often other team members are consulted to help make a decision.

A complete input file setup with AERMOD tends to take at least an entire workday, which means that the model is often run overnight. So, in this example, the permit engineer would not be aware of any initial modeled exceedances until Tuesday morning. Then after checking their calculations and consulting with the company, it might not be until Wednesday morning that another scenario was proposed; Wednesday afternoon before those results were available; and Thursday before the final results were sent out.

It is easy to see that if a modeler is working on an average of 4 to 6 projects at one time, multiple runs for one project could severely limit work on other projects. Further, the computer is limited to running AERMOD for one project at a time and other computing capabilities such as accessing aerial photos and topographic maps are slowed dramatically when the model is running.

Accurate and valid facility data can be helpful in cutting down on the number of model runs performed for a project. So, a thorough check of data helps for a timely review.

4.2.2 Model Input Information

4.2.2.1 General

4.2.2.1.1 Permit Reviewer Information

Name of Reviewer, Date of Request Submittal, Date of Project Completion, Priority of Request

4.2.2.1.2 Company Information

Name, FID Number, Permit Number, Facility Address, City, County, Permit Contact (Name and Phone Number)

4.2.2.2 Dispersion Model and Options

4.2.2.2.1 Model Selection

Dispersion modeling projects in the State of Wisconsin are completed using AERMOD.

4.2.2.2.2 Options

The regulatory default options should be selected in the input file.

4.2.2.2.3 Dispersion Coefficients

Most locations in Wisconsin are defined as "Rural" using the Auer Land Use Method. In 2004, the modeling team conducted a land use analysis in order to identify urban locations within the state. The only "Urban" location found in Wisconsin is in the Milwaukee area. A memo and a map were prepared detailing the area. For urban locations, please use a population of 600,000 and a roughness length of 1.0 meter (in accordance with USEPA guidance).

4.2.2.3 Source Information

The following information should be provided within the modeling request:

4.2.2.3.1 Stack Parameters for All Stacks (combined parameters should not be used in the refined analysis)

- Stack height (feet or meters) as measured from ground
- Stack inside diameter (feet or meters) with an indication of whether the stack exit opening is circular or rectangular
- Normal or average stack exit flow rate (used to calculate exit velocity) with an indication of the stack orientation and obstruction status. Any stack that has a vertical orientation and has unobstructed flow (or has a rainhat that opens when there is pollutant discharge) may have exit velocity calculated and included in the modeling input files. A stack that either deviates from the vertical by more than 10 degrees and/or is obstructed will be assigned a default exit velocity of 0.10 meters per second.
- Normal or average stack gas exit temperature. "Ambient" temperature should be further clarified to represent indoor ambient conditions (~68^{o}F) or actual outdoor ambient temperature, represented in the input file by using -0.1.
- Maximum hourly emission rate in pounds per hour for all pollutants requiring modeling (requested permit limit should be modeled).

4.2.2.3.2 Plot plan identifying all locations of all stacks, all buildings (with heights and elevation differences clearly identified), true north, location of facility with respect to nearby roads or other identifying landmarks, fenceline (if applicable), and property line. Stack and building locations will be measured in Universal Transverse Mercator (UTM) North American Datum 1983 (NAD83) with true north along the y-axis. Buildings at the facility, as well as neighboring buildings that are not part of the facility should be examined to determine if they affect the source. A building influences a stack's plume if the distance from the nearest building edge to the stack is less than five times the building height. Or, all buildings at the facility and any neighboring building that may be thought to have an impact can be measured and input to the BPIPPRM (Building Profile Input Program for PRiMe). The output of BPIPPRM will include all buildings that cause downwash.

When inputting buildings to BPIPPRM, the WDNR preferred method includes entering buildings that touch as one building with different tiers. The first tier height should include the entire structure at the lowest height. Tiers should be built up on the building in ascending order.

If modeling has been completed previously in another datum (i.e. NAD27), the applicant may continue to use that datum as long as WDNR is notified. The facility should be aware that WDNR terrain data is in NAD83, so the applicant should provide all input files and be sure to verify that the terrain elevations are accurate.

4.2.2.3.3 Operating Scenarios

Examples of varying operating scenarios that may be included in the modeling request include hours of operation restrictions, stacks that do not operate simultaneously, stacks operating at varying loads, varying seasonal emission rates, or any other operational procedure varying from 100% load and 100% operation at all times. These scenarios do not have to be included in the request if the facility is not willing to have the scenarios placed in their permit, but the information may help resolve modeled exceedances.

4.2.2.4 Increment Sources

Facilities located in a county that has its PSD baseline set may need to have an increment analysis performed. Sources at a facility constructed or modified after the baseline date are subject to an increment analysis. In addition, sources (at other facilities) near the facility that have been constructed or modified after the baseline date may need to be included in an increment analysis. In general, sources within two kilometers of the facility should be included in the analysis, but any increment-consuming source that has an impact within the area of significant concentration gradient should be included in the analysis. The ambient air standards for increment analyses are included in Table 4.4. More information regarding increment analyses can be found in the PSD section of this document.

4.2.2.5 Receptor Information

Receptors should be placed where impact will be the greatest. The selection of receptor sites should be done on a case-by-case basis, taking into account the topography, climatology, proximity of neighborhoods, etc., but the resolution of the receptor grid in the area of maximum impact should be 25 meters.

4.2.2.5.1 Ambient Air

Receptors should be placed in locations such that they are measuring “ambient air” as defined by USEPA. The definition states, “the air everywhere outside of contiguous plant property to which public access is precluded by a fence or other effective physical barrier should be considered in locating receptors. Specifically, for stationary source modeling, receptors should be placed anywhere outside inaccessible plant property.” (taken from a USEPA letter from “Regional Meteorologists” to Joseph Tikvart regarding ambient air). The Wisconsin DNR SSMT has generally determined that:

A fence is any permanent, effective, physical barrier that impedes public access to a facility at all times. For refined modeling purposes, the air everywhere outside this barrier should be considered when locating receptors. For example, receptors should be included over unfenced plant property, over bodies of water, over roadways, and over property owned by other sources. Property that is not completely enclosed by a fence is considered ambient air.

It should be noted that receptor placement in the case of HAP modeling does not need to follow the fenceline guidelines, as ch. NR 445 mandates that all modeled concentrations of regulated toxics should be determined at the property line and beyond.

4.2.2.5.2 Terrain
AERMOD is specifically designed to handle the inclusion of terrain in modeling. Therefore, terrain should be used in analyses done for facilities in Wisconsin. If there are specific cases where the use of terrain is suspect, the cases should be brought to the attention of SSMT and a decision will be made regarding its use on a case-by-case basis.

Terrain data should be processed using the AERMOD terrain processor, AERMAP, according to the procedures described in the AERMAP user's guide.

In February 2009, USEPA released an updated version of AERMAP, which incorporated the use of the USGS National Elevation Dataset (NED). The dataset has been developed by merging the best quality elevation data into a seamless raster format. This is a significant improvement on the Digital Elevation Model (DEM) data. Additionally, USEPA has indicated that NED should be used when processing terrain with AERMAP, so WDNR will only accept the use of NED derived terrain elevations.

All modeling projects submitted to WDNR or completed by WDNR will be analyzed using NED derived terrain elevations. Previously completed modeling work will not be redone, but the facility will be updated using the NED data when it comes in for permit work.

NED information can be found on the USGS website at ned.usgs.gov. The data is updated periodically, so it is recommended that new data be downloaded for each project in areas of complex terrain. At this time, WDNR recommends the use of the 1-arc-second resolution.

4.2.2.6 Meteorological Data
In the AERMOD Implementation Guide, USEPA addresses the selection of surface characteristics for facilities. The guide stresses the importance of using surface characteristics specific to the meteorological instrumentation location, not the source site. WDNR has processed many sets of NWS meteorological data for use in AERMOD. The AERMOD implementation guide suggests that if the "nearest NWS meteorological site's surface characteristics are determined to NOT be representative of the application site, it may be possible that another nearby NWS site may be representative of both weather parameters and surface characteristics." WDNR agrees with this position and suggests the use of the preprocessed meteorological data provided by WDNR. If a situation arises where site-specific meteorological data may

be warranted, the applicant should contact WDNR before proceeding in order to determine a protocol for assembling the meteorological data prior to any modeling submittals. When using the preprocessed NWS meteorological data, WDNR requires running the five consecutive meteorological data years for each applicable pollutant. The WDNR preprocessed meteorological data is available from the Stationary Source Modeling website. If an applicant is performing modeling and is unsure which meteorological data set to use, the applicant should contact the appropriate WDNR regional contact.

For an in-depth guide to the use of AERMOD and related programs, please see the USEPA SCRAM website.

4.3 Types of Dispersion Modeling Analyses

The number and types of sources that should be included in modeling vary according to the type of project. The following descriptions of project types are intended to assist in understanding how the modeling analysis is done, as well as to aid the permit writer in preparing the modeling request properly.

4.3.1 Prevention of Significant Deterioration (PSD) Sources

The PSD regulations were devised to be more restrictive than the federal AAQS in order to permit “economic growth in a manner consistent with the preservation of existing clean air resources…in areas such as national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historic value” (Clean Air Act, 1990). There are two classes of PSD areas in Wisconsin for PM_{10}, SO_2, and NO_x. (Ch. NR 404.05). The two categories are designated Class I and Class II.

Congress specified the initial classification of lands for PSD purposes in the Clean Air Act Amendments of 1977. Class I lands are those where the existing good air quality is determined to be of national importance. Class I areas may not be reclassified. These mandatory Class I areas include all international parks, national memorial parks larger than 5,000 acres, and national parks larger than 6,000 acres that were in existence when the Amendments were passed. All other areas to which the PSD provisions apply were classified as Class II.

Class I areas are the most stringently regulated as these are generally locations that have remained untouched by development. The State of Wisconsin has one federal Class I Area and one tribal Class I Area. The federal Class I Area is the Rainbow Lake Class I Area. Rainbow Lake and Bradwell Bay Wildlife Area in Florida are unique among the PSD Class I areas. Both are specified in the USEPA New Source Review Workshop Manual as areas where visibility is not recommended as an important value. Consequently, air quality modeling that considers Rainbow Lake does not have to include an air quality visibility analysis.

Any PSD source that locates within 50 kilometers of the Rainbow Lake Class I area must perform a significance analysis for the increase in emissions. In this analysis, the first highest concentration for each time period is compared to the Class I significant impact level (SIL). If the impact of the increase in emissions is less than the SILs for all pollutants, then no further analysis on Rainbow Lake is required.

In addition, any PSD source that locates within 200 kilometers of a Class I Area, must notify the applicable Federal Land Manager (FLM). For information regarding a facility’s proximity to Class I Areas, please click on the following memo and map for more information.

Effective May 29, 2008 a portion of the Forest County Potawatomi Community (FCP) Reservation was designated as a tribal Class I Area under the Prevention of Significant Deterioration (PSD) rules. The State of Wisconsin negotiated an agreement with FCP that provides the framework for establishing implementation of the Class I area. According to the agreement:

- All proposed PSD permits from facilities located within a ten (10) mile radius of the Class I area are subject to an increment analysis and consumption requirements using Class I standards.

- All proposed PSD permits from facilities located outside the 10-mile radius are subject to an increment analysis and consumption requirements using Class 2 standards, as per standard practice.

The FCP Tribe has defined aquatic systems and water quality as AQRV's (Air Quality Related Values). The Tribe has identified that acidic deposition and metals deposition (including mercury) have the potential to adversely affect these AQRV's. Until threshold effects have been established, a Scientific Review Panel (SRP) has the authority to determine if adverse impacts may occur. The SRP will be established jointly by the State and the Tribe to review analyses and resolve disputes.

According to the 1999 Memorandum of Agreement between the FCP Community and the State of Wisconsin:

- All proposed PSD permits from facilities located within a sixty-two (62) mile radius of the Class I area are subject to an AQRV effects analysis. The Tribe is responsible for performing the analysis, but may request the State to require the permit applicant to perform the analysis as part of a complete application. In either event, the permit applicant is required to provide all information necessary to conduct or review an AQRV effects analysis.

The provisions of the agreement may change in the future, and the Bureau of Air Management should be contacted to confirm current policy.

The FCP Class I area as defined by USEPA on May 29, 2008 and the 10-mile and 62-mile boundaries as tentatively established are shown in the map. Until the areas are agreed to by both parties, please contact the Bureau of Air Management to confirm the current designations.

New sources that exceed major source thresholds in attainment counties require a PSD permit review (Ch. NR405.02 (22)). Before PSD application submittal to the Department, the applicant should provide a modeling protocol, outlining any assumptions and data used in the modeling analysis. Questions regarding proper protocol submittal should be directed to the Stationary Source Modeling Team.

As part of the dispersion modeling analysis for a PSD permit, the new or modified source(s) and any ancillary changes will be modeled alone to assess the significance of its modeled impact. The modeling will include credit for emissions permanently removed as part of the construction or modification. If the impact of the new and/or modified source's permit allowable or voluntarily accepted emission rates (including fugitive dust and any other quantifiable sources) is less than 75% of the PSD Significant Impact Levels (SIL) then no further modeling is necessary for the current project. In addition, the facility must also have hazardous air pollutant emissions below the threshold values in Tables A, B, and C in s. NR 445.07, Wis. Adm. Code.

If the project impact is above 75% of any SIL, or if the emission rates exceed the threshold levels values in Tables A, B, and C in s. NR 445.07, Wis. Adm. Code, then a full review of increment and all applicable air quality standards will be performed. Although not required, it is strongly recommended that the applicant supply the full analysis to expedite the modeling process. If the source does not submit a full review of increment and applicable standards, and the impact of the new and modified sources is above 75% of any SIL but less than 100% of any SIL, WDNR will perform the full analysis.

If the facility's impact is greater than the SIL, then an increment analysis should be performed. The increment analysis should consider all sources at the facility that contribute to the PSD increment, which includes all new sources, as well as any sources on site that were installed after the PSD baseline was set. Additional increment-consuming sources that have an impact within the area of significant concentration gradient should also be included. In general, this distance is at least 2 kilometers from the source requesting a permit, but may vary due to the nature of the sources in the area. For example, a small facility 2 kilometers away may have less of an impact than a large facility 2 kilometers away.

The modeled concentration for each applicable baseline pollutant is compared to the increment consumption value for the type of PSD area involved in the analysis. Background concentrations are not added to the modeled concentration when being compared to the increment. The PSD increments for Class I and Class II areas, as well as the significant impact levels are included below in Table 4.4:

Table 4.4
PSD Class I and Class II Increments

Pollutant	Averaging Time	Class I Increment	Class II Increment	Class I SIL	Class II SIL
		(µg/m³)	(µg/m³)	(µg/m³)	(µg/m³)
Sulfur Dioxide (SO_2)	3 hour 24 hour Annual	25 5 2	512 91 20	1.2 0.3 0.1	25 5 1
Particulate Matter (PM_{10})	24 hour Annual	8 4	30 17	1.3 0.2	5 1
Nitrogen Oxide (NO_x)	Annual	2.5	25	0.1	1

CC

The total impact of the new or modified sources along with any additional increment consuming sources may not consume more than the increment in order to be approvable.

Another portion of the PSD review is the NAAQS analysis. Any proposed facility that has an impact above the SIL as defined above, must have an NAAQS analysis performed for that pollutant. This analysis will contain all the emission sources at the facility, as well as all emission sources at all nearby facilities.
If the facility applying for a PSD permit already has an operation permit that contains a Compliance Schedule, please refer to the "Special Cases" section for information.

4.3.2 Minor New Source Review (NSR)

The new or modified source(s) and any ancillary changes will be modeled alone to assess the significance of its modeled impact. The modeling will include credit for emissions permanently removed as part of the construction or modification. If the impact of the new or modified source's permit allowable or voluntarily accepted emission rates is below the PSD Significant Impact Levels (SIL) for all pollutants, then no further modeling is necessary for the current project. The facility must also have hazardous air pollutant emissions below the threshold values in Tables A, B, and C in s. NR 445.07, Wis. Adm. Code. This SIL analysis can be performed by the WDNR or the facility. If the facility performs the analysis, WDNR will review the SIL modeling if the impacts are more than 75% of any SIL.

If the SIL analysis shows impacts above the SILs, or if the emission rates exceed the threshold levels values in Tables A, B, and C in s. NR 445.07, Wis. Adm. Code then a full review of increment and all applicable air quality standards will be performed.

4.3.3 Operation Permits Issuance, Revision, or Renewals

Initial issuance of any type of operation permit, will require a full modeling analysis of the permit allowable or voluntarily accepted emission rates for all pollutants. The analysis will include comparisons to increments, ambient air standards, and ch. NR 445 standards. If a revision to the operation permit (including a revision to a construction permit, where the construction permit and operation permit are issued concurrently) is necessary and if it is determined that the changes associated with the revision will affect dispersion, a full dispersion modeling analysis will be performed similar to that performed for initial issuance. Operation permit renewals where the facility has made no changes to emission rates or no changes that adversely affect dispersion will not require modeling.

If a modeling analysis is necessary for an operation permit issuance, revision, or renewal, the source can submit an analysis, but WDNR will perform an independent modeling review.

4.3.4 Nonattainment Area Analyses

The ozone nonattainment areas in Wisconsin are not addressed in dispersion modeling performed by SSMT. Details for modeling within the proposed $PM_{2.5}$ nonattainment areas within Wisconsin have not been established as of this publication. Please consult with a modeling team member for the latest information.

4.4 Special Cases

4.4.1 Fugitive Dust

All PSD applications submitted to WDNR should include fugitive dust modeling including an assessment of the impact compared to the SIL. This includes modeling for unpaved roads, coal piles, and other emissions that are not vented, but rather dispersed naturally. The process fugitive emissions should be parameterized as either volume or area sources, according to how the emissions are generated. For example, if the emissions are from the surface of a clarifying pond, then an area source should be used. If the emissions are from indoor processes that are exhausted to the atmosphere through open windows and doors, then a volume source (or several volume sources) should be used. If the building has many powered roof vents that keep the air flowing into the building at ground level, then each vent should be modeled as a point source if the stack parameters are known or as an elevated area source if the vent parameters are unknown.

For roadway dust generated by vehicle traffic, a series of volume sources separated according to USEPA guidance for line sources should be modeled. Generally, one-meter source heights are used, with the initial vertical term representative of the size of the vehicle tire. For fugitive dust emissions from storage piles, either volume sources or elevated area sources with initial vertical terms can be used, depending on the configuration of the piles. In either case, the source height should be set to one-half the normal height of the pile. The wind-generated emissions from the pile can also be modified in the modeling run using the STAR flag on the EMISFACT keyword.

Non-PSD fugitive sources are not usually modeled by WDNR, but such an analysis could be performed should it be requested by the permit review engineer or an air management supervisor.

4.4.2 Fugitive Emissions

There are fugitive emissions that should be modeled for all types of permit analyses. These include emissions that are created within a facility building that are not vented directly to a stack and small emission units that are grouped together in the permit. Also, if the emissions are reasonably ducted to and emitted from an opening, then they are not fugitive. Examples include natural gas heaters with roof vents, foundry furnaces, and dip tanks vented to general building ventilation. These types of sources should be submitted in the modeling request.

4.4.3 Toxic Modeling

Hazardous air pollutants (HAPs) are regulated both for their short term (acute) and long term (chronic) effects. People exposed to toxic air pollutants at sufficient concentrations and durations may have an increased chance of getting cancer or experiencing other serious health effects. These health effects can include damage to the immune system, or neurological, reproductive (e.g., reduced fertility), developmental, respiratory and other health problems. Wisconsin regulates several hundred toxic air pollutants under ch. NR 445, Wis. Adm. Code (PDF, exit DNR). WDNR has compiled a table of the various regulated compounds, sortable by name or Chemical Abstracts Service (CAS) number.

There are a number of ways for a facility with toxic emissions to show compliance with ch. NR 445. One way to show NR 445 compliance is to use the table threshold values. Columns (c), (d), (e), and (f) of Table A in s. NR 445.07(6), Wis. Adm. Code, are emission thresholds for different stack height categories and are expressed in pounds per time period. The thresholds act as triggers to determine what a facility would need to do in order to demonstrate compliance. A source with non-exempt, potential emissions equal to or less than the threshold values for the respective stack heights does not need to do anything further under the rule. A source with non-exempt potential emissions greater than the threshold values for the respective stack height may need to explore modeling as a means of demonstrating compliance.

Modeling for HAPs is done using the same methodology as for criteria pollutants, with the only exceptions being that the ambient air (for a HAP analysis) begins at the property line, and the first highest modeled impact is compared to the appropriate standard.

4.4.3.1 Cancer Causing HAPs

Many compounds regulated by the WDNR are thought to cause cancer in humans. These compounds do not have an Ambient Air Standard (AAS). Rather, they are listed as a Best Available Control Technology (BACT) or Lowest Achievable Emission Rate (LAER) compound. Cancer causing compounds can be modeled in order to determine their inhalation risk. All non-exempt emissions should be included in HAP modeling. The modeled concentration is multiplied by the risk factor found in the WDNR compiled HAP table. If the risk is calculated at one in a million or less, the facility has demonstrated compliance with ch. NR 445. If the facility cannot meet threshold emission levels, and cannot demonstrate compliance through modeling (at the one in a million level), they will need to explore other options such as a multi-pollutant inhalation risk analysis, or requesting a toxic BACT or LAER analysis.

4.4.3.2 Non-Cancer Causing HAPs

Many of the compounds regulated by WDNR are not thought to cause cancer. These types of HAPs will have an AAS found in column (g) of Table A in s. NR 445.07(6), Wis. Adm. Code. If a facility needs to model a non-cancer causing HAP, the modeled concentration (first highest value for corresponding time period) can be compared to the AAS.

4.4.4 Facilities with Compliance Plans

Occasionally, a facility with an operation permit that contains a Compliance Schedule will want to obtain a PSD permit for construction of a new source. In order for the modelers to assess the facility at the time of the application, it may be necessary for the facility to supply updated information as to the status of the changes made to come into compliance. As changes are made to the facility and information is subsequently supplied to the SSMT, the facility can be modeled to take the changes into account.

4.4.5 Emergency Generators

Any emergency generators (link is to document describing WDNR emergency generator modeling and permitting) at a facility that emit at levels above permit inclusion thresholds should be included in a permit review/modeling request. Often when these units are modeled assuming 24 hours per day operation, they contribute heavily to a predicted exceedance. In order to increase the efficiency of permit issuance, emergency generators can be reviewed according to their typical operating scenario (i.e. when tested). The normal hourly restrictions from these tests can be placed into the permit. In the event of an outage or true emergency event, in which the facility would need to operate the generator for a longer period of time, the facility would need to notify WDNR (Section NR 436.03(2) (c), Wis. Adm. Code).

4.4.6 Flares

In accordance with EPA policy, WDNR models flares using the following methodology:
Height of stack = Height of stack
Temperature = 1273K
Exit Velocity = 20 m/s
Diameter = 9.88e-4$(Q_H)^{0.5}$
Where Q_H = 0.45(H)
And H = total heat release rate in cal/sec

4.4.7 Flagpole Receptors

Within the dispersion model, receptors can be assumed to be at ground level, or above the terrain as if set on a pole. These are known as flagpole receptors. USEPA has indicated that flagpole receptors are not acceptable for use in regulatory (permit) applications. Flagpole receptors should only be used on a case-by-case basis for model evaluation purposes. It is both the convention and the default mode to assume a height of zero meters above ground to represent ambient air. This convention should be followed for regulatory modeling purposes.

4.5 Model Output Analysis

When using NWS preprocessed meteorological data, refined modeling analyses should be completed using all five years of sequential meteorological data. All concentrations calculated by the model are based on a one-hour value averaged over the requisite time period. The modeled concentrations are then compared to the appropriate standard. The monthly, quarterly, and annual standards, PSD increments, and all AAS may never be exceeded, so the first highest value is examined for making the comparison. The short-term NAAQS standards (1 hour, 3 hour, 8 hour, and 24 hour) may be exceeded once per calendar year, so modeled results are given as the highest of the five second-highest values from the five years of meteorological data (i.e. one value per year).

4.5.1 NO_2 Output Analysis

The USEPA Guideline on Air Quality Models suggests a multi-tiered screening approach for estimating an annual NO_2 value. This approach uses an assumption that only a portion of the NO_x is converted to NO_2.

Tier 1 involves using the appropriate Gaussian model to estimate the maximum annual average concentration. A total conversion of NO_x to NO_2 assumed. If the concentration exceeds the NAAQS and/or PSD increments, then the modeler is to proceed to the second tier, using the Ambient Ratio Method as allowed by USEPA in March of 2002 to be applied during Significant Impact Level analyses.

Tier 2 (Ambient Ratio Method) consists of multiplying the Tier 1 estimate by an empirically derived NO_2 / NO_x value of 0.75. This value is the national default ratio of NO_2 conversion from NO_x.
If Tier 2 is applied and the facility is found to pass the NO_2 standard, no further analysis is necessary.

4.5.2 Background Concentrations

Before the model output can be compared to the ambient standard, a regional background concentration must be added. The purpose of using a background value is to assess the total impact on human health by examining all sources of air contaminants, including those sources that are not modeled, but exist within the region. Examples of sources included in the background concentration are other point sources, mobile sources, other fugitive sources, and fugitive dust from a number of sources including but not limited to coal piles and roadways. Background concentrations are derived from several years of actual monitoring data collected at sites around the state. In order to ensure that the numbers are as accurate as possible, the monitors are situated such that they are not directly affected by a particular source. The background values are added to the modeled concentration in order to determine the maximum impact. Background concentrations are not used in an increment analysis.

The background approach used by WDNR was recently redeveloped. Where backgrounds used to be assigned on a county basis, they are now determined based on metropolitan statistical area. For more information, and the see the current background concentrations read the following memo.

4.5.3 Reducing Impact

Once the appropriate background value has been added to the modeled concentration, the total is compared to the NAAQS standards. If the maximum modeled impact is greater than the NAAQS, then the permit applicant may want to explore opportunities to reduce the impact. A list of some options is included below.

1. **Emission Rate:** The most logical place (from a modeling standpoint) to begin is with a reduction in the emission rate. The following is the Gaussian dispersion equation upon which dispersion models are based.

   $$C\,(x,y,z;H) = \frac{QVD}{2\pi u_s \sigma_y \sigma_z} \exp[-0.5(y/\sigma y)^2]$$

   The concentration, C, is directly proportional to the emission rate, Q. The relationship between the two guarantees that the most direct way to reduce the impact of a source is to reduce the emissions. So the logical place for a permit reviewer to start would be to double check emission estimates. If emission factors were used, perhaps there is stack test data that is more accurate than emission factors. Also, any conservative safety factors put into the rate calculation should be reviewed or reduced. In addition, there may by opportunities for emission reductions that the permit reviewer could explore by having the source adjust fuels or material input.

2. **Check Stack Parameters:** The second recommendation is to verify the accuracy of the stack parameters and confirm whether a fence exists. In many cases, the fence line has not been noted on the plot plan and so is not taken into account in the modeling. If a plot showing the position of the fence can be provided, this information can be included in the modeling and can make a large difference.

3. **Review Plot Plan and Building Heights:** The next recommendation is to thoroughly review the plot plan and accurately label all building tier heights, both at the eave and the peak. AERMOD is sensitive to building effects, so providing building heights as the structure was actually built helps insure the accuracy of the analysis.

4. **Obstruction/Orientation Status:** Another way to reduce concentrations is to alter the characteristics of the exit gas itself. Vertical and unobstructed stacks provide the

best dispersion, so removal of rain-hats and turning horizontal discharges upward can make a difference in modeled impacts.

5. **Operational Restrictions:** A possible way to reduce a facility's modeled impact is to limit the hours that a piece of equipment can operate. The information necessary for modeling depends on what is being modeled. For example, if the pollutant of concern is NO_x, the annual limit is the only piece of information that is necessary. The modelers will scale the emission rate based on the annual limit.

   If the pollutant of concern has a short term standard (24 hour, 8 hour, 3 hour, 1 hour), the approach is more involved than for the annual standard. The facility can choose to supply a general limit (i.e. 16 hours per day), or a limit for a specified set of hours (i.e. 6 AM to 6 PM). The general limit involves more testing because every set of consecutive hours will be checked, but it allows the most flexibility for the company. Since there is more work for the modeler, the general limit takes more time to execute. The specific limit is much easier and quicker to set up and run in the model, but requires the company to more carefully watch their hours of operation.

   The hours of operation limitation can be helpful to companies trying to pass modeling and often allows them to take advantage of an operational reality. For example, companies located within cities might not be allowed to operate during the nighttime hours because of local ordinances. Other facilities may only run two shifts during the day. These types of operating scenarios can be run in the model with minimal effort.

   It is also possible to set up modeling that varies according to the time of day or time of year. For example, equipment at a facility that is only operated during the summer months can be examined as such within the model. Emission rates can be varied by season as well, for equipment that is run more during one season than another. Equipment that is operated at one rate during the morning hours and a different rate during the rest of the day can also be examined within the model.

6. **Process Operation Restrictions:** Limiting the number of processes that can operate at one time can also impact the modeling in a way that might benefit a facility. Many facilities have processes that cannot or will not operate at the same time. Often, a company will have multiple boilers, but will not operate them all at once. The modelers can set up scenarios within a model run that can look at different operational circumstances. The time needed to perform this task is minimal because the scenarios can be input to one file, so results can be collected with one model run.

   Other times, a company has a piece of equipment that cannot operate at the same time as another piece of equipment, or that operates at a lower level of emissions. These are also scenarios that can be input to the model, especially in the situation where one stack emits at a lower emission rate when something else is in use. If the modelers are provided with all possible scenarios, the model inputs can be set up to verify that all scenarios are able to meet applicable standards.

7. **Raise Stacks:** Another way to mitigate an exceedance is by raising the stack. Increasing the stack height physically moves the emissions further from the ground. It also reduces the downwash effects of nearby buildings. The amount of height increase required to reduce concentration depends on a number of factors including stack gas exit velocity and temperature, nearby building heights, and the physical layout of the facility. No standard ratio can be used, which means that each new scenario must be remodeled.

8. **Load Analysis:** Occasionally, facilities disagree with the use of maximum emissions and normal flow in modeling. If a facility would like to consider the maximum flow and temperature along with the maximum emissions, it will be necessary for the facility and the permit engineer to provide the corresponding information for varying loads, so that a load analysis can be performed. Standard modeling practices avoid this by using the normal flow and temperature along with the maximum emissions, thus encompassing all possible operating scenarios. Consult a modeling team member for more information on the requirements, as they can vary slightly based on the process in question.

There are a variety of creative ways a model run can be set up to help a company determine whether sources will meet air quality standards. If other scenarios come to mind that are not listed here, please consult a WNDR modeler for assistance.

5. Staff Contacts

For any questions related to modeling, please contact one of the WDNR modelers listed below. The contacts are assigned to regions, so for questions specific to a particular region, please contact the appropriate person.

Northeast - John Roth (SSMT leader) – 608 267-0803
Northern – Jeff Sims – 608 266-0151
West Central – Jeff Sims – 608 266-0151
Southeast – Gail Good – 608 267-0803
South Central – Gail Good – 608 267-0803