Particulate Matter Less Than Two and One Half Microns ($PM_{2.5}$) consists of particles that are less than two and one half microns in diameter. $PM_{2.5}$ is generated from various sources including the combustion of fuel, fires, industrial processes and vehicles.

In the Federal Register Notice dated January 15, 2013, the Environmental Protection Agency strengthened the existing primary $PM_{2.5}$ NAAQS through the establishment of a lower annual standard of 12μg/m^3 (existing standard is 15 μg/m^3). The 24-hour NAAQS was retained at 35 μg/m^3; a value that was established on September 21, 2006. Unlike the annual NAAQS, the 24-hour standard is a statistical standard that is based upon the three-year average of the 98th percentile of the 24-hour average concentrations, refer to Table 1.

Table 1
$PM_{2.5}$ NAAQS

Pollutant	Averaging Time	NAAQS	Comment
		(μg/m^3)	
$PM_{2.5}$	24-Hour	35.0	3-year average of the 98th percentile of the annual distribution of the daily maximum concentrations
$PM_{2.5}$	Annual	12.0	3-year average of the highest annual values

$PM_{2.5}$ can be directly emitted or secondarily formed in the atmosphere and is generated from various sources including the combustion of fuel, fires, industrial processes and vehicle emissions. $PM_{2.5}$ that is directly emitted as a solid or a liquid is defined as filterable particulate matter. Particulate matter that is released as a vapor and condenses to form a solid or liquid particle is defined as condensable particulate matter. Primary $PM_{2.5}$ calculations should include both filterable and condensable particles.

IMPORTANT! **All** permit applicants that trigger a full impact analysis for $PM_{2.5}$ must demonstrate compliance with the NAAQS based upon the total amount of particulate matter that is emitted from the facility (primary $PM_{2.5}$), including the condensable fraction.

Additionally, because $PM_{2.5}$ can form in the presences of precursor emissions, such as nitrogen oxides (NO_X) and sulfur dioxide (SO_2) **all Section 8**, major source permit applicants must determine if a secondary impact assessment is necessary.

Information regarding the air quality analysis for primary $PM_{2.5}$ should follow the procedures outlined in 40 CFR Part 51, Appendix W. A brief description of the requirements can be found under the following heading "Primary $PM_{2.5}$ NAAQS Compliance Demonstration" within this document. Details concerning the secondary formation of $PM_{2.5}$ can also be found under the heading entitled "Secondary $PM_{2.5}$ NAAQS Compliance Demonstrations for Major Source Permit Applications."

Primary $PM_{2.5}$ NAAQS Compliance Demonstration

The annual NAAQS for $PM_{2.5}$ is based upon the multiyear average of the maximum annual concentrations that are predicted to occur at each receptor within the modeling domain across the five year period under consideration. For NAAQS compliance purposes, the monitored design value should be added to the five year average of the maximum annual concentrations and compared to the NAAQS of 12.0 $\mu g/m^3$.

For the 24-hour averaging period, Table 1 displays the actual form of the standard where monitored compliance with the 24-hour NAAQS is demonstrated when the three-year average of the 98th percentile of the 24-hour concentrations are less than 35.0 $\mu g/m^3$. In order to demonstrate modeled compliance, the applicant must show that the 5-year average of the 98th percentile of the daily maximum concentrations is less than 35 $\mu g/m^3$. It should be noted that the modeled compliance demonstration is based upon a five-year average, rather than the 3-year average noted in Table 1. For modeling purposes, Section 8.3.1.2 of Appendix W to Part 51 states "[T]he use of 5 years of NWS [National Weather Service] meteorological data or at least 1 year of site specific data is required." The Environmental Protection Agency has indicated that the use of the five years of data does not result in biased model results and should be used for NAAQS compliance purposes, refer to the draft March 4, 2013 guidance document entitled "Draft Guidance for $PM_{2.5}$ Permit Modeling."

Based upon the form of the 24-hour standard, the modeled design value is the five year average of the eighth highest, daily maximum, 24-hour concentrations. For NAAQS compliance purposes, the 24-hour monitored design value should be added to the 98th percentile of the five year average of the maximum 24-hour concentrations and compared to the NAAQS of 35.0 $\mu g/m^3$.

If the predicted impact due to the proposed source, interactive sources and the monitored background value is below the NAAQS for each applicable averaging period, compliance has been demonstrated and no further analysis for the primary $PM_{2.5}$ NAAQS will be necessary. Again, it is important to note that the inclusion of secondarily formed $PM_{2.5}$ is required for Section 8, major source applications. Section 5, *de minimis* permit applications and Section 6, minor source permit applications do not have to include a secondary impact analysis.

If violations of the 24-hour $PM_{2.5}$ NAAQS are predicted to occur at one or more receptors, the applicant will be required to determine if the proposed project or modification has a significant ambient impact. If the source can demonstrate that it does not have a significant impact on a violating receptor(s), measured in time and space, a permit can be issued without further review of the standards. If the source cannot demonstrate less than significant impacts, the facility must consider emission limits, the installation of controls or other measures in order to reduce its ambient impact at violating receptors.

For the annual averaging period, the proposed project cannot significantly impact a violation. If annual violations are predicted to occur and the applicant has a significant annual impact, a construction permit cannot be issued. If insignificant ambient impacts are predicted to occur on a violating receptor, no further analysis is necessary for the annual averaging period. In order to determine if a significant impact has taken place on an annual basis, the five year average of the maximum annual concentrations

from the NAAQS analysis should be compared to the five year average of the maximum annual concentrations from the significant impact analysis.

The determination of significant impact for the 24-hour averaging period is similar to the annual averaging period and should include a comparison of the five year average of the maximum 24-hour concentrations from the NAAQS analysis versus the five year average of the maximum 24-hour concentrations from the significant impact analysis.

IMPORTANT! If the difference between the NAAQS and the monitored background number is less than the significant impact level, the applicant will not be able to conduct a significant impact determination as described in the previous paragraphs. In those instances, the applicant will be required to take limits and/or add controls in order to demonstrate compliance with the NAAQS.

The following paragraphs provide a hypothetical example of a NAAQS evaluation for primary $PM_{2.5}$. The data describes a basic situation and is not meant to address all modeling scenarios and/or issues that might arise during the review process.

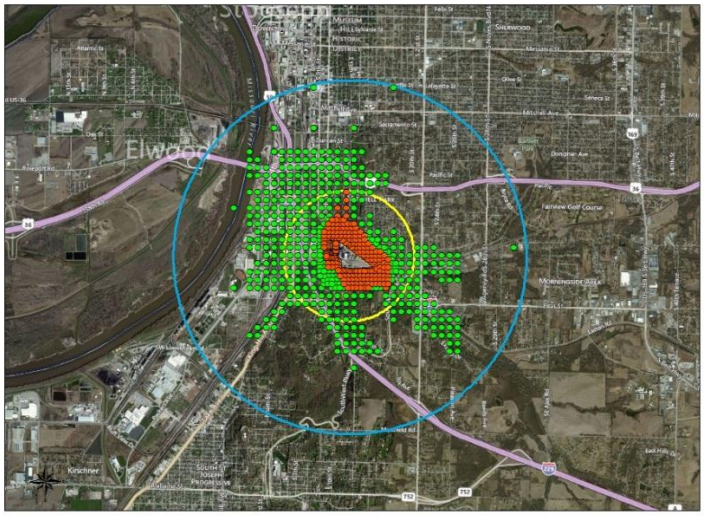
Example NAAQS Demonstration-Primary $PM_{2.5}$

Facility A is proposing to install a food processing facility at an existing site. Based upon the emissions from the worst case operating load, the preliminary impact analysis (project emissions only), indicates that Facility A's radius of impact extends 2.18-kilometers beyond the center of the proposed facility, refer to Figure 1.

Because the ambient impact due to the proposed construction exceeds the 24-hour and annual significant impact thresholds of 1.2 $\mu g/m^3$ and 0.3 $\mu g/m^3$, a full impact analysis is required and must include an evaluation of compliance with the NAAQS.

As noted in the introduction, NAAQS compliance is based upon the impact due to the combination of the emissions from the proposed source, existing "interactive" sources and monitored background concentrations. In order to determine the impact due to the proposed source and interactive sources, the emissions from Facility A and existing $PM_{2.5}$ sources were explicitly modeled. The monitored background value was obtained from a representative monitoring site.

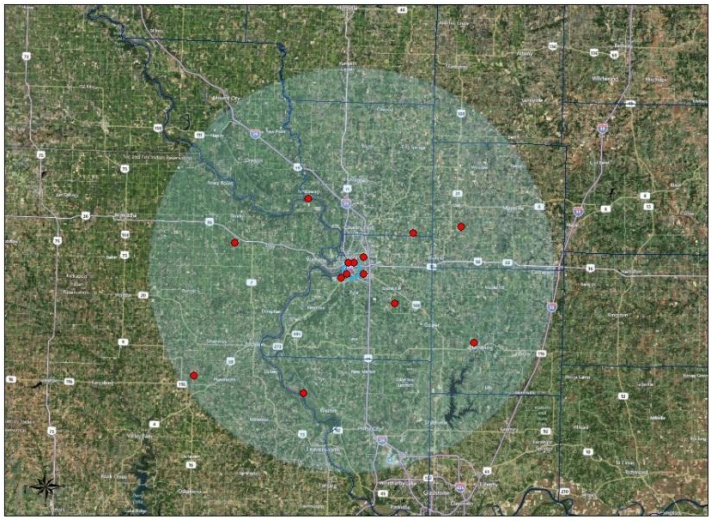
Figure 1
$PM_{2.5}$ Significant Impact Determination
24-Hour and Annual Significant Impact Comparison



Legend
24-Hour Significant Impact Receptor | 24-Hour Radius of Impact | Annual Radius of Impact | Annual Significant Impact Receptor | Property Boundary

The radius of impact due to the proposed project determined what sources were explicitly modeled for compliance purposes. Facility A is undergoing a Prevention of Significant Deterioration (PSD) review and, as such, the air quality analysis considered any emission source that could significantly impact the air quality within the region of Facility A, i.e. 50-kilometers beyond the furthest extent of the significant impact area, refer to Figure 2.

Figure 2
$PM_{2.5}$ Prevention of Significant Deterioration Domain
Interactive Source Inventory Development



Legend
Interactive Source Inventory | Facility Radius of Impact | 50-Kilometer PSD Domain | Property Boundary

Emission rates and release parameters for each source within the inventory were input into the air quality model. The combined ambient impact due to the modeled sources were calculated and output on a receptor by receptor basis for use in the compliance demonstration. It is important to note that the model outputs do not include the monitored background concentration; this value must be added to the model predictions prior to determining compliance with the NAAQS. As previously noted, the background concentrations are based upon the design value for each averaging period. Table 2 contains the model outputs for a sampling of receptors that were evaluated for this example.

Table 2
$PM_{2.5}$ NAAQS Compliance Determination

Easting (Meters)	Northing (Meters)	Elevation (Meters)	Hill (Meters)	2003 ($\mu g/m^3$) (H1H)	2004 ($\mu g/m^3$) (H1H)	2005 ($\mu g/m^3$) (H1H)	2006 ($\mu g/m^3$) (H1H)	2007 ($\mu g/m^3$) (H1H)	5-Yr Average ($\mu g/m^3$) (Average)	Background ($\mu g/m^3$) (Monitored)	NAAQS ($\mu g/m^3$) (Average)
24-Hour Averaging Period (NAAQS = 35 $\mu g/m^3$)											
341400.00	4400600.00	253.20	253.20	34.31	32.50	39.53	39.32	39.99	37.13	19.50	56.63
347500.00	4399500.00	291.10	291.10	16.81	22.01	34.01	38.19	34.34	29.07	19.50	48.57
340900.00	4400100.00	250.00	250.00	14.72	15.96	20.59	23.44	21.10	19.16	19.50	38.66
338500.00	4398500.00	244.00	244.00	18.83	19.75	21.61	19.76	18.05	19.60	19.50	39.10
340900.00	4400200.00	251.60	251.60	8.40	9.15	13.76	12.71	11.47	11.10	19.50	30.60
347500.00	4400000.00	287.90	287.90	7.26	7.25	13.72	11.99	10.33	10.11	19.50	29.61
341000.00	4403000.00	253.70	253.70	5.73	5.71	5.81	7.11	7.32	6.34	19.50	25.84
341000.00	4403500.00	260.80	260.80	4.58	4.37	7.28	6.20	5.27	5.54	19.50	25.04
339500.00	4399000.00	249.80	249.80	5.00	5.66	5.88	6.89	7.16	6.12	19.50	25.62
340900.00	4399900.00	248.60	307.00	4.55	4.34	5.67	6.61	6.80	5.59	19.50	25.09
Annual Averaging Period (NAAQS = 12 $\mu g/m^3$)											
Easting (Meters)	**Northing (Meters)**	**Elevation (Meters)**	**Hill (Meters)**	**2003 ($\mu g/m^3$) (H1H)**	**2004 ($\mu g/m^3$) (H1H)**	**2005 ($\mu g/m^3$) (H1H)**	**2006 ($\mu g/m^3$) (H1H)**	**2007 ($\mu g/m^3$) (H1H)**	**5-Yr Average ($\mu g/m^3$) (Average)**	**Background ($\mu g/m^3$) (Monitored)**	**NAAQS ($\mu g/m^3$) (Average)**
341400.00	4400600.00	253.20	253.20	8.58	8.12	9.88	9.83	10.00	9.28	8.80	18.08
347500.00	4399500.00	291.10	291.10	4.20	5.50	8.50	9.55	8.58	7.27	8.80	16.07
340900.00	4400100.00	250.00	250.00	3.68	3.99	5.15	5.86	5.27	4.79	8.80	13.59
338500.00	4398500.00	244.00	244.00	4.71	4.94	5.40	4.94	4.51	4.90	8.80	13.70
340900.00	4400200.00	251.60	251.60	2.10	2.29	3.44	3.18	2.87	2.77	8.80	11.57
347500.00	4400000.00	287.90	287.90	1.81	1.81	3.43	3.00	2.58	2.53	8.80	11.33
341000.00	4403000.00	253.70	253.70	1.43	1.43	1.45	1.78	1.83	1.58	8.80	10.38
341000.00	4403500.00	260.80	260.80	1.14	1.09	1.82	1.55	1.32	1.38	8.80	10.18
339500.00	4399000.00	249.80	249.80	1.25	1.42	1.47	1.72	1.79	1.53	8.80	10.33
340900.00	4399900.00	248.60	307.00	1.14	1.09	1.42	1.65	1.70	1.40	8.80	10.20

The first four columns contain information regarding the location of the receptor under review, followed by the predicted concentration from the dispersion model for each year under consideration. The maximum concentration for each year within the five-year period was obtained, averaged and added to the monitored background number. The sum represents the total concentration that should be compared to the NAAQS in order to determine compliance. Based upon the results contained within Table 2, the first five concentrations for the 24-hour averaging period and the top two concentrations for the annual averaging period exceed the

NAAQS of 35.0 μg/m^3 and 12.0 μg/m^3, respectively. Because NAAQS violations are predicted to occur, the analysis must go one step further to determine if Facility A has a significant impact on a violating receptor, refer to Table 3.

Table 3 $PM_{2.5}$ NAAQS Violations vs. Significant Impact					
24-Hour NAAQS (35.0 μg/m^3) vs. Significance (1.2 μg/m^3)					
Easting	**Northing**	**Elevation**	**Hill**	**NAAQS**	**Significant Impact Concentration**
(Meters)	***(Meters)***	***(Meters)***	***(Meters)***	***(μg/m^3)***	***(μg/m^3)***
				(Average)	***(Average)***
341400.00	4400600.00	253.20	253.20	56.63	1.15
347500.00	4399500.00	291.10	291.10	48.57	1.09
340900.00	4400100.00	250.00	250.00	38.66	0.05
338500.00	4398500.00	244.00	244.00	39.10	1.15
340900.00	4400200.00	251.60	251.60	30.60	0.50
Annual NAAQS (15.0 μg/m^3) vs. Significance (0.3 μg/m^3)					
Easting	**Northing**	**Elevation**	**Hill**	**NAAQS**	**Significant Impact Concentration**
(Meters)	***(Meters)***	***(Meters)***	***(Meters)***	***(μg/m^3)***	***(μg/m^3)***
				(Average)	***(Average)***
341400.00	4400600.00	253.20	253.20	18.08	0.298
347500.00	4399500.00	291.10	291.10	16.07	0.105

For the 24-hour and annual averaging periods, the impact due to the proposed project at Facility A were below the significant impact levels on each of the violating receptors; as such, Facility A's compliance with the $PM_{2.5}$ NAAQS has been demonstrated and no further analysis is necessary.

Secondary $PM_{2.5}$ NAAQS Compliance Demonstrations for Major Source Permit Applications

On March 4, 2013, the Environmental Protection Agency issued draft $PM_{2.5}$ modeling guidance, "Draft Guidance for $PM_{2.5}$ Permit Modeling," for major source permit applicants. In the draft guidance document, the Environmental Protection Agency outlined four differing scenarios in order to describe what analyses an applicant would be required to conduct for $PM_{2.5}$ if a PSD review was triggered:

1. No air quality analysis for $PM_{2.5}$ is required if:
    a. Direct $PM_{2.5}$ (including condensable emissions) < 10 tons per year, and
    b. NO_x and SO_2 emissions < 40 tons per year.
2. Primary $PM_{2.5}$ impact analysis is required if:
    a. Direct $PM_{2.5}$ (including condensable emissions) > 10 tons per year, and
    b. NO_x and SO_2 emissions < 40 tons per year.
3. Primary $PM_{2.5}$ and secondary impact analysis is required if:
    a. Direct $PM_{2.5}$ (including condensable emissions) > 10 tons per year, and
    b. NO_x and SO_2 emissions > 40 tons per year.
4. Secondary $PM_{2.5}$ impact analysis is required if:
    a. Direct $PM_{2.5}$ (including condensable emissions) < 10 tons per year, and
    b. NO_x and SO_2 emissions > 40 tons per year.

If a secondary impact analysis is required, the applicant should follow the recommendations contained within the "Draft Guidance for $PM_{2.5}$ Permit Modeling." Within this document, three differing options are available to applicants:

1. A qualitative assessment,
2. A hybrid approach that relies upon qualitative data and existing photochemical analyses or other technical documentation;
3. Photochemical grid modeling.

Prior to conducting the secondary impact analysis, the applicant must contact the department's Air Pollution Control Program for pre-approval with possible concurrence from the Environmental Protection Agency Region VII.