We are now soliciting comments from DNR staff and external partners on The Wisconsin Smoke Management Plan: Best Management Practices for Prescribed Burns and the accompanying Memorandum of Agreement (MOA) is now available for public review.

These documents promote agreement between the Department and external partners in conducting prescribed burns according to the best management practice guidelines of the Smoke Management Plan (SMP), and the agreement of each party to undertake the responsibilities described in the SMP. Both the SMP and the MOA have been open to public review previously; however, recent changes to the draft documents spurred another opportunity for public review. Items in ‘track changes’ are edits made to the document to reflect recent updates in EPA guidelines and a change in reporting parties. Once the 21-day notice period is complete, all comments will be considered, revisions will be made to the documents as needed, and final guidance will be made available to Department staff.

Comments related to the Smoke Management Plan should be sent to: 
Michele.Witecha@Wisconsin.gov
Wisconsin Smoke Management Plan:

Best Management Practices for Prescribed Burns
# Wisconsin Smoke Management Plan: Best Management Practices for Prescribed Burns

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INTRODUCTION

Use of Fire for Ecosystem Management in Wisconsin

Many of the vegetation cover types within the state evolved with fire as the natural process for restoration and maintenance (Curtis, 1959). For thousands of years, vast, sweeping wildfires occurred naturally through lightning strikes, or were set by Native Americans for settlement preparation or to attract game species to the area (Domey, 1981; Domey & Domey, 1989). Because frequent fire played a significant role in the development of much of Wisconsin's native plant communities, many plant and animal species now depend on fire for their continued existence. Prescribed fire, therefore, is the preferred management tool when safety and environmental conditions permit. Vegetation types ranging from grasslands and prairie plantings, to wetlands, savannas, conifer and hardwood forests, brush lands and agricultural fields are all treated with prescribed fire. Prescribed fire, also known as open burning, is the preferred method for landscape scale land treatments. Piled slash is also burned throughout the year for cover type conversion, site preparation, and to mitigate insect- and disease-related problems such as oak wilt.

Prescribed fire is an important tool in Wisconsin for restoring and maintaining fire-dependent ecosystems, providing wildlife habitat, reducing hazardous fuelbuildups, and meeting silvicultural and other needs. However, wildland fire (wildfire and prescribed fire) can be a large, intermittent source of particulates that have the potential to cause significant short-term impacts on human health, welfare, safety, and visibility.

Use of prescribed fire has been intermittent since the post-logging era wildland fires. The various fire-dependent ecosystems such as savannas, oak and pine barrens, grasslands, and many other plant communities, reflect the impacts of this intermittent pattern. The decline of fire occurrence over the past 100 years has contributed to the loss of acreage of these ecosystems, and a decrease in the integrity of the remaining acreage.

In summary, the main reasons to use prescribed fire include:

- Wildlife habitat improvement and maintenance
- Site preparation and seed production
- Ecosystem management and restoration
- Maintenance of biological diversity
- Restoration of fire as a natural process
- Control of insect and disease
- Fuel reduction, including hazardous fuels
- Minimizing the potential for significant air quality impacts from wildfire
- The training of fire personnel resources
- Testing of fire suppression equipment and suppression techniques.

The use of prescribed fire presents the need to weigh the trade-offs associated with the ecological benefit of this practice vs. the impact of increased emissions from current and accelerated prescribed burning programs. Part of this trade-off involves the careful consideration of and application of smoke management techniques to minimize the impact of emissions, while still meeting ecological needs. An example of this trade-off to be considered is the increased fuel consumption from a wildfire burning under severe meteorological conditions versus the reduced fuel consumption of a prescribed fire that might burn under moderate weather conditions.
**Background**

This Smoke Management Plan (SMP) has been developed to minimize those potential air quality impacts while optimizing the opportunity to use prescribed fire as a land management tool. In 2005, several public and private land management agencies and organizations agreed to develop and implement smoke management best management practices to mitigate potential air quality impacts from prescribed fire. In general, agencies and organizations in Wisconsin that conduct prescribed burns prepare site specific individual burn plans. State law and/or local ordinances may require burn permits for “open burning.” Currently most prescribed fire plans include provisions that address the effects of smoke to varying degrees. This SMP will begin a formal effort to minimize impacts of smoke produced from managed wildland fires in Wisconsin.

The EPA Exceptional Events Rule published on September 30, 2016 states that all wildfires will be considered as natural events and will not be counted in determining an area’s attainment or non-attainment status. The impact of prescribed fires may be discounted if the burn was conducted under a certified Smoke Management Plan or the burner was using basic smoke management practices (as defined by the applicable air quality regulatory agency).

The Division of Forestry, Division of Fish, Wildlife, & Parks, and the Bureau of Air Management (Division of Environmental Management) of the Wisconsin Department of Natural Resources (WIDNR) serve as the central authority for the State’s SMP. The SMP guidelines will become effective when the WIDNR certifies in writing to Environmental Protection Administration (EPA) that a SMP has been adopted and implemented.

**Purpose**

These smoke management best management practices are a set of guidelines and procedures that are followed by signatory organizations to reduce the adverse effects of smoke from prescribed fires. The goal of the Wisconsin SMP is to prevent violations of the federal fine particles standard (PM$_{2.5}$) and minimize adverse effects including:

- Health effects from smoke inhalation
  - Premature death
  - Decreased lung function
  - Increased asthma attacks and chronic bronchitis
  - Acute respiratory symptoms
  - Respiratory and cardiopulmonary related hospital admissions
  - Increased work and school absences
- Visibility related travel hazards
  - Aircraft
  - Highways
  - Rail
- Electric utility hazards
- Violations of an ambient air quality standard
- Decreased visibility in scenic vistas
Organizations that May Wish to Sign On to the Smoke Management Plan

In Wisconsin, The Nature Conservancy (TNC), WIDNR, National Park Service (NPS), U.S. Fish & Wildlife Service (USFWS), U. S. Forest Service (USFS), Department of Defense (DOD), the Bureau of Indian Affairs (BIA), Menominee Indian Tribe of Wisconsin (MITW), Pheasants Forever, several non-profit conservation groups, and numerous private prescribed burn contractors all use fire to accomplish goals and objectives ranging from ecosystem management to fuels reduction (Table 1). USDA conservation programs (e.g., Conservation Reserve Program, Wildlife Habitat Incentives Program) offered through the Farm Service Agency and Natural Resources Conservation Service (NRCS) place an emphasis on prescribed fire, making the increased use of prescribed fire in the private sector a general trend.

Table 1 – Agency/Organization Prescribed Burn Annual Acreages

<table>
<thead>
<tr>
<th>Agency/Organization</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
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</table>

**NOTE:** The prescribed burn acres in Table 1 are the best data available; some burn acreage may have been missed or double reported.

For further information on the basis for developing smoke management best management practices in Wisconsin, please see Appendix C.
SMOKE MANAGEMENT BEST MANAGEMENT PRACTICE GUIDELINES:
AUTHORIZATION TO BURN & AIR QUALITY ADVISORIES

Signing organizations agree to follow the SMP best management practice guidelines below as part of their day-of-burn decision-making.

The WIDNR Division of Forestry is responsible for issuing permits for open burning in organized protection areas, outside of incorporated cities or villages in Wisconsin (Figure 1), for forest fire protection purposes. In cooperative protection areas, town chairpersons are responsible for issuing permits for open burning for forest fire protection purposes. This authority is stated in Wisconsin State Statute Chapter 26 and associated administrative rules.

The WIDNR issues written permits for open burning of vegetation. A permit is not required when the ground is covered with snow. Permitting of open burning is also administered locally when municipalities or townships have local ordinances more restrictive than the state rules.

Wisconsin Administrative Code, NR 429.04(1) prohibits open burning with certain exceptions. One of those exceptions is backfires to control forest fires or fires set for forest or wildlife habitat management with the approval of the WIDNR where no reasonable alternative is available. Factors in considering the reasonableness of alternatives may include: 1) costs of other alternatives, 2) availability of other alternatives, or 3) effectiveness of each of the other alternatives in comparison to a prescribed burn in achieving the land management objectives. In addition, NR 429.04(2) specifies that all allowed open burning shall be conducted in a safe, pollution-free manner, when wind and weather conditions will minimize adverse effects and in conformance with local and state fire protection regulations.

Figure 1 – Forest Fire Protection and Co-op Areas in Wisconsin
Historically, federal agencies in Wisconsin have complied with state burning regulations. The SMP is a formal agreement among signatory agencies for following state burning regulation compliance for the purposes of future smoke-related emission and impact reduction. For information on Federal and State laws related to smoke management best management practices, please see Appendix B.

In the event that an air quality advisory is declared by WIDNR, signatories to this SMP agree to cancel all open burning related to prescribed fire use for the applicable county or counties affected by the burn while the advisory remains in effect. The WIDNR has a website for determining air quality advisories throughout the state. Individuals can sign up to receive email notifications as well.

**SMOKE MANAGEMENT BEST MANAGEMENT PRACTICE GUIDELINES: BURN PLANS**

Signing organizations agree to follow the SMP best management practice guidelines below as part of their burn plan content.

**Burn Plan Elements**

All signatories to this SMP agree to have burn plans that incorporate the elements listed below. They should be on file at agency or organization offices and are available upon request. These prescribed burn plans will include the following elements at a minimum:

- Location and legal description (Town, Range, Section and quarter-quarter section) of the area to be treated, including ownership.
- Personnel and/or certified prescribed Burn Boss responsible for managing the fire.
- Type of vegetation or fuel model (utilizing the National Fire Behavior Prediction System) to be burned.
- Area in acres to be burned.
- Amount of fuel to be consumed*
- Fire prescription including smoke management components and ventilation index limits.
- Criteria the fire manager will use for making go/no-go burn decisions.
- Safety and contingency plans.

*As an example, if burning in a Fuel Model 6 (brush fuel type), and the objective is to reduce 75% of the woody vegetation, this can be calculated by multiplying average fuel present (6 tons/acre) by 75%. This results in amount of fuel to be consumed equaling 4-1/2 tons/acre. Fuel loading assumptions for the standard 13 fuel models can be found within the *Aids to Determining Fuel Models for Estimating Fire Behavior* (Anderson, 1982).

**Burn Planning**

**Actions to Minimize Fire Emissions**

The burn plan should document the steps to be taken prior to, during, and after the burn to reduce air emissions. This could include, but may not be limited to, any of the following measures stated in the *Smoke Management Guide for Prescribed and Wildland Fires* (NWCG, 2001).
• Minimize the area burned; reduce the acreage burned per burning period, or use non-fire treatments.
• Reduce the fuel loading in the area to be burned by mechanical means, or by using frequent, low intensity burns to gradually reduce fuels.
• Reduce the amount of fuel consumed by the fire by burning when large non-target fuel moistures and duff moistures are higher.
• Minimize emissions per ton of fuel consumed, by using mass ignition techniques, using backing fires, increasing combustion efficiency and performing rapid and complete mop-up.
• Pre-treat heavy fuels or use firing techniques that exclude them from the burn.
• Minimize potential smoke impacts on sensitive receptors

Evaluate Smoke Dispersion and Sensitive Receptor Sites

Prescribed burn plans should identify and evaluate potential smoke impacts on sensitive receptors. Fires should be timed to minimize exposure of sensitive populations (those that smoke may present particular health risks). For more information on smoke production and dispersion, please see Appendix D.

There are 5 steps to address sensitive receptor sites and smoke dispersion:

1. Identify and list sensitive receptor sites
2. Specify the requirements for smoke dispersal at sensitive receptor sites
3. Check for Air Quality Advisories
4. Notify affected populations and authorities
5. Identify monitoring plans for sensitive receptor sites

These steps are further described below.

1. Identify and list sensitive receptor sites
   Sensitive receptor sites are usually defined as locations where human populations tend to concentrate and where smoke could impact the health of those populations or significantly impact visibility that may be detrimental to health or the enjoyment of scenic qualities of the landscape. These may be residential concentrations in the form of towns or cities, or locations where people tend to gather in groups such as parks and schools. Areas where citizens can be especially sensitive to smoke include hospitals, schools, and retirement facilities. Travel routes such as highways may be labeled as sensitive receptor sites where smoke can be a factor in potential motor vehicle accidents. Particular areas along highways or other locations may be more prone to being declared sensitive receptor sites because of topographic and microclimate features.

2. Specify the requirements for smoke dispersal at sensitive receptor sites
   The plan should identify the distance and direction from the burn site to local sensitive receptor areas where appropriate. Fire prescriptions will specify minimum requirements for the atmospheric capacity for smoke dispersal such as minimum surface and upper level wind speeds, desired wind direction, minimum mixing height, and dispersion index. Utilize the Ventilation Index explained in Appendix E for minimum requirements.

Another source of information for burn day decisions in counties with an air quality monitor is the Air Quality Index (AQI). Check the AQI for the area of the burn and downwind impact zone on the WIDNR website. Values at or above the AQI orange (unhealthy for sensitive groups) category for the burn and the downwind impact zone should be considered in the decision-making process.
3. **Check for Air Quality Advisories**
   The Burn Boss or prescribed fire manager responsible for a proposed prescribed burn has the responsibility to ensure that there is no air quality advisory in effect for the county or counties affected by smoke dispersal on the day that the prescribed burn occurs. This can be done by email alerts, which staff can sign up for, or on the AirNow website, which posts air quality advisories.

4. **Notify affected populations and authorities**
   The burn plan should identify actions that will be taken to notify populations and authorities at sensitive receptors, including those in adjacent jurisdictions, prior to the fire. The plan should also identify contingency recommendations that should be taken during a fire to reduce the exposure of people at sensitive receptors if smoke intrusions occur.

   These recommendations are from the National Wildfire Coordinating Group’s Smoke Management Techniques Course (RX-410) and include the following:
   - Notify sensitive receptors and the WIDNR Air Management Bureau as soon as possible when conditions change.
   - Place field observers at sensitive receptors to monitor smoke conditions.
   - Work with local health agencies and WIDNR Air Management Bureau (issues air quality health advisories).
   - Relocate smoke-sensitive people.
   - Terminate project.
   - Accelerate completion of project.

5. **Identify monitoring plans for sensitive receptor sites**
   The plan should identify how the effects of the fire on air quality at sensitive receptor areas should be monitored. The extent of the monitoring plan should match the size of the fire, fuel loading and consider the proximity to smoke sensitive areas. For small, or short duration fires (such as those in grass or leaf litter), visual monitoring of the directions of the smoke plume and monitoring nuisance complaints by the public may be sufficient. Other monitoring techniques include posting personnel at sensitive receptors to look for smoke intrusions and continued tracking of meteorological conditions during the fire. For fires in fuels with longer duration burning (such as timber litter or slash), and which are expected to last more than one day, locating real-time PM monitors at sensitive receptors may be warranted to facilitate timely response to smoke impacts.

**Smoke Dispersion**

The National Weather Service (NWS) forecast offices in Green Bay, Sullivan, LaCrosse, Duluth, MN, and Minneapolis, MN provide twice daily fire weather forecasts every day during the fire season (generally April 1st to November 1st). The fire weather forecasts issued by the respective NWS offices, at 0700 and again by 1500, include projected smoke management information. The Fire Weather Annual Operating Plan (FWAOP), available at the forecast offices or most agency dispatch or coordination centers, provides extensive forecast information.

To ensure optimum dispersal of smoke emissions during prescribed burns, the mixing height should be deep enough and have sufficient transport wind speed to ensure the dilution and dispersal of emission concentrations. The ventilation index multiplies mixing height (measured in feet) and transport wind speed (measured in knots per hour) to produce an index that expresses the ability of the atmosphere to disperse emissions. This dispersion information is included as part of the daily fire weather forecast. It describes the mixing height, transport wind speed and ventilation index for the peak or low conditions during the forecast period. State and federal agency prescribed fire managers who plan ignitions at other than the time listed on the forecast may request...
dispersion/ventilation criteria as part of a spot weather forecast from the NWS. At this time, a spot weather forecast from the NWS is not available to the private sector. For more information on the ventilation index, refer to Appendix E.

**SMOKE MANAGEMENT BEST MANAGEMENT PRACTICE GUIDELINES: TRANSPORTATION & UTILITIES**

Signing organizations agree to follow the SMP best management practice guidelines below as part of their mitigation strategy for transportation and utility infrastructure.

**Road Impacts**

The Wisconsin Department of Transportation (WDOT) is responsible for maintaining the state and federal highways within Wisconsin. If a prescribed burn is being planned within a WDOT right-of-way (ROW) by another state or federal land management agency, organization or private landowner, a DOT permit may be required. Planning for smoke management adjacent to state and federal highways begins with contacting the local WDOT Regional Office to determine if a DOT permit is required. Each WDOT Regional Office has an individual contact for obtaining right-of-way permits.

The following documents will be submitted to the WDOT Regional Right of Way permit contact:

1. **Application/Permit To Work on Highway Right-Of-Way** (WDOT Form DT 1812)
2. The burn plan

Processing time for permit approval is up to 30 days and is intended for non-emergency activities. The approval of an annual permit rather than an individual permit may be desirable to accommodate flexibility in the time range to complete multiple burns adjacent to highways planned by state and federal land managers.

The thresholds for pre-planning the distance of a burn from travel routes should be determined on a site-by-site basis. Property ownership, rural vs. urban environment, average daily traffic (ADT) and the justification for burning within the vegetated ROW should be evaluated and addressed within the burn plan.

Participation in the WDOT ROW permit process as described above should assure that the Burn Boss/Fire Manager should receive specific information on the required signage and its proper placement within the ROW.

The WDOT brochure *Work Zone Safety: Guidelines for Construction, Maintenance, & Utility Operations* is an excellent reference. The use of electronically programmable signs for smoke warning and speed reduction is an option. The responsibility for providing standard signs or renting the programmable signs lies with the agency or organization conducting the prescribed burn. Traffic control devices placed and maintained by the state, county, city or other local officials are required by Wisconsin law to conform to the *Wisconsin Manual on Uniform Traffic Control Devices*.

For emergency situations, fire officials should immediately call 911 or local law enforcement or contact the local Region WDOT Emergency Coordinator for the fastest response. The use of signage, the decision to temporarily close a state or federal highway and to reroute traffic must be coordinated with WDOT in cooperation with fire officials and law enforcement.
Responsibility for county, city, or town roads is under the jurisdiction of the local unit of government. Prescribed fire managers/burn bosses need to contact local highway officials for the permitting process. Contact information for each **County Highway Commissioner** in Wisconsin is available on the WDOT website.

Authority to control traffic must be coordinated with state, county, or local units of government having jurisdiction over the road. **The best practice would be not to burn when it is apparent that smoke would be placed over a roadway.**

Detailed information about all roads within the state of Wisconsin including State and Federal Routes, County roads, Town roads or others can be found at the [WDOT maps website](https://www.wi.gov).

**Railway Impacts**

Contact the emergency management representative for the specific railroad effected. These representatives should have firsthand knowledge of their internal processes for emergency response to smoke and the timing of rail activity along the rail line.

The **Official Rail Map and directory of railroads** is available from the WDOT public website. The **Wisconsin Rail Map, Emergency Railroad Phone Numbers and Required Clearances near Railroad Tracks** are just a few of the documents available to assist in planning for smoke management along railroad corridors.

**Air Traffic Impacts**

The coordinating agency should contact any private and/or public airport within 10 miles of the closest burn perimeter so that air traffic control is aware of the situation. Prescribed burning within 5 miles of an airport perimeter should be closely coordinated with the airport manager/owner so that the burn does not conflict with airport usage (e.g. new pilot training). The [WDOT airport website](https://www.wi.gov) can provide detailed information on airport locations and contact information on locations.

**Utility Impacts**

The safety of fireline personnel in relation to fire use near overhead transmission lines, where smoke, ash and incidental mist from fireline operations may contaminate the insulators on transmission structures is a consideration. Standard utility recommendations are to maintain a minimum radial distance of 35 feet between firefighters, vehicles, and transmission structures to protect fire fighting personnel from this electrical hazard. Further recommendations would be to place containment lines no closer than 100 feet of and parallel to the edge of the outer most conductor.

Planning to address the direction and dispersion of smoke in these situations is critical as a heavy smoke plume on power lines may cause a conductor to ground short. Consider including any utility owner or operator that maybe impacted in the planning process. Qualified company representatives are responsible for safely adhering to all other rules pertaining to this subject matter.
SMOKE MANAGEMENT BEST MANAGEMENT PRACTICE GUIDELINES:
OUTREACH, ENFORCEMENT, & EVALUATION

Signing organizations agree to follow the SMP best management practice guidelines as part of their outreach, enforcement, and evaluation strategies.

**Public Education and Awareness**

Agencies and organizations should work to establish and maintain programs to stress the use and importance of fire for ecosystem and related land management goals. Public health and safety are critical to this effort.

**Surveillance and Enforcement:**

Prescribed burn bosses should follow a pre-burn Go/No-go procedure to ensure that the burn day parameters meet the burn plan prescription, including the smoke management best management practices. Failing to follow the burn plan prescription, burn bosses would be subject to that organization’s specific review protocols and possible disciplinary action. Agencies are encouraged to include prescribed burn personnel from other signatory agencies or private sector members from the Wisconsin Prescribed Fire Council Board of Directors in any prescribed fire review. Should legal action be taken for a prescribed burn that may trigger a review, the review may be delayed or pre-empted by necessary legal considerations.

**Optional Air Quality Protection**

Agencies should consider opportunities to establish specific, stringent protection for those special areas requiring additional regulation in the interest of public health and safety. Recognition of these areas should be documented in site-specific burn unit plans, along with the steps to minimize impacts.

**Program Evaluation**

To evaluate the effectiveness of the SMP, an interagency prescribed fire stakeholder group should annually review information on acres burned by fuel type with prescribed fire. Reports of nuisance complaints or smoke intrusions should be noted and the interagency prescribed fire stakeholder group should use this information to measure the effectiveness of this plan. The WIDNR recommends that SMP member agencies maintain records necessary to demonstrate an Exceptional Event, per Environmental Protection Agency Exceptional Event Rules, for the necessary time that the WIDNR is required to report data to the EPA. In 2017, the duration was 4 years.

In addition, the WIDNR should review data from the existing PM$_{2.5}$ and ozone monitors in Wisconsin. Any correlations of National Ambient Air Quality Standards (NAAQS) with prescribed fire should be assessed. In the event an exceedance (PM$_{10}$, PM$_{2.5}$, or ozone) is recorded, WIDNR will notify the principal contacts listed in the SMP Memorandum of Agreement to ensure the documentation necessary to demonstrate an Exceptional Event is collated and available.

The interagency prescribed fire stakeholder group should also review annually:

1. The acres of prescribed burns by fuel type and any associated air quality issues,
2. The need for changes in the SMBMP.

This SMP is an evolving document and will undergo ongoing evaluation using stakeholder input. The SMP document will be reviewed together by the principle contacts of the signatories every five years and amended as necessary.
necessary to achieve the purpose of the SMP and incorporate changes in regulations, policies and advances in technology.

Upon implementation of this plan, by January 31st of each year signatories should annually submit electronically to the Forest Protection Section—Operations WIDNR Prescribed Fire Specialist the following:

1. Acres prescribed burned by fuel model for the previous calendar year.
2. Amount of fuel consumed, based on fuel model
3. Date of burns
4. Moisture content (if available)
5. Location and legal description of burns conducted.
6. Nuisance complaints or smoke intrusions.

WIDNR will estimate emissions based upon stakeholder inputs for inclusion in the annual emissions report for the previous calendar year to EPA.
GLOSSARY

**air quality** – The characteristics of the ambient air (all locations accessible to the general public) as indicated by concentrations of the six air pollutants for which national standards have been established [i.e., particulate matter (PM), sulfur dioxide (SO\(_2\)), nitrogen dioxide (NO\(_2\)), ozone (O\(_3\)), carbon monoxide (CO) and lead], and by measurement of visibility in mandatory Federal Class I areas.

**Air Quality Advisory** – An air quality advisory is issued when the ambient air quality in an area is unhealthy for sensitive individuals or when the air quality is expected to degrade to that level within a few hours.

**ambient air** – That portion of the atmosphere, external to buildings, to which the general public has access.

**attainment area** – A geographic area in which levels of a criteria air pollutant meet the national ambient air quality standard (NAAQS) for the pollutant. An area may have an acceptable level for one criteria air pollutant, but may have unacceptable levels for others. Thus, an area could be both attainment and non-attainment at the same time. Attainment areas are defined using federal pollutant limits set by EPA.

**Burn Boss** – Person responsible for supervising a prescribed burn from ignition through mop-up.

**Class I Area** – An area set aside under the Clean Air Act (CAA) to receive the most stringent protection from air quality degradation. Mandatory Class I Federal areas are (1) international parks, (2) national wilderness areas which exceed 5,000 acres in size, (3) national memorial parks which exceed 5,000 acres in size, and (4) national parks which exceed 6,000 acres and were in existence prior to the 1977 CAA Amendments. The extent of a mandatory Class I Federal area includes subsequent changes in boundaries, such as park expansions.

**combustion** – Burning. Many important pollutants, such as sulfur dioxide, nitrogen oxides, and particulates (PM\(_{10}\)) are combustion products, often products of the burning of fuels such as coal, oil, gas and wood.

**criteria air pollutants** – A group of very common air pollutants regulated by EPA on the basis of criteria (information on health and/or environmental effects of pollution) and for which NAAQS have been established. In general, criteria air pollutants are widely distributed all over the country. They are: particulate matter (PM), carbon monoxide (CO), sulfur dioxide (SO\(_2\)), ozone (O\(_3\)), Nitrogen Oxide (NOx) and lead (Pb).

**emission** – Release of pollutants into the air from a mobile source (e.g. vehicle), stationary source (e.g. industry), or area sources (e.g. gas stations, chimneys, vegetative burning). We say sources emit pollutants.

**fuel** – Includes combustible vegetative matter such as grass, trees, shrubs, limbs, branches, duff, and stumps.

**haze** – Particles in the air that scatter light and degrade visibility.

**monitoring (monitor)** – Measurement of air pollution is referred to as monitoring. EPA, state and local agencies measure the types and amounts of pollutants in the ambient in community air.

**National Ambient Air Quality Standards (NAAQS)** – National standards for maximum acceptable concentrations of “criteria” pollutants in the ambient air. Designed to protect public health with an adequate margin of safety (primary standard), and to protect public welfare from any known or anticipated adverse effects of such pollutants (e.g., visibility impairment, soiling, materials damage, etc.) in the ambient air (secondary standard).

**non-attainment area** – A geographic area in which the level of a criteria air pollutant is higher than the level allowed by the federal standards. A single geographic area may have levels that are acceptable of one criteria air.
pollutant but unacceptable levels of one or more other criteria air pollutants; thus, an area can be both attainment and non-attainment at the same time.

nuisance smoke – Amounts of smoke in the ambient air, that interfere with a right or privilege common to members of the public, including the use or enjoyment of public or private resources.

ozone – A highly reactive gas consisting of three oxygen atoms.

particulate matter (PM) – Any airborne finely divided material mixture of very small particles that are suspended in the atmosphere, except uncombined water, which exists as a solid or liquid at standard conditions (e.g., dust, smoke, mist, fumes, or smog).

PM$_{10}$ – Particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers (including PM$_{2.5}$). Concentrations in the air are measured as micrograms per cubic meter of air ($\mu$g/m$^3$).

PM$_{2.5}$ – Particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers. Concentrations in the air are measured as micrograms per cubic meter of air ($\mu$g/m$^3$).

prescription – Measurable criteria that guide selection of appropriate management response and actions. Prescription criteria may include the meteorological conditions affecting the area under prescription, as well as factors related to the state of the area to be burned such as the fuel moisture condition and other physical parameters. Other criteria which may be considered include safety, economic, public health, environmental, geographic, administrative, social or legal considerations, and ecological and land use objectives.

Prevention of Significant Deterioration (PSD) – A requirement in the Clean Air Act, which establishes the maximum allowable increases in ambient air concentrations of selected air pollutants above baseline concentrations in areas designated as Class I, Class II, or Class III.

prescribed fire – Any fire ignited by management actions to meet specific objectives. For federal agencies a written, approved prescribed fire plan must exist, and NEPA requirements (where applicable) must be met, prior to ignition.

sensitive populations – Those populations to which smoke emissions may present particular health risks.

sensitive receptors – Locations where human population tend to concentrate and where smoke could impact the health of those population or significantly impact visibility that may be detrimental to either health or the enjoyment of scenic qualities of the landscape. These may be residential concentrations in the form of towns or cities, or locations where people tend gather in groups such as parks. Travel routes such as highways may be labeled as sensitive receptor sites where smoke can be a factor in potential motor vehicle accidents. Particular areas along highways or other locations may be more prone to being declared sensitive receptor sites because of topographic and microclimate features. (i.e., Population centers such as towns and villages, camp grounds and trails, hospitals, nursing homes, schools, roads, airports, mandatory Class I Federal areas, etc. where smoke and air pollutants can adversely affect public health, safety and welfare.)

smoke management best management practices – Establish a basic framework of procedures and requirements for managing smoke from fires that are managed for resource benefits. The purpose of these best management practices are to mitigate the health, nuisance and public safety hazards (e.g., on roadways and at airports) posed by smoke intrusions into populated areas; to prevent deterioration of air quality and NAAQS violations; and to address visibility impacts in mandatory Class I Federal areas in accordance with the regional haze rules.

source – Any place or object from which pollutants are released, such as power plants, factories, dry cleaners, gas stations, farms, motor and consumer products.
State Implementation Plan (SIP) – State implementation plans are collections of the regulations and emission reduction measures used by a state to reduce air pollution in order to attain and maintain NAAQS or to meet other requirements of the Clean Air Act. The Clean Air Act requires that EPA approve each state implementation plan.

Violation of the PM NAAQS – As revised in 2006, the daily PM$_{10}$ standard is violated when the 99th percentile of the distribution of 24-hour concentrations for a period of 1 year (averaged over 3 calendar years) exceeds 150 µg/m$^3$ at any monitor within an area. PM$_{2.5}$ are set at a daily concentration less than or equal to 35 µg/m$^3$, and an annual mean concentration of less than or equal to 15 µg/m$^3$. For PM$_{2.5}$ the daily standard is violated when the 98th percentile of the distribution of the 24-hour concentrations for a period of 1 year (averaged over 3 calendar years) exceed 35 µg/m$^3$ at any monitor within an area. The annual standard is violated when the annual arithmetic mean of the 24-hour concentrations from a network of one or more population-oriented monitors (averaged over 3 calendar years) exceeds 15 µg/m$^3$.

wildfire – An unplanned and unwanted wildland fire including unauthorized human-caused fire, escaped prescribed fire, and all other wildland fires where the objective is to put the fire out.

wildland fire – Any non-structural fire that occurs in the wildland. Two distinct types of wildland fire have been defined in Wisconsin and include wildfire and prescribed fire.
LITERATURE CITED


APPENDICES

Appendix A:
Principle Contacts for Wisconsin Smoke Management Plan
Appendix B
Federal and State Laws Related to Smoke Management Best Management Practices

Legal Requirements and Environmental Regulations for Wisconsin Smoke Management Best Management Practices

The Clean Air Act (Public Law 95-95) as amended in 1977 and 1990 identifies standards and legal requirements that must be met by the EPA, other Federal agencies, the states, and industry. Prior to 1990, the Federal Clean Air Act did not directly address prescribed burning. However, the latest amendments contain a number of sections which may result in both direct and indirect regulatory controls.

Section 109 of the Clean Air Act (CAA) requires EPA to develop primary ambient air quality standards to protect human health and secondary standards to protect welfare. In July of 1987, the EPA promulgated ambient air quality standards for those particulates less than 10 microns in diameter (PM$_{10}$). The PM$_{10}$ standards were designed to protect that portion of the population which is most susceptible to the effects of airborne respirable particles with an adequate margin of safety. However, more recent research indicated that the PM$_{10}$ standard did not protect those people who already had existing respiratory problems. As a result, EPA issued their initial fine particulate standards in July, 1997 to regulate those particulates less than 2.5 microns in diameter (PM$_{2.5}$). These standards are of interest to the fire community because approximately 70% of the particulate emitted from biomass burning are in this size range. More current epidemiological studies indicate a much stronger relationship between increases in PM$_{2.5}$ concentrations and mortality and morbidity. As a result, EPA revised these standards in September, 2006 reducing the 24 hr standard from 65 to 35 micrograms per cubic meter ($\mu g/m^3$). The annual standard stayed the same at 15 ($\mu g/m^3$). (Table B1, PM Ambient Air Quality Standards)

Table A1 – EPA’s PM Standards: Old and New (MI SMP 2007)

<table>
<thead>
<tr>
<th></th>
<th>1997 Standards</th>
<th>2006 Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>July 17th, 1997</td>
<td>September 21st, 2006</td>
</tr>
<tr>
<td><strong>PM$_{2.5}$</strong></td>
<td>Annual</td>
<td>24-hour</td>
</tr>
<tr>
<td>(fine particles)</td>
<td>15 $\mu g/m^3$</td>
<td>65 $\mu g/m^3$</td>
</tr>
<tr>
<td></td>
<td>(average)</td>
<td>(96th percentile)</td>
</tr>
<tr>
<td><strong>PM$_{10}$</strong></td>
<td>Annual</td>
<td>24-hour</td>
</tr>
<tr>
<td>(coarse particles)</td>
<td>15 $\mu g/m^3$</td>
<td>65 $\mu g/m^3$</td>
</tr>
<tr>
<td></td>
<td>(average)</td>
<td>(1 expected exceedance)</td>
</tr>
</tbody>
</table>

Wisconsin has several monitoring sites (Green Bay, Milwaukee and Madison) that have measured violations of the new 24-hour PM$_{2.5}$ standard based on 2005 through 2007 monitoring data. Based on this information and additional monitoring data EPA has designated three nonattainment counties in Wisconsin: Milwaukee, Racine and Waukesha Counties. Wisconsin is currently working on a comprehensive plan with Illinois, Indiana, Michigan and Ohio to address ozone, PM$_{2.5}$ and haze problems. WIDNR’s analysis indicates that the problem is regional in nature and the most effective way to deal with the problem is to limit emissions of SO$_2$ and NO$_x$ on a regional basis. NO$_x$ comes from combustion in cars, trucks, off-road equipment, power plants and industrial sources. SO$_2$ comes primarily from coal combustion in power plants and industrial boilers.

Up-to-date monitoring data and monitor address information is available from the WIDNR Air Quality Index website.
Section 110 CAA requires the state to develop State Implementation Plans (SIPs) which identify how the state will attain and maintain national ambient air quality standards (NAAQS) and meet other Federal air quality regulations. Section 112 identifies 188 hazardous air pollutants; the EPA has focused their attention on 33 of the 188 pollutants at this time. *Five of these are emitted from biomass burning: Acetaldehyde, Acrolein, 1, 3 Butadiene, Formaldehyde, and Polycyclic organic matter.* While this section focuses control requirements on major and minor stationary air pollution sources, the State and EPA are trying to determine the risk to the public from all air toxic emission sources *including biomass burning.*

Sections 160-169 provide for the prevention of significant deterioration of air quality in those areas of the county which currently have air quality concentrations which are better than the standards set under Section109.

Section 169A provides visibility protection for the mandatory Federal Class I areas. There are no Class I areas in Wisconsin where visibility is an air quality related value. However, Wisconsin must submit a plan to limit the effects of our sources on visibility on any Class I area. The closest Class I areas are in Michigan and Minnesota (Seney National Wildlife Refuge and Isle Royale National Park in Michigan, and Voyageurs National Park and Boundary Waters Canoe Area Wilderness in Minnesota).

Section 176 (c) prohibits Federal Agencies from permitting, approving, providing financial assistance, or supporting in any way an activity which does not conform to an EPA approved State Implementation Plan. This section of the Act only applies to federal agencies. However, a federal agency’s prescribed burn emissions are presumed to conform to these plans provided the burn is conducted under certified smoke management best management practices, and thus no determination is required.

Section 319 directs EPA to promulgate regulations governing the review and handling of air quality monitoring data influenced by an exceptional event. These regulations were designed to codify a number of existing EPA policies into a rule. That rule was published on March 22, 2007. The Rule provides that if exceptional events cause violations of the NAAQS, EPA would use its discretion not to re-designate an area as non-attainment. One of those policies included in the Rule was the 1998 EPA Interim Air Quality Policy on Wildland and Prescribed Fire. The policy integrated two public policy goals: (1) to allow fire to function as nearly as possible in its natural role in maintaining healthy wildland ecosystems, and (2) to protect public health and welfare by mitigating the impacts of air pollution emissions on air quality and visibility. The document identified significant procedural and legal benefits for the States and the users of wildland fire if they develop smoke management plans that are state-certified. A state Smoke Management Program would establish a standard framework of those related procedures and requirements for managing smoke from prescribed fires. As a result of the new Exceptional Events Rule, EPA has committed to revise the Interim Policy, which will be forthcoming.

The Rule defines an exceptional event as an event that:

- Affects air quality
- Is not reasonably controllable or preventable
- Is an event caused by human activity that is unlikely to reoccur at a particular location
- Is a natural event

The Rule also states that wildfires will be treated as natural events.

Examples of Natural Events:

- Volcanic & Seismic Activities
- Natural Disasters & Associated Clean-up Activities
- High Wind Events
- Wildfires
- Stratospheric Ozone Intrusions
Examples of Exceptional Events:
  Chemical Spills and Industrial Accidents
  Structural Fires
  Exceedances due to Transported Pollution
  Exceedances due to a Terrorist Attack

Prescribed fires managed for resources benefits may qualify for exceptional events if they meet certain criteria: “Unlikely to recur at the same location” and “not reasonably controllable or preventable”, or if the responsible party was part of a EPA-approved smoke management plan.

When the state certifies that a smoke management program or basic smoke management practices are in place, EPA’s handling of data from all other fires will continue to be addressed under the Interim Air Quality Policy for Wildland and Prescribed Fires.

Agency Authority

The Wisconsin Department of Natural Resources (WDNR) has the authority to implement and enforce Federal regulations related to air quality standards.

The WDNR maintains the air monitor system throughout the state. If an air monitor station in the state records a violation of the NAAQS, then the area in violation of the standard is designated as “non-attainment area”. As required by Section 110 of the CAA, the state must submit a SIP to the EPA identifying what measures the state will take to reduce emissions affecting the area in order to meet and maintain compliance with the standard. Each plan shall include “enforceable emission limitation and other control measures” as required by Section 110. This would apply to facilities and sources that contribute to the violation of the standard. Construction and modification of stationary sources within non-attainment areas would be subject to emission offset regulations which require any new emissions to obtain emission offsets from existing air pollution sources. This requirement is designed to result in a net emission decrease to help bring the area back into attainment.

By implementing the requirements of a SIP that has EPA approval, the WDNR enforces compliance with air quality standards within the State of Wisconsin. Regulatory instruments that may be included in a SIP in order to return an area to compliance with an air quality standard, include statutes, rules, orders, or permit conditions. If any of these become part of a federally approved WI SIP, the measure would become both State and Federal enforceable.

Wisconsin is currently working to develop a Regional Haze SIP and PM$_{2.5}$ SIP as a member of the Midwest Regional Planning Organization (RPO) which includes Michigan, Ohio, Indiana, and Illinois. The projects underway by the Midwest RPO include visibility monitoring, data analysis, photochemical modeling, and engineering analysis of selected large PM$_{2.5}$ emitters in the region.
Appendix C
Basis for Developing Smoke Management Best Management Practices

The purposes of the Smoke Management Plan (SMP) and its accompanying best management practices are directly related to the mitigation of any public health, nuisance and safety hazards posed by smoke intrusions into populated areas and roadways. The goals are to prevent deterioration of air quality and National Ambient Air Quality Standards (NAAQS) violations, and address visibility impacts on mandatory Class 1 Federal areas. The NAAQS referred to here are for particulate matter (PM) less than 2.5 microns (PM$_{2.5}$) and PM less than 10 microns (PM$_{10}$) in diameter.

The reasons the SMP is being developed for Wisconsin are:

1. **There has been an increase in the use of prescribed fire in Wisconsin.**
   Table A1 identifies a trend of increased use of prescribed fire in Wisconsin. This follows a nationwide trend identified by federal and state land managers. This increase of prescribed fire has strong ecosystem and landscape management implications to increase biodiversity and productivity.

2. **To utilize a voluntary program to prevent PM NAAQS violations related to emissions from prescribed fire managed for resource benefits.**
   Implementation of the smoke management best management practices by land management agencies, organizations and the private sector should reduce potential emissions and smoke impacts from prescribed fires so that emissions do not result in “non-attainment” status with NAAQS and state air quality standards. The EPA Interim Guidance document explains that states which implement a certified SMP and do violate the PM$_{10}$ or PM$_{2.5}$ standards will not have areas designed as “non-attainment”, if the State demonstrates that prescribed and/or wildland fire significantly contributed to the concentration of pollutants that exceeded the standards. This incentive by the EPA for implementation of a Smoke Management Plan is important if an area of the state were to violate the air quality standards due to smoke produced by prescribed burning.
   The EPA Exceptional Events Rule published on September 30, 2016 states that all wildfires will be considered as natural events and will not be counted in determining an areas attainment or non-attainment status. The impact of prescribed fires may be discounted if the burn was conducted under a certified Smoke Management Plan or the burner was using basic smoke management practices (as defined by the applicable air quality regulatory agency).

3. **The EPA Regional Haze Rule to protect and improve visibility in mandatory Class I areas the Lake States.**
   Section 169A of the Clean Air Act Amendments (CAA) of 1977 sets forth “the national goal of preventing any future, and remedying any existing, impairment of visibility in mandatory Class I Federal areas which impairment results from man-made air pollution.” The EPA rules issued in 1980 included language directed at those sources “reasonably attributable” to visibility impairment. With the addition of section 169B of the CAAA of 1990, congress addressed “regional haze” visibility impairment in the nation’s national parks and wilderness areas. The EPA determined that all 156 listed mandatory Class I areas across the nation demonstrate impaired visibility based on monitoring data from the Interagency Monitoring of Protected Visual Environments (IMPROVE). This includes the Class 1 areas of Seney National Wildlife Refuge and Isle Royale National Park in Michigan, and Voyageurs National Park and Boundary Waters Canoe Area Wilderness in Minnesota. For the Class I areas, in Minnesota and Michigan, smoke from Wisconsin prescribed fire have not been shown to be a significant contributor to visibility impairment.
   EPA published their final Regional Haze Rule on July 1, 1999 (64FR35714). This rule is directed at man-made air pollution sources that have the potential to cause or contribute to visibility impairment including: 1) stationary sources (industry), 2) mobile sources (vehicles), 3) area sources (gas stations, dry cleaners, etc.), and 4) the use of managed fire. Of the pollutants most responsible for haze (nitrates, sulfates, soil material, organic carbon, and elemental carbon), nitrates, organic carbon and elemental carbon are produced by vegetative burning. The regional haze program goal is to show continued improvement in monitored visibility in Class 1 areas and restore natural background conditions by 2064.
Other factors that do not apply to Wisconsin at this time but are “strong indications” that a smoke management plan is necessary are listed in the EPA “Interim Air Quality Policy on Wildland and Prescribed Fires” issued April 1998. These include any of the following if they result from fire use:

1. Citizens increasingly complain of smoke intrusions.
2. The trend of monitored air quality values is increasing (approaching the daily or annual NAAQS for PM$_{2.5}$ or PM$_{10}$) because of significant contributions from fires managed for resource benefits.
3. Fires cause or significantly contribute to monitored air quality that is already greater than 85 percent of the daily or annual NAAQS for PM$_{2.5}$ or PM$_{10}$.
4. Fires in the area significantly contribute to visibility impairment in mandatory Class I Federal areas.
Appendix D
Smoke Production and Dispersion

Overview and Definition of Smoke Dispersion

Information pertaining to smoke dispersion is an important element of a prescribed burn plan. Smoke dispersion is directly related to ventilation, which is the process within the atmosphere that mixes and transports smoke away from its source. Ventilation is a function of atmospheric stability, mixing height and transport winds. Mixing height is defined as the upper limit of an unstable mixed layer, in which upward and downward exchange of air occurs. In theory, the mixing height represents the level that smoke will rise to before spreading out horizontally. Transport wind is defined as the arithmetic average of the wind speed and direction within the mixed layer. Transport wind should provide a basic estimate of the movement of the smoke column as it advects out of the source region.

Just as various indices are used to estimate fire behavior, a ventilation index has been developed to estimate the lower atmosphere’s ability to diffuse and disperse smoke. The Ventilation Index (also known as the Dispersion Index) is calculated by multiplying the mixing height (feet) by the transport wind (knots). A high Ventilation Index usually means that smoke will disperse in an efficient manner. A low Ventilation Index usually means that the dispersion of smoke in the lower atmosphere will be hindered. Caution should be used when interpreting the Ventilation Index, as the values can sometimes be misleading. For instance, a high Ventilation Index can be produced with either a high transport wind and low mixing height or a low transport wind and high mixing height. In both of these situations, smoke dispersion may still be hindered.

Table C1 – Ventilation Index

<table>
<thead>
<tr>
<th>Dispersion Rate</th>
<th>Dispersion Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;13,000</td>
<td>Poor</td>
</tr>
<tr>
<td>13,000 - 29,999</td>
<td>Fair</td>
</tr>
<tr>
<td>30,000 - 59,999</td>
<td>Good</td>
</tr>
<tr>
<td>60,000 or greater</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

Smoke dispersion information is available on the Fire Weather Planning Forecast (FWF), which is issued twice daily during the fire season at 7 am and 3 pm. Average mixing height and transport wind for the noon to 6 pm period are provided for the daytime periods (through day 2) in the Fire Weather Planning Forecast. The Ventilation Index, which is labeled as smoke dispersal in the FWF, is also averaged between noon and 6 pm, and is provided for the daytime periods of the forecast through day 2. Average values are used in order to provide a more representative estimate for prescribed burn projects, which may be started at varying times of the day (depending on the agency, type and size of the project). Fire Weather Planning Forecasts are posted on all local National Weather Service (NWS) websites. Smoke dispersion forecasts are also available as part of a spot forecast request.

Climate Factors that Influence Smoke Dispersion in Wisconsin

Wisconsin resides in the humid continental climate region, due to its interior location in the mid-latitudes of North America. The state lies in the boundary zone between many different air masses, including those of polar and tropical origin. As a result, Wisconsin experiences highly variable weather conditions and large seasonal changes in temperature. Weather conditions are most variable during the spring and fall months, when the jet stream migrates across the Great Lakes, resulting in strong storm systems tracking through the region. Lake Superior and Lake Michigan strongly influence local weather conditions near their respective shorelines in northwest and eastern Wisconsin.
Here are some more detailed explanations of the various factors that influence smoke dispersion potential in Wisconsin:

**Air Masses and Frontal Systems** are the main factors that influence day-to-day variations in smoke dispersion. There are five different types of air masses that affect the United States, including continental polar, continental arctic, continental tropical, maritime polar and maritime tropical. Wisconsin can be affected by all of these air masses during the course of a fire season, but is most commonly affected by continental polar, maritime polar and maritime tropical air masses. Continental polar air masses, which arrive from northern Canada, are usually cool, dry and stable, and sometimes result in low mixing heights and poor smoke dispersion due to the presence of a subsidence inversion. Maritime polar air masses form over the northern Pacific Ocean region, where they take on their typical cool, moist and unstable characteristics. However, these air masses usually lose most of their moisture as they ascend the west slopes of the Rocky Mountains, and warm as they descend the east slopes. By the time they arrive in Wisconsin, they are usually dry, mild and unstable. As a result, mixing heights are typically quite high in air masses of Pacific origin. Maritime tropical air masses, which originate from the Gulf of Mexico, are usually warm, moist and unstable.

Frontal systems can also have a significant effect on smoke dispersion. Cold fronts are usually accompanied by windy and unstable conditions, which provide for excellent smoke dispersion. Conditions are quite variable with warm fronts, with stable conditions and poor smoke dispersion expected north of the front, and unstable and windy conditions to the south.

**Latitude**, which controls the sun angle and length of the day, is responsible for seasonal temperature contrasts. Mid-latitude locations such as Wisconsin experience sharp changes in seasonal temperatures due to widely varying sun angle and day length. These temperature changes can significantly impact smoke dispersion. For example, mixing heights are typically lowest during the winter months, since daytime heating is limited due to low sun angle, short day length and snow covered ground. During the spring and summer, increased solar heating due to a high sun angle and longer day length is usually sufficient to mix out low level inversions, resulting in higher mixing heights and more effective smoke dispersion.

**Lake Superior and Lake Michigan** have a significant impact on smoke dispersion, especially during the spring and summer months. Lake breezes, which frequently develop in northwest and eastern Wisconsin from April through August, often result in poor smoke dispersion near the lakeshore. Lake breezes typically form during the late morning or early afternoon, become strongest during the mid to late afternoon, then weaken by early evening. On most days, the lake breeze front will only push inland 5 to 10 miles, but in extreme cases, may move inland 50 miles or more. Stable conditions develop as the cooler marine air penetrates inland, forcing warmer air aloft. In addition to smoke dispersion concerns, shifting winds associated with a lake breeze front can occasionally cause fire control problems.

**Upper Level Disturbances**, also known as upper level troughs of low pressure, often result in improved smoke dispersion as they pass through the western Great Lakes region. These disturbances, which are usually accompanied by pockets of cold air aloft, often produce windy and unstable conditions, and help to generate large scale rising motion in the atmosphere.

**Weather Patterns that Affect Smoke Dispersion in Wisconsin**
Wisconsin usually receives good ventilation throughout most of the fire season. During the months of April through October, solar radiation is usually strong enough to either mix out or lift inversions that are near the surface. However, there are some typical seasonal weather patterns that cause smoke dispersion problems.

- During the early spring and late fall, strong Canadian high pressure systems often sag into the northern Great Lakes region and persist for several days. These Canadian highgs typically have strong subsidence inversions, which gradually lower toward the surface, leading to poor smoke dispersal. Ventilation is especially poor when widespread low clouds (stratus) are present. The low clouds typically form in two ways; either due to low level east winds advecting marine moisture off of Lake Michigan, or due to the presence of a warm front over Iowa.
and northern Illinois, which lifts warm, moist air from the Gulf of Mexico over the top of the cooler Canadian air mass. The poor smoke dispersal is the net result of low mixing heights (generally 1,000-2,000 feet) and light winds.

- Persistent (lasting up to a week or more) summertime high pressure systems accompanied by a large blocking ridge of high pressure aloft can produce significant smoke dispersion problems. Although daytime mixing heights are often sufficiently high, transport winds are typically too light to support efficient smoke dispersion. The stagnant conditions eventually lead to reduced visibility and poor air quality, especially during the nighttime and early morning hours, when smoke particles aloft fall back to the surface.

- Radiation inversions (also known as nocturnal inversions), which develop as the earth’s surface cools at night, can trap smoke near the ground during the nighttime and morning hours. Radiation inversions can occur throughout the year, and typically form on nights when skies are clear and winds are light. Summertime radiation inversions tend to be shallower, and usually mix out earlier in the morning, than those that develop during the spring and fall.

- Inland intrusions of cool, stable marine air associated with lake breeze fronts (or persistent onshore winds) can significantly hinder smoke dispersion during the spring and summer months. Lake breeze fronts are most common on days when winds at the surface and aloft are light. Lake breezes that develop near Lake Superior in northwest Wisconsin typically have a northerly component to their wind direction, while those that develop near Lake Michigan (and the bay of Green Bay) have an easterly component. Although a lake breeze front will typically remain within 5 to 10 miles of the lake during the early to mid afternoon, they can occasionally penetrate well inland (50 miles or more) before weakening during the late afternoon or early evening hours.
Appendix E
Guidance for Use of the Ventilation Index and Dispersion Tables

The Ventilation Index (also known as the Dispersion Index) is calculated by multiplying the mixing height (feet) by the transport wind (knots). A high Ventilation Index usually means that smoke will disperse in an efficient manner. A low Ventilation Index usually means that the dispersion of smoke in the lower atmosphere will be hindered.

Table D1 – Ventilation Index

<table>
<thead>
<tr>
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<td>Good</td>
</tr>
<tr>
<td>60,000 or greater</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

Note: In using the ventilation index, exercise caution with high transport wind speed and low mixing height or low transport wind speed and high mixing height. Either combination may result in a false representation of an acceptable category, which can result in smoke dispersion problems and potential control problems.

When utilizing the ventilation index it is important to consider the total fuel load being burned, both in terms of the fuel loading (tons of fuel per acre) and the total area to be treated. The proximity of downwind smoke sensitive areas to the burn unit should also be considered, so that in general the lower the expected total fuel consumption and the farther away from smoke sensitive receptors, the lower the ventilation index can be. Additionally, practices that reduce the total fuel load available for consumption can lower the acceptable dispersion category either by reduction of fuel, or acres to be treated.

Two methods that can be utilized for mitigation of smoke impacts during the burn planning process are as follows:

**Method A:** This method may be used as a general guide to use the Ventilation Index in combination with a smoke screening map to screen for sensitive downwind receptors. It is recommended for those burn units with low to moderate potential for smoke impacts.

1. From the Daily Burn Unit Size chart (Table D2) select the size of the planned burn unit* in acres.
2. Determine the general fuel category which best represents the majority of the burn unit.
3. On a map of the area locate the sensitive downwind receptors that could be impacted by smoke produced by the burn unit.
4. Use the Dispersion Category charts (Table D3) and determine the minimum distance which a burn should take place upwind of a sensitive receptor on a certain Dispersion Category day.

*Note: These are voluntary guidelines which may vary based on the local unit’s definition of smoke sensitive receptor and the ability to mitigate potential smoke problems by instituting traffic controls when smoke could impact major roads or by burning under fuel moisture conditions which limit consumption of heavier fuels.
### Table D2 – Daily Burn Unit Sizes

<table>
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<tr>
<td>Small</td>
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<td>Medium</td>
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<tr>
<td>Large</td>
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<tr>
<td>Landscape</td>
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</tbody>
</table>

### Table D3 – Distances to Smoke-sensitive Areas

<table>
<thead>
<tr>
<th>DISPERSION CATEGORY</th>
<th>PROXIMITY OF CLOSEST DOWNWIND SMOKE-SENSITIVE AREAS</th>
<th>DESCRIPTION OF UNIT SIZE AND AVAILABLE FUEL LOAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXCELLENT</td>
<td>&lt;0.25 mile</td>
<td>Small – Large burns in grass or leaf litter</td>
</tr>
<tr>
<td></td>
<td>&lt;0.25 mile</td>
<td>Small – Med burns in timber, slash, or piled fuels</td>
</tr>
<tr>
<td></td>
<td>&gt;0.25 mile</td>
<td>Landscape burns in grass or leaf litter</td>
</tr>
<tr>
<td></td>
<td>&gt;0.25 mile</td>
<td>Large burns in timber, slash, or piled fuels</td>
</tr>
<tr>
<td></td>
<td>&gt;0.5 mile</td>
<td>Landscape burns in timber, slash, or piled fuels</td>
</tr>
<tr>
<td>GOOD</td>
<td>&lt;0.25 mile</td>
<td>Small – Large burns in grass or leaf litter</td>
</tr>
<tr>
<td></td>
<td>&lt;0.25 mile</td>
<td>Small – Med burns in timber, slash, or piled fuels</td>
</tr>
<tr>
<td></td>
<td>&gt;0.5 mile</td>
<td>Landscape burns in grass or leaf litter</td>
</tr>
<tr>
<td></td>
<td>&gt;0.5 mile</td>
<td>Large burns in timber, slash, or piled fuels</td>
</tr>
<tr>
<td></td>
<td>&gt;0.75 miles</td>
<td>Landscape burns in timber, slash or piled fuels</td>
</tr>
<tr>
<td>FAIR</td>
<td>&lt;0.25 mile</td>
<td>Small – Med burns in grass or leaf litter</td>
</tr>
<tr>
<td></td>
<td>&gt;0.25 mile</td>
<td>Large burns in grass or leaf litter</td>
</tr>
<tr>
<td></td>
<td>&gt;.5 mile</td>
<td>Small – Med burns in timber, slash, or piled fuels</td>
</tr>
<tr>
<td></td>
<td>&gt;0.75 mile</td>
<td>Landscape burns in grass or leaf litter</td>
</tr>
<tr>
<td></td>
<td>&gt;0.75 miles</td>
<td>Large burns in timber, slash or piled fuels</td>
</tr>
<tr>
<td></td>
<td>&gt;1.0 mile</td>
<td>Landscape burns in timber, slash, or piled fuels</td>
</tr>
<tr>
<td>POOR*</td>
<td>&lt; 0.25 mile</td>
<td>No burns</td>
</tr>
<tr>
<td></td>
<td>&gt;0.50 mile</td>
<td>Small burns of primarily grass fuels.</td>
</tr>
<tr>
<td></td>
<td>&gt;1.00 mile</td>
<td>Single large pile or scattered small piled debris</td>
</tr>
</tbody>
</table>

*On Poor Category days no burning is suggested within ¼ mile of any downwind smoke sensitive area and is not recommended in general.

As an example, for a 500 acre burn in grass fuels, a minimum distance that a burn should occur upwind of a sensitive receptor would be: greater than 0.25 miles with Excellent Dispersion, greater than 0.5 mile with Good Dispersion, greater than 0.75 miles with Fair Dispersion and there should be no burn under Poor Dispersion.
**Method B:** Recommended for complex prescribed burns where there is a high potential for smoke impacts.

1. Estimate the fuel loading for the area to be burned. This may be done formally, utilizing site-specific survey data if available or by consulting the fuel model information found in: *Aids in Determining Fuel Models for Estimating Fire Behavior*, or *Standard Fire Behavior: A Comprehensive Set for Use with Rothermel’s Surface Spread Model* or the *Natural Fuels Photo Series*.

2. Determine the acreage to be burned in one day.

3. Estimate the expected fuel consumption using hand calculations or computer models such as FOFEM or CONSUME. Selection of higher fuel moistures (such as higher 100 and 1,000 hour fuel moisture), which should reduce the fuel available for consumption, should be factored into the calculations.

4. Determine the total PM$_{10}$ and PM$_{2.5}$ emissions per day based on outputs from #3.

5. Locate downwind sensitive receptors that could be impacted from your smoke.

6. Utilize a dispersion computer program to screen for the potential to exceed ambient air quality standards.

**Mapping guidance to identify the closet smoke sensitive target and distance from the prescribed fire (figure D1).**

1. Locate on a map the prescribed fire and all potential smoke sensitive targets, plus areas known to already have air pollution problems.

2. Determine the wind direction that should have the least impact on smoke sensitive targets.

3. Draw a line representing the centerline of the path of the smoke plume using the wind direction chosen in the previous step.

4. Determine the distance from the edge of the prescribed fire to the nearest smoke-sensitive target.

5. To allow for horizontal dispersion of the smoke, as well as shifts in wind direction, draw two other lines from the burn at an angle of 30 degrees from the centerline.

**Figure D1 – SMOKE PLOTTER (NWCG RX 410)**
MEMORANDUM OF AGREEMENT

Between

Wisconsin Department of Natural Resources
United States Department of Agriculture, Forest Service
United States Department of Agriculture, Natural Resources Conservation Service
United States Department of the Interior, National Park Service
United States Department of the Interior, Fish and Wildlife Service
United States Department of the Interior, Bureau of Indian Affairs
United States Department of Defense, Fort McCoy
Menominee Indian Tribe of Wisconsin
and
The Nature Conservancy

This Memorandum of Agreement (MOA) is hereby entered into by and between the Wisconsin Department of Natural Resources; the United States Department of Agriculture, Forest Service Chequamegon-Nicolet National Forest and Natural Resources Conservation Service; Wisconsin management units of the United States Department of the Interior, National Park Service, Fish and Wildlife Service, and Bureau of Indian Affairs; The United States Department of Defense, Fort McCoy; The Menominee Indian Tribe of Wisconsin; and The Nature Conservancy, a nonprofit corporation of the District of Columbia, hereinafter collectively referred to as the “Land Management Parties” or “Parties”.

I. PURPOSE

A. The purpose of this MOA is to provide a means for the Parties to formally adopt and implement the Wisconsin Smoke Management Plan (SMP), which is attached and incorporated into this Memorandum, and to:

1. Promote agreement among the Land Management Parties in conducting prescribed burn programs according to the best management practice guidelines of the Smoke Management Plan, and the agreement of each Party to undertake the responsibilities described in the SMP.

2. Encourage cooperation among Land Management Parties that conduct prescribed burning in Wisconsin; the National Weather Service, and the U.S. Environmental Protection Agency (EPA) in implementing the Wisconsin SMP.
B. The purpose of the Wisconsin SMP is to describe minimum best management practices to reduce air emissions from prescribed fire; to mitigate the effects of those emissions on air quality and visibility; to define the responsibilities of the Land Management Parties in conducting prescribed burning in Wisconsin; to define the responsibility of the National Weather Service to perform fire weather forecasting; to define the responsibilities of the State regulatory agencies to issue permits for open burning; and to assess the effects of burning on air quality and visibility.

C. This Memorandum of Agreement defines practices and procedures the parties intend to follow. It is not a basis for legal enforcement actions among the parties, nor does it set legal standards for fire and smoke management.

II. BACKGROUND

The federal Regional Haze Rule published by the U.S. EPA on July 1, 1999 (64 FR 35714) includes requirements to improve visibility in the national parks and wilderness areas. Among the sources of air pollution that may contribute to visibility impairment are emissions from vegetative burning.

EPA guidance “Interim Air Quality Policy on Wildland and Prescribed Fires” of April 23, 1998, specifically addresses smoke emissions from fire and sets forth components of Smoke Management Programs that can be adopted by States. Public and private land management parties that adopt and implement programs to manage smoke from prescribed burning will reduce the amounts of smoke generated from fire and/or the effects of that smoke on the public health and welfare. The lower concentrations of smoke emissions will assist in preventing violations of National Ambient Air Quality Standards (NAAQS) for particulate matter (PM). For those states that adopt smoke management plans, under certain conditions and for a limited period of time, EPA will exempt smoke emissions from both prescribed burning and managed wildland fire from determinations of NAAQS violations for PM.

III. ROLES AND RESPONSIBILITIES

A. The Parties agree to comply with the provisions of the SMP and with applicable State and federal regulations when conducting prescribed burns or managing wildland fires.

B. Party Responsibilities:

1. The Land Management Parties agree to incorporate the smoke management best management practice guidelines of the SMP into each burn plan to manage smoke from prescribed fires in order to minimize the amount and/or the effect of the smoke on air quality, to annually attempt to retain, compile, and report number of acres and fuel type burned, prescribed burn information to the Wisconsin Interagency Fire Council, Wisconsin Department of Natural Resources.
Wisconsin Smoke Management Plan
Memorandum of Agreement

Wisconsin Smoke Management Plan
Memorandum of Agreement

Resources Prescribed Fire Specialist, and to participate in public education regarding prescribed fire and smoke management.

2. The Wisconsin Department of Natural Resources (WIDNR) agrees to act as the “Central Authority” under the 1998 EPA guidance “Interim Air Quality Policy on Wildland and Prescribed Fires” for the SMP and, except for federal and tribal lands, to review burn applications and issue written burn permits for all open burning in Wisconsin Protection Areas, or to delegate this authority.

3. The WIDNR Air Management Program agrees to annually review data from the ambient particulate matter and ozone monitors in Wisconsin and the IMPROVE monitors, to assess correlations of air quality with wildland fire and prescribed fire, and to report this information to the Wisconsin Interagency Fire Council for the annual evaluation of the SMP.

IV. REVIEW AND REPORTING

A. The Wisconsin Interagency Fire Council The principle contacts of the Parties will hold an annual meeting every five years to evaluate the SMP and amend it as determined necessary. The Parties to this MOA will each send a representative to attend this meeting or provide the necessary information to the meeting, if an the principle contacts agency representative cannot attend. Changes to the SMP will be made with the approval of the signatories, or their representatives, to this MOA. An amended and signed MOA will formally implement revisions to the SMP.

B. The Parties will each attempt to retain and compile reports of complaints due to smoke from wildland and prescribed fire and report these at the Wisconsin Interagency Fire Council annual meeting to review the SMP: the following prescribed burn information:

1. Total acres burned by each fuel model for the previous calendar year
2. Amount of fuel consumed, based on fuel model
3. Date and location of prescribed burns
4. Moisture content (if available)
5. Nuisance complaints or smoke intrusions

This information will be reported to the WIDNR Prescribed Fire Specialist no later than January 31st of the following year.

1. The Parties will each report number of acres and fuel type burned by prescribed fire and managed wildland fire at the annual meeting to review the SMP.

B.C. The Wisconsin Department of Natural Resources, WIDNR Air Management Program will review air quality data from monitors in Wisconsin and the Class I areas with regard to information on emissions from wildland fire and prescribed fire and report
this assessment annually to the Wisconsin Interagency Fire Council WIDNR Prescribed Fire Specialist.

C.D. The Wisconsin Department of Natural Resources WIDNR Prescribed Fire Specialist will report compile the number of written burn permits issued for open burning in Wisconsin and the number of total acres burned, or report how this information could be compiled, at the annual meeting to review the SMP on an annual basis. Prescribed burn information from WIDNR and other participating signatories will be compiled and reported to the EPA.

V. AGREEMENT DURATION AND WITHDRAWAL:

This Agreement shall go in effect upon the date of the last signature and remain in effect until modified or terminated with the written consent of all Parties. A party may withdraw from this Agreement one year following written notification to the all Parties.
IN WITNESS WHEREOF, the parties to this agreement have executed this agreement intending to be bound by it.

APPROVED BY:

For the Wisconsin Department of Natural Resources

________________________________________________________________________  ___________
Cathy Stepp  
Secretary  

For the US Forest Service

Chequamegon-Nicolet National Forest

________________________________________________________________________  ___________
Gordon Blum  
Acting Forest Supervisor  

For the Natural Resources Conservation Service

________________________________________________________________________  ___________
Jimmy Bramblett  
State Conservationist  

For the National Park Service

________________________________________________________________________  ___________

For the US Fish and Wildlife Service

Region 3

________________________________________________________________________  ___________
Jason Riggins  
Region 3 Fire Management Coordinator  

Wisconsin Smoke Management Plan  
Memorandum of Agreement  

5
For the Bureau of Indian Affairs

Scott Sufficool
Acting Regional Director

Date

For The US Department of Defense
Fort McCoy

David J. Pinter, Sr.
Colonel, U.S. Army
Commanding

Date

For The Menominee Indian Tribe of Wisconsin

Joan Delabreau
Tribal Chairwoman

Date

For The Nature Conservancy

Mary Jean Houston
State Director for Wisconsin

Date