



**Forest County Potawatomi Community  
AQRV Project – Visibility Report**

Prepared for  
Forest County Potawatomi Community  
Crandon, WI

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## EXECUTIVE SUMMARY

Air Resource Specialists, Inc. (ARS) has been asked to assist the Forest County Potawatomi Community (FCPC) develop threshold effect levels for visibility as an Air Quality Related Value (AQRV). Since 2008, FCPC lands have been designated as Class I under the Prevention of Significant Deterioration (PSD) regulations of the Clean Air Act.

Visibility has been determined by FCPC to be an important physical resource that deserves protection from degradation caused by new and/or modified source of air pollution. First, visibility is important to FCPC tribal members from a cultural perspective. Also, FCPC's Class I lands contain a high concentration of glacial drumlins that form interesting and unique landforms that include wetlands and lakes that together provide numerous scenic vistas. Finally, visibility is a general indicator of air pollution and visibility protection generates ancillary benefits for FCPC in terms of protecting other important tribal resources such as flora, fauna, and cultural resources from potential degradation.

The table below summarizes the threshold effect levels selected by FCPC to protect visibility as an AQRV.

### Forest County Potawatomi Community Air Quality Related Value (AQRV) Thresholds Effect Levels for Visibility

Indicator	Recommended Threshold
Uniform Haze (Deciview)	The AQRV threshold for acceptable change is a 0.5 deciview (dV) increase on the 98 <sup>th</sup> percentile day compared to natural conditions for the best 20% days.
Layered Haze (Plume Color Difference Index, Delta-E)	The AQRV threshold for acceptable change is 2.0 or less for the worst-case hourly value (1.0 if the visibility modeling analysis is conducted using PLUVUE II).
Layered Haze (Plume Contrast)	The AQRV threshold for acceptable change is an absolute value of 0.05 or less for the worst-case hourly value (0.02 if the visibility modeling analysis is conducted using PLUVUE II).

ARS believes that the selected visibility AQRV thresholds are consistent with the Federal Land Manager's Air Quality Related Values Workgroup (FLAG) Phase I Report and Wisconsin's implementation of the Best Available Retrofit Technology (BART) rules [See NR 433.03(3) WAC].



The visibility AQRV thresholds at FCPC are compared to a “natural background” condition, which represents the expected visibility level in the absence of any anthropogenic (human-caused) emission sources. The Tribe has selected the natural background determined by FLAG at the Seney National Wildlife Refuge in upper Michigan to be representative of natural background at FCPC. Also, FCPC has selected the Best 20% Days condition to represent the natural background. The Best 20% Days is consistent with the default natural background defined by Wisconsin’s BART regulations and is also consistent with the standard practice of other Federal Land Manager’s (FLMs) in the upper Midwest.



## 1.0 INTRODUCTION

### 1.1 BACKGROUND

The Forest County Potawatomi Community (FCPC) is a federally-recognized Indian Tribe with governmental headquarters located near Crandon, WI. Since April 2008, parts of the FCPC Reservation has been designated as having “Class I” status under the Prevention of Significant Deterioration (PSD) regulations of the Clean Air Act.

Figure 1-1 shows the FCPC tribal lands that have been designated as Class I.

Class I areas that were originally established in 1977 by the PSD regulations are generally called “mandatory” Class I areas. For each “mandatory” Class I area, the Federal Land Manager (FLM) responsible for that area has an affirmative responsibility to protect air quality related values (AQRVs) of the Class I area, including visibility [See: 42 USC 7475(d)(2)(B)]. Example AQRVs include visibility, aquatic systems, and vegetation. Indian reservations that are redesignated as Class I, such as the FCPC Reservation, are generally termed “non-mandatory” Class I areas. For any such areas, the Administrator of the U.S. Environmental Protection Agency (EPA) must protect the area’s AQRVs when resolving any dispute between a Class I tribe and a State [See: 42 USC 7474(e)]. For FCPC, the 1999 Agreement between the State of Wisconsin and FCPC established water quality and aquatic systems as the initial AQRV.

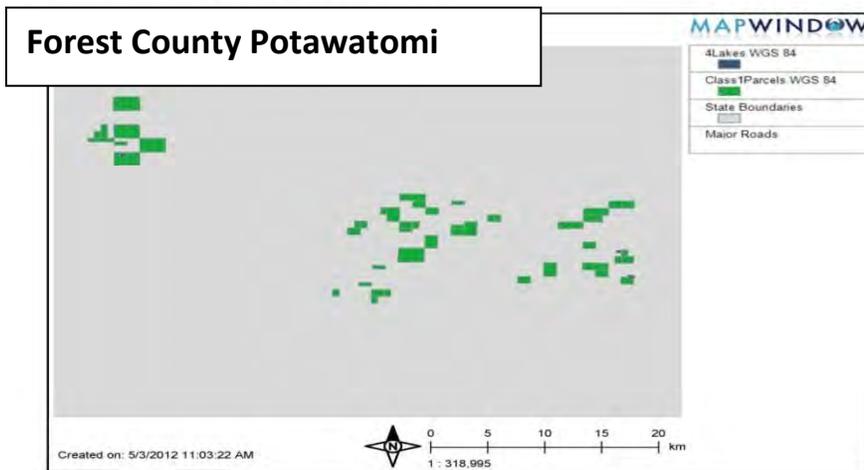
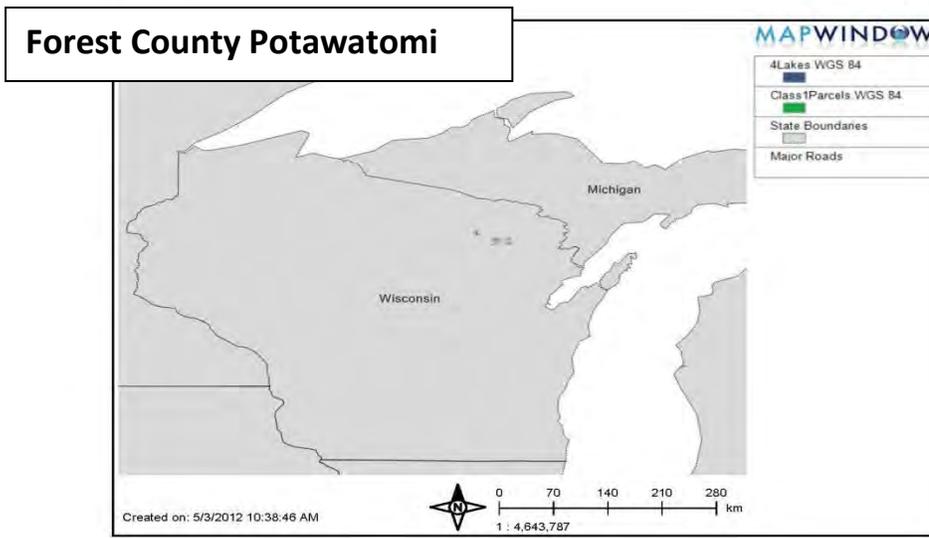
Under the 1999 Agreement, FCPC may modify its AQRVs and establish threshold effects for each AQRV every 10 years. According to a Memorandum of Understanding between the FCPC and the State of Wisconsin implementing the 1999 Agreement, FCPC may modify and add to the AQRVs and may establish threshold effects for each listed AQRV on or before July 31, 2012. FCPC has currently identified visibility and vegetation as additional AQRVs.

The FCPC Air Resources Program has requested technical assistance from Air Resource Specialists, Inc. (ARS) in preparing a report documenting the visibility AQRV and establishing appropriate threshold effect levels. The report is intended to cover the following:

- Establish the background and threshold effects level(s) for visibility using data collected by FCPC at its ambient air quality monitoring station and/or through adoption of background and threshold effects levels already established for other Class I areas in the region.
- Prepare a document that provides technical support and justification for the selected threshold effects level to be established by FCPC.

This report fulfills the above project objectives for the visibility AQRV at FCPC.





**Figure 1-1: Map Showing FCPC Class I areas**



## 1.2 FCPC's SELECTION OF VISIBILITY AS AN AQRV

An air quality related value is a resource that may be adversely affected by changes in air quality (FLAG, 2010). The resources in question may include visibility or a specific scenic, cultural, physical, biological, ecological, or recreational resource identified by the land manager for a particular area.

Visibility has been specifically identified as an important AQRV in nearly all of the existing Class I areas in the United States.

FCPC's selection of visibility as AQRV for its Class I area is based in part on the following:

- The visual beauty of the sky is an important cultural resource to FCPC tribal members and is reflected in the many members bearing Potawatomi names that connote the importance of the sky, e.g., Skeb Gishek (Green Sky), A Bo Shan Kot (Storm Cloud Coming), Mskwa Gishek (Red Sky Woman), Wed Jon Kak (Lightening Before the Storm), etc.
- FCPC's Class I lands have the second highest elevation of all lands in Wisconsin and offers more vertical relief than other forested areas in the region. The rolling topography offers opportunities for scenic vistas which are enjoyed by tribal members and other persons travelling through the region.
- FCPC's lands also have unique natural features. For example, this region contains a high concentration of glacial drumlins. These drumlins provide good vantage points for scenic vistas and the drumlins themselves provide for interesting and unique landscapes.
- FCPC's glacial landscape also contains lakes and large wetlands in the form of marshes and bogs that provide for additional scenic vistas.
- Visibility is also a general indicator of air quality conditions. Visibility degradation is caused by increases in concentrations of air pollutants, especially secondary aerosols such as sulfates and nitrates. Protection of visibility as an AQRV provides ancillary benefits to FCPC by also protecting other significant tribal resources such as flora, fauna, cultural resources, etc. from potential damage resulting from increases in air pollution levels.



## 2.0 GENERAL CONCEPTS OF VISIBILITY AS AN AIR QUALITY RELATED VALUE

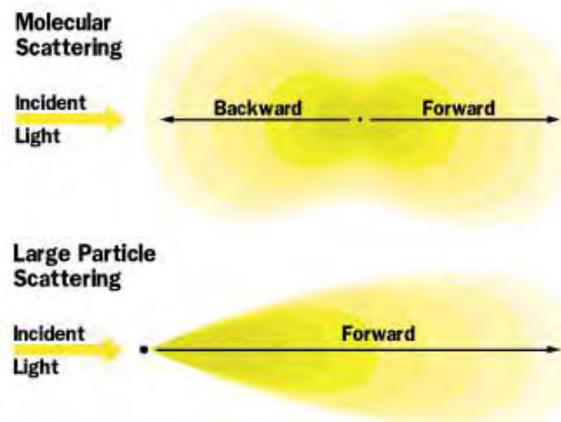
Historically, visibility has often been considered pseudonymous with “visual range” or the greatest distance at which an observer can view a black object against the horizon. However, visibility is actually more closely associated with conditions that allow the appreciation of the inherent beauty of landscape features. This perspective takes into account the form, contrast, detail, and color of near and distant landscapes.

It is also known that the introduction of air pollutants (particles and gasses) may interfere with the observer’s ability to see and distinguish landscape features. By selecting visibility as an important “air quality related value” (AQRV), the desire is to protect degradation of visibility and air quality through control of air pollution emissions.

### 2.1 HOW AIR POLLUTION AFFECTS VISIBILITY

Visibility degradation results from light scattering and absorption by particles and gasses in the atmosphere, although light scattering is typically the dominant cause of visibility degradation. Some scattering of light occurs naturally in the atmosphere. Air molecules themselves scatter light, and since the air molecules are approximately the same size as the wavelength of blue light, the blue light is more efficiently scattered compared to other wavelengths (red and green). The preferential scattering of blue light by air molecules is why the sky appears blue.

When air pollution is introduced to the atmosphere, the incremental particles and gasses also scatter and/or absorb light. Particles and gasses at or near the wavelength of light scatter light more or less equally in all directions. However, as the particles increase in size, the tendency is for light to be preferentially scattered in the forward direction. Once the particle size approaches 10 microns or larger, nearly all of the incident light is scattered in the forward direction (Malm, 2000). This concept is illustrated in Figure 2-1.



**Figure 2-1. Scattering of light by air molecules and particles (from Malm, 2000)**



The particle size also impacts its scattering efficiency, or the amount of light scattered relative to the particles size (Malm, 2000). The scattering efficiency is maximized when the particle size is close to the wavelength of light although the particle scattering efficiency remains high when the size is greater than the wavelength of the incoming light. Also, these larger particles tend to scatter all incoming wavelengths of the incident light. When all of the colors are scattered equally, the result is a white or gray haze.

## **2.2 ATMOSPHERIC AEROSOLS AND VISIBILITY**

Air pollution effects on visibility are dominated by aerosols in the atmosphere. Primary aerosols are those emitted directly from pollution sources, while secondary aerosols form through atmospheric reactions involving primary precursor pollutants. Important secondary aerosols include ammonium sulfate and ammonium nitrate, which form through atmospheric reactions involving emissions of sulfur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>). SO<sub>2</sub> and NO<sub>x</sub> emissions are byproducts from combustion of fuels.

Most secondary aerosols are in the size range of 0.1 to 1.0 microns. However, sulfates and nitrates are both “hygroscopic”, in that the aerosols can combine with water vapor and grow in size, particularly once the relative humidity exceeds about 70 percent. This size growth leads to an increase in the scattering efficiency for sulfates and nitrates, as noted in the previous section. Because of their hygroscopic nature, sulfate and nitrate aerosols have been found to have a disproportionate impact on atmospheric extinction and the resulting visibility (Malm, 2000). For this reason, much of the focus on improving visibility impacts related to air pollution has been to control SO<sub>2</sub> and NO<sub>x</sub> emissions.

## **2.3 HUMAN PERCEPTION OF VISIBILITY**

Typically, air pollution can manifest itself as either a layered haze or uniform haze (Malm, 2000). Layered haze is represented by a confined layer of pollutants within the atmosphere that results in a visible discontinuity between the layer and the background sky. Layered hazes can be associated directly with an individual plume of air pollution emissions. Generally, when such conditions occur, they occur within tens of kilometers from an individual emissions source. However, the layered haze can be detached from the source if the emissions remain coherent during transport and there is adequate time for atmospheric conversions of emissions to sulfate and/or nitrate.

The more common haze is the uniform haze. Since a uniform haze produces no immediate contrast to an observer, the haze is perceived by the observer “remembering” the view of a particular scene without the haze present. Generally, a uniform haze cannot be traced to an individual source of emissions and instead results from the cumulative impact of all air pollution emission sources. The uniform haze concept also is known as “regional haze” in the current regulatory context.



In the Regional Haze State Implementation Plan for Wisconsin (Wisconsin Department of Natural Resources, 2011), regional haze is described as “a widespread haze from a multitude of sources which impairs visibility in every direction over a large area.”

## 2.4 QUANTIFICATION OF VISIBILITY EFFECTS

For the quantification of hazes, an important concept is “extinction”. Extinction represents the combined effect of an individual pollutant to scatter and/or absorb light, and is expressed in units of inverse distance. Higher extinction values indicate a lower visual range and therefore greater air pollution impacts to visibility. The combined extinction from all pollutants derives the total visibility impact caused by air pollution.

The Interagency Monitoring of Protected Visual Environments (IMPROVE) workgroup has developed a mathematical equation for calculating light extinction from various species of air pollutants (IMPROVE, 2006). This equation is shown in Figure 2-2.

$$\begin{aligned} B_{\text{ext}} \approx & 2.2 \times f_s(\text{RH}) \times [\text{Small Sulfate}] + 4.8 \times f_L(\text{RH}) \times [\text{Large Sulfate}] \\ & + 2.4 \times f_s(\text{RH}) \times [\text{Small Nitrate}] + 5.1 \times f_L(\text{RH}) \times [\text{Large Nitrate}] \\ & + 2.8 \times [\text{Small Organic Mass}] + 6.1 \times [\text{Large Organic Mass}] \\ & + 10 \times [\text{Elemental Carbon}] \\ & + 1 \times [\text{Fine Soil}] \\ & + 1.7 \times f_{ss}(\text{RH}) \times [\text{Sea Salt}] \\ & + 0.6 \times [\text{Coarse Mass}] \\ & + \text{Rayleigh Scattering (Site Specific)} \\ & + 0.33 \times [\text{NO}_2(\text{ppb})] \end{aligned}$$

Where [ ] indicates concentrations in  $\mu\text{g}/\text{m}^3$

$f_s(\text{RH})$  = Relative humidity adjustment factor for small sulfate and nitrate

$f_L(\text{RH})$  = Relative humidity adjustment factor for sea salt

**Figure 2-2. IMPROVE Equation for Calculating Light Extinction.**



Related to the quantification of visibility effects is the concept of a “deciview”. The deciview is intended to represent an equal level of humanly-perceptible change at a particular scene. In practice, as a particular scene is more polluted, a higher level of increased/decreased pollution is required before a change in that scene becomes perceptible to an observer. A change of 0.5 to 1.0 deciviews (dVs) is believed to generally represent the threshold of human perception to the average observer.

In a regulatory context, a change of 0.5 dV from the air pollution caused by an individual source is listed under the U.S. Environmental Protection Agency (EPA) regional haze regulations in 40 CFR 51 Appendix Y as “contributing” to any existing visibility impairment [See: Federal Register, July 6, 2005, page 39161]. The same 0.5 dV threshold has also been adopted by the Federal Land Manager’s Air Quality Related Values Workgroup (FLAG, 2010) and the Wisconsin Regional Haze SIP (Wisconsin Department of Natural Resources, 2011) as the threshold for determining if an individual emissions source may contribute to an adverse impact on visibility. In the regulatory analyses described above, the computed change is relative to the “natural background”, or the expected background visibility conditions in the absence of anthropogenic emission sources.

Mathematically, the “deciview” (dV) is computed as follows where the extinction ( $B_{ext}$ ) is determined in units of inverse megameters ( $Mm^{-1}$ )

$$dV = 10 * \ln (B_{ext} / 10)$$



### 3.0 BACKGROUND CONDITIONS

#### 3.1 BACKGROUND AIR QUALITY CONDITIONS

FCPC operates an ambient air quality monitoring station on tribal lands. Based on the USEPA Air Quality System (AQS) database, the station location is on Fire Tower Road.

Table 3-1 summarizes the FCPC air quality monitoring data for the most recent three-year period (2009 through 2011). All FCPC monitoring data show compliance with the applicable National Ambient Air Quality Standards (NAAQS).

**Table 3-1  
FCPC Ambient Air Monitoring Data  
(from EPA AQS Database)**

Pollutant	Averaging Time	Units	2009	2010	2011	NAAQS
<b>Sulfur Dioxide</b>	1-Hour (Maximum)	ppb	15.0	22.0	23.7	75 <sup>1</sup>
	Annual		2.92	2.53	1.23	N/A
<b>Ozone</b>	8-Hour (Maximum)	ppb	67	68	75	75 <sup>2</sup>
<b>PM-2.5</b>	24-Hour (Maximum)	micrograms per cubic meter	21.3	25.3	14.6	35 <sup>3</sup>
	Annual		6.27	6.49	5.57	15 <sup>4</sup>

- Notes: <sup>1</sup> NAAQS for SO<sub>2</sub> based on the 99<sup>th</sup> percentile of the maximum daily one-hour concentration, averaged over three years.  
<sup>2</sup> NAAQS for O<sub>3</sub> based on the annual fourth-highest daily maximum concentration averaged over three years.  
<sup>3</sup> NAAQS for PM-2.5 (24-hour average) based on the 98<sup>th</sup> percentile concentration averaged over three years.  
<sup>4</sup> NAAQS for PM-2.5 (annual mean) based on the average annual concentration over three years.



### 3.2 BACKGROUND VISIBILITY CONDITIONS

The background visibility condition is intended to represent the “natural background”, which is defined as the background visibility that would be present in the absence of any anthropogenic emission sources.

ARS’ recommendation is to establish the “natural background” visibility levels at the FCPC Class I area based on the natural background aerosol concentrations for the Seney National Wildlife Refuge Wilderness in Michigan listed in the Federal Land Manager’s Air Quality Related Values Work Group (FLAG) Phase I Report (FLAG, 2010).

The choice for Seney is based on the following:

- Seney is the closest existing Class I area with IMPROVE visibility monitoring data to the FCPC tribal lands.
- Seney, located in the Michigan Upper Peninsula, better represents the land use and background air emission sources of northeastern Wisconsin compared to other alternative background sites in the upper Midwest with appropriate data, such as Boundary Waters Canoe Area or Isle Royale National Park.
- Based on the geographic distribution for aerosol data summarized in the most recent IMPROVE data report (Hand et al, 2011), the interpolated concentrations across northeastern Wisconsin for aerosol constituents related to visibility are better correlated with observations at Seney compared to observations at Boundary Waters and/or Isle Royale.

Figures 3-1 and 3-2 are reproductions of figures from the most recent IMPROVE Data Report (Hand et al 2011). These figures show the average sulfate and nitrate concentrations nationwide based on the IMPROVE monitoring program along with other similar data. For northeastern Wisconsin, the relevant data sites are the IMPROVE monitor at Seney and the EPA Chemical Speciation Network (CSN) monitor from Perkinstown, Wisconsin, located in Taylor County to the west of FCPC.

Based on Figure 3-1, the measured sulfate levels appear similar at Seney and Perkinstown and the isopleth drawn for northeastern Wisconsin would suggest that sulfate levels are similar near FCPC. Based on Figure 3-2, the measured nitrate levels appear to be higher at Perkinstown compared to Seney. This is expected as observations show a relative maximum for nitrate in the agricultural regions of the Midwest. Using Figure 3-2, the nitrate concentration at Seney would appear to underestimate the nitrate for northeastern Wisconsin. However, based on Figure 3-2, despite the tendency for underestimation, the nitrate levels at Seney appear to better represent FCPC compared to the nitrate levels at Isle Royale or Boundary Waters.



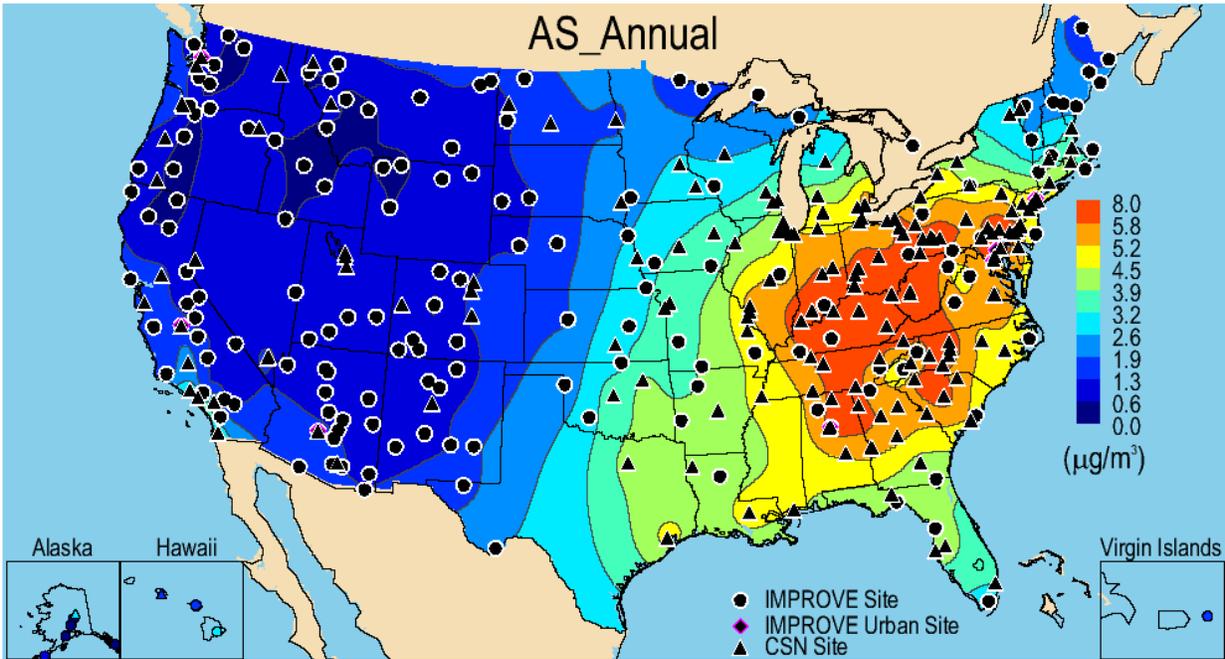


Figure 3-1. Average Sulfate Concentrations (2008-2010), from Hand et al (2011).

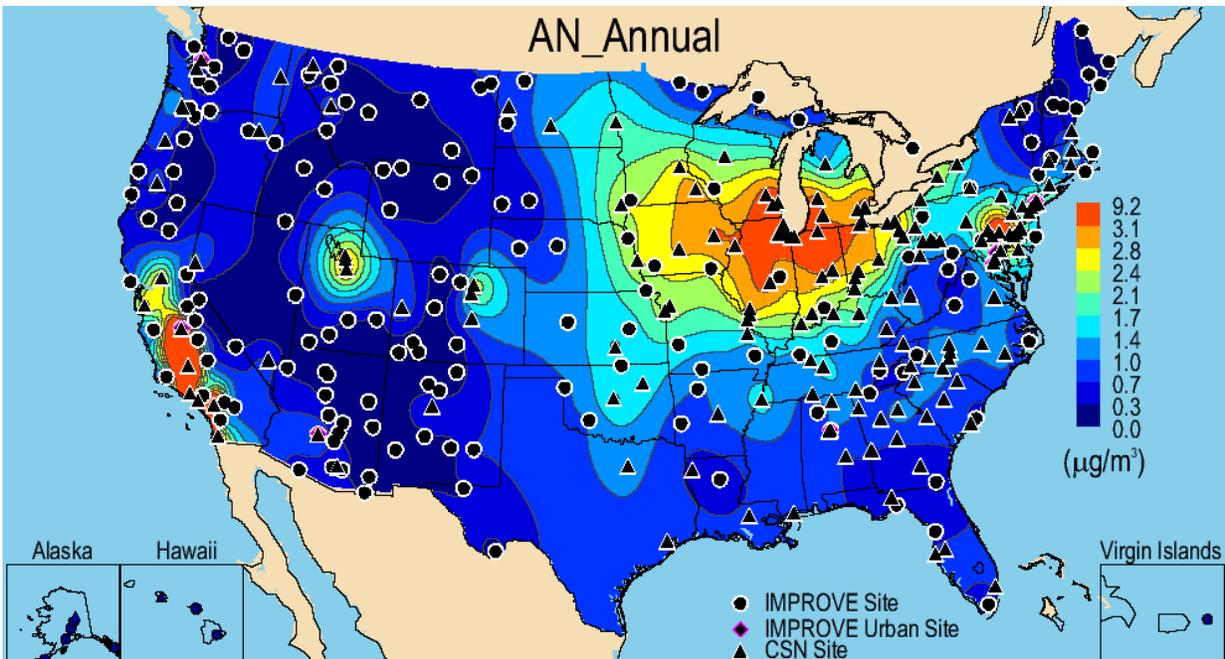


Figure 3-2. Average Nitrate Concentrations (2008-2010), from Hand et al (2011).

Table 3-2 summarizes the natural background aerosol concentrations for Seney Wilderness as taken from FLAG (2010). Natural background is described both in terms of the annual average and the average of the “best” 20% days.

**Table 3-2**  
**FCPC Natural Background for Visibility**  
**Concentrations in micrograms per cubic meter**  
**Data from FLAG (2010) from Seney Wilderness (Michigan)**

	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	NH <sub>4</sub> NO <sub>3</sub>	OM	EC	Soil	CM	Sea Salt	Rayleigh Scattering (Mm <sup>-1</sup> )
Best 20% Days	0.08	0.01	0.38	0.01	0.09	0.80	0.01	12
Annual Average	0.23	0.10	1.74	0.02	0.26	1.95	0.02	12

Notwithstanding the recommendations above, ARS computed the background visibility conditions based on data from the FLAG 2010 Phase I Report at Seney, Boundary Waters, and Isle Royale. These calculations followed the IMPROVE extinction equation described in Section 2 and used the annual mean from the monthly f(RH) values reported by FLAG (2010). The calculated natural background extinction is listed below in Table 3-3.

**Table 3-3**  
**Background Extinction (Mm<sup>-1</sup>) for Class I Areas in the Upper Midwest**  
**Calculated Using Natural Background Aerosol Concentrations from FLAG (2010)**

	Seney Wilderness	Boundary Waters Canoe Area	Isle Royale National Park
Best 20% Days	14.55	14.19	14.55
Annual Average	21.86	20.84	21.49



The data in Table 3-3 show that the natural background visibility determined using the FLAG (2010) data for the three Upper Midwest Class I areas are relatively close. For the annual average condition, the range in background visibility is about  $1.0 \text{ Mm}^{-1}$ . For the best 20% days condition, the range in background visibility is around  $0.3 \text{ Mm}^{-1}$ . These data are also consistent with Table 2 contained in the Wisconsin Regional Haze SIP (Wisconsin Department of Natural Resources, 2011), which list the baseline natural conditions for the above Class I areas along with Voyagers National Park.

Based on the results shown in Table 3-3, the choice regarding which upper Midwest Class I natural background visibility site to use to characterize background visibility at FCPC probably does not result in significant differences as all of the available data produce approximately equivalent results.



## **4.0 RECOMMENDED THRESHOLD EFFECTS LEVEL FOR VISIBILITY**

Visibility is already an established AQRV for all except two mandatory Class I areas. The recommended procedure to address potential visibility impacts from new/modified air pollution emission sources on Class I areas is contained within the FLAG Phase I Report (FLAG, 2010).

Because visibility effects have already been studied with respect to the existing mandatory Class I areas, ARS believes that FCPC is best served by relying on this existing framework in establishing the appropriate thresholds for the visibility AQRV at FCPC's Class I area. Consistency with the current FLAG guideline also eases the burden on applicants performing technical modeling analyses on visibility impacts as well as simplifying the regulatory review conducted by WDNR and/or other agencies.

Readers should consult FLAG (2010) for additional background and technical justification for the recommended visibility AQRV threshold effects level.

The recommended threshold effects level for visibility on FCPC tribal lands designated as Class I is documented in Table 4-1. The recommended threshold effects level for the visibility AQRV varies depending on whether the source in question is located in the near-field (50 km or closer) or far-field (more than 50 km distant). The different threshold effects level reflects that near-field sources are more apt to produce a layered haze and far-field sources are more apt to produce or contribute to a uniform haze. The air quality modeling approaches used to address layered haze vs. uniform haze also vary and dictate the need for a different metric for evaluation of any potential impact.

### **4.1 THRESHOLD EFFECTS LEVEL FOR FAR-FIELD IMPACTS (50 KM OR GREATER DISTANCE)**

This section describes the recommended threshold effects level for visibility when the adverse effect is a uniform haze (regional haze). Consistent with current air dispersion modeling principles (FLAG 2010), regional haze dominates once the emission source in question is 50 km or greater distant from the Class I area.

Under the Clean Air Act, visibility impacts are generally defined by the “magnitude, frequency, and duration” of impacts. Based on FLAG (2010), the magnitude of visibility impacts can be described using the “deciview” (dv) metric, described previously in Section 2.0.

Initially, consistent with FLAG (2010), sources may elect to conduct an initial “screening test”, based on the ratio of emissions (Q) to the distance (D) from FCPC's Class I area. If the Q/D ratio is less than 10, FLAG (2010) indicates that the potential for adverse visibility impact is small and no further analysis is required. It is recommended that FCPC also adopt this initial screening test for sources located more than 50 km from tribal lands to ease the regulatory burden on smaller emission sources with little potential for having adverse effects on the FCPC visibility.



**Table 4-1**  
**Forest County Potawatomi Community**  
**Recommended Air Quality Related Value (AQRV) Thresholds for Visibility**

Indicator	Recommended Threshold
Uniform Haze (Deciview)	The AQRV threshold for acceptable change is a 0.5 deciview (dV) increase on the 98 <sup>th</sup> percentile day compared to natural conditions for the best 20% days.
Layered Haze (Plume Color Difference Index, Delta-E)	The AQRV threshold for acceptable change is 2.0 or less for the worst-case hourly value (1.0 if the visibility modeling analysis is conducted using PLUVUE II).
Layered Haze (Plume Contrast)	The AQRV threshold for acceptable change is an absolute value of 0.05 or less for the worst-case hourly value (0.02 if the visibility modeling analysis is conducted using PLUVUE II).

**Notes:**

The above AQRV thresholds are derived from FLAG (2010) and are intended to be consistent with FLAG and Wisconsin's implementation of the BART rules [See NR 433.03(3) WAC]. Please refer to the FLAG (2010) for additional background on the selected AQRVs.

The Deciview threshold applies to far-field projects modeled using CALPUFF (generally 50 km or greater from FCPC tribal lands). New/modified sources need to demonstrate that they meet this threshold.

The Delta-E and Plume Contrast thresholds apply to near-field projects modeled using VISCREEN and/or PLUVUE II (generally closer than 50 km from FCPC tribal lands). New/modified sources must demonstrate that they meet both the Delta-E and Plume Contrast thresholds.

The recommended threshold effects level is a change in visibility levels of 0.5 dV, which is the threshold effects level already defined in federal Best Available Retrofit Technology (BART) regulations at 40 CFR 51 Appendix Y and in similar state regulations adopted by the Wisconsin Department of Natural Resources at NR 433 WAC. Under these rules, any “BART-eligible” source is deemed to “contribute” to existing visibility impairment if the modeled change in visibility compared to the natural background exceeds 0.5 dV. Using FLAG (2010), the recommended threshold level is a 5% change in light extinction compared to natural background, which is approximately equal to 0.5 dV. The visibility impairment thresholds advanced by FLAG (2010) and state and federal BART rulemaking can logically be extended to other emission sources, whether or not they are technically covered by the underlying regional haze and BART regulations.

For the frequency of impact under FLAG (2010), the 98<sup>th</sup> percentile of modeled impacts is used to define an acceptable frequency of perceptible visibility changes. Again, the same impact frequency threshold was established by USEPA and the State of Wisconsin under the BART regulations in 40 CFR 51 Appendix Y and NR 433 WAC respectively. For a one-year period (365 days), the 98<sup>th</sup> percentile represents the eighth-highest modeled daily visibility impact.

For “natural background”, FCPC has selected the Best 20% Clean Days as the baseline condition for the visibility computations. This choice is predicated on the following:

- The natural background based on the Best 20% Days provides the strongest level of protection for the FCPC Class I area.
- The Best 20% Days is the default choice for natural background in Wisconsin’s air pollution control regulations at NR 433.03(3) WAC.
- The Best 20% Days is the current choice for natural background used by Federal Land Manager’s in the upper Midwest when reviewing project impacts to Class I areas in the region (Wickman, 2012).

The dispersion model of choice for the technical analyses required to make these visibility computations is generally the CALPUFF dispersion model (Scire, 2000).

#### **4.2 THRESHOLD EFFECTS LEVEL FOR NEAR-FIELD IMPACTS (LESS THAN 50 KM DISTANCE)**

If the new/modified emission source is located within 50 km of the Class I area of interest, the concern shifts from the “regional haze” analysis described above to “plume impairment” by a layered haze. For “plume impairment”, the model of choice generally starts with the EPA VISCREEN model (EPA, 1992a), but a more detailed analysis using EPA’s PLUVUE model (EPA, 1992b and EPA, 1996) may be employed if the initial VISCREEN modeling results suggest an unacceptable level of impairment. The recommended FCPC



threshold effects level for near-field visibility impacts also follows the currently established guidance in FLAG (2010).

VISCREEN and PLUVUE would be used to compute values for the contrast (C) and the color difference index (Delta-E). The AQRV threshold for acceptable change in color difference index (Delta-E) is 2.0 or less for the worst-case hourly value, or 1.0 if the visibility modeling analysis is conducted using PLUVUE. The AQRV threshold for acceptable change for contrast (C) is an absolute value of 0.05 or less for the worst-case hourly value, or an absolute value of 0.02 or less if the visibility modeling analysis is conducted using PLUVUE. Again, the acceptable threshold effects level selected by FCPC is consistent with FLAG (2010).



## 5.0 TECHNICAL REFERENCES

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