Guidance on Nitrogen and Sulfur Deposition Analysis Thresholds

Background

The National Park Service (NPS) and the U.S. Fish and Wildlife Service (FWS) have developed criteria for evaluating the contribution of additional nitrogen (N) or sulfur (S) to deposition within Class I areas. This document describes the equation and process by which Deposition Analysis Thresholds (DATs) have been developed for Class I areas. The NPS and FWS have developed this DAT equation in response to requests by permitting authorities and permit applicants to continue to develop consistent, predictable permit review processes, and to expedite the permit review process. In developing DATs, the NPS and FWS seek to further improve the process by providing a quantitative method with which to evaluate sulfur deposition in Class I areas. DATs for both sulfur and nitrogen have been developed and are presented here.

The Clean Air Act Amendments of 1977 give Federal Land Managers (FLMs) an "affirmative responsibility" to protect air quality and air quality related values (AQRVs) within Class I areas. An AQRV is a resource that may be adversely affected by a change in air quality. The resource may include visibility or a specific scenic, cultural, physical, biological, ecological, or recreational resource identified by the FLM for a particular area. FLMs are responsible for reviewing air quality permit applications from proposed new or modified major sources near Class I areas, and determining the potential impacts, if any, that may result from source emissions. FLMs take into account the particular resources and AQRVs that would be affected; the frequency and magnitude of any potential impacts; and the direct, indirect, and cumulative effects of any potential impacts. In making these determinations, FLMs are mandated to err on the side of resource protection.

Deposition-induced changes to AQRVs are of serious concern to FLMs and these thresholds are intended to distinguish where deposition increases may result in potentially adverse ecosystem stresses, as well as where the deposition increases are likely to have a negligible impact on AQRVs.

Deposition Analysis Thresholds

A DAT is *the additional amount of N or S deposition within a Class I area, below which estimated impacts from a proposed new or modified source are considered insignificant*. The DAT for a park or refuge will be compared with the amount of additional deposition resulting from a source, as modeled using CALPUFF or other appropriate models. The N DAT represents total N, including both wet and dry deposition. Total nitrogen includes NO, NO_2, HNO_3, NO_3, NH_3, and NH_4. The S DAT represents total S deposition. Total N and total S were selected in order to be consistent with conventions used in deposition loading, to represent the total amount of N and S inputs received in an ecosystem and to be compatible with CALPUFF model outputs.

The framework for calculating both the N and S DATs is:
DAT = Natural Background Deposition * Variability Factor * Cumulative Factor

Using this framework, DATs for N and S have been calculated for the Eastern and Western regions of the United States, and are presented below. A discussion of each component used to develop this equation and DATs is also presented.

Determination of Background Nitrogen (B_N) and Sulfur (B_S) Deposition

Natural background deposition was used to determine the DAT because aquatic and terrestrial ecosystems evolved under natural background deposition conditions. Therefore, some fraction of natural background deposition is likely within the range of natural variability for these ecosystems.

The B_N values were selected from a range of natural background deposition values published in peer-reviewed scientific literature, and from information provided by consultations with researchers (Dentener *pers. comm*.; Galloway *et al.* 1995; Galloway *et al.* 1996; NAPAP 1991; NADP 2000). The B_S values were determined in the same manner (Bates, Lamb 1992; Bates *et al.* 1992; Dentener *pers. comm*.; Galloway *et al.* 1996; Galloway *et al.* 1982; Galloway, Whepdale 1980). From this range of deposition values, the values of 0.50 kg/ha/yr for the East and 0.25 kg/ha/yr for the West were selected for both N and S, as they fulfilled the requirements of being scientifically valid as well as being conservative. These values represent the low end of the regional range of values that are presented in estimates of regional natural background deposition. This conservatism is necessary in order to fulfill the mandate to err on the side of resource protection, and to protect air quality and AQRVs within Class I areas. A reference of all literature used to determine B_N and B_S is attached, as well as Supporting Literature references for all sources used in developing both DATs.

Different B_N and B_S values were developed for the Eastern and Western United States. These separate values are based on the distinction between east and west natural deposition estimates made through global and national scale modeling analyses. The East DAT and West DAT are applicable to Class I areas located east and west of the Mississippi River, respectively.

The NPS and FWS do not intend to devise methodology for assessing exact pre-industrial deposition throughout the United States. Currently it is not possible or necessary to determine natural deposition values for each Class I area. It is most appropriate to determine the B_N and B_S values on a large spatial scale, such as the Eastern and Western regions of the United States. This has the added advantage of allowing for a simpler application process for applicants.

Use of a Variability Factor

Once natural background deposition numbers are determined, FLMs have a responsibility to determine what fraction of this deposition could be added to existing natural and anthropogenic deposition amounts within an ecosystem and still be considered insignificant. The NPS and FWS selected very conservative natural background numbers from the range of values presented in scientific literature, and have determined that all combined anthropogenic sources could contribute up to 50% of this conservative natural background value without triggering concerns regarding resource impacts. Rationale for this decision came from looking at the modeled historical deposition scenarios in the scientific literature, where the range of estimates for any given area are often + or – 50% or more between various studies. Furthermore, the range of natural variability associated with annual natural background deposition at any given site is unknown, but 50% above or below the historical mean is plausible during any given year due to fluctuations in climate, biotic productivity, bacterial decomposition, lightning occurrence, fire, volcanic activity, sea spray, and other factors.

The NPS and FWS have determined that a total increase in deposition, from all sources over time, greater than fifty percent of natural background deposition would trigger management concerns. Therefore, the natural background value (B_N or B_S) is multiplied by 0.5, or 50%.

Use of a Cumulative Factor

There is an FLM concern that, over time, cumulative deposition from emissions sources may produce impacts upon Class I areas. It is beneficial to the FLMs, the permitting authority, and the applicant to determine what amount, if any, a new source could contribute to total deposition while having a reasonable assurance that cumulative deposition from all new sources would not exceed 50% of natural background. In developing the 1996 proposal for New Source Review Reform, the U.S. Environmental Protection Agency (EPA) determined that, as long as no individual source contribution exceeds 4% of a Class I increment, it is unlikely that the accumulation of sources over time will exceed that increment. The FLMs have applied the 4% value used in Class I increment significant impact levels to these new deposition analysis thresholds. By incorporating this value into the DAT equations, new sources whose modeled deposition amounts are below the DATs are not likely to significantly contribute to cumulative impacts from N or S deposition.

Deposition Analysis Threshold Equation

The DAT for a specific Class I area is calculated as:

$$\textbf{Nitrogen DAT} = B_N(0.5) * 0.04$$

$$\textbf{Sulfur DAT} = B_S(0.5) * 0.04$$

Where: B_N = natural background nitrogen deposition value.
Eastern Class I areas: B_N = 0.50 kg/ha/yr
Western Class I areas: B_N = 0.25 kg/ha/yr
B_S = natural background sulfur deposition value.
Eastern Class I areas: B_S = 0.50 kg/ha/yr
Western Class I areas: B_S = 0.25 kg/ha/yr
0.5 = Variability Factor
0.04 = Cumulative Factor

This equation incorporates a 0.5 Variability Factor and a 0.04 Cumulative Factor. The value of 0.04 represents a four percent safety factor to protect Class I areas from cumulative deposition impacts. B_N or B_S is multiplied by 0.5 to result in a value that is fifty percent of the natural background deposition. The NPS and FWS consider an increase in deposition (resulting from all sources over time) that is greater than fifty percent of the B_N or B_S value to be a threshold that triggers management concerns. The use of both factors is explained in more detail below.

Therefore, DATs for nitrogen and sulfur in Eastern and Western Class I parks and refuges are:

East DAT: (0.50 kg/ha/yr N *or* S * 0.5) * 0.04 = 0.01 kg/ha/yr N *or* S

West DAT: (0.25 kg/ha/yr N *or* S * 0.5) * 0.04 = 0.005 kg/ha/yr N *or* S

Discussion

The DAT is a deposition threshold, not necessarily an adverse impact threshold. The DAT is the additional amount of deposition that triggers a management concern, not neccesarily the amount that constitutes an adverse impact to the environment. Both the NPS and the FWS utilize a case-by-case approach to permit review. Adverse impact determinations will be considered on a case-by-case basis for modeled deposition values that are higher than the DAT. This approach considers the best scientific information available for each park or refuge to assess existing as well as potential future deposition impacts. The magnitude of the deposition that an individual source would contribute as well as the sensitivity of the ecosystem must be considered. At present there is no equation that would, in all situations, allow an FLM to determine whether or not a source of N or S deposition would cause or contribute to an adverse impact. Therefore, FLMs will continue to use scientific data and information, in conjunction with modeling, to evaluate whether or not an adverse impact would occur. FLMs must also take into account site-specific information for each Class I area. This would include evaluating the potential deposition impacts from a source not just in relation to the DAT, but with other factors as well, such as whether adverse impacts resulting from deposition have been documented, or are suspected, in that specific Class I area.

Coastal ecosystems have evolved under naturally higher sulfur deposition rates due to contribution from oceanic sources. This factor will be considered by the NPS and FWS when making the case-by-case determination as to whether S deposition from a proposed source will adversely impact a Class I area containing coastal ecosystems.

While the values used in the DAT equation reflect current NPS/FWS guidance and the scientific information available, it is important to note that these values could be updated as new changes in effects-related information becomes available. These DATs replace any previous screening level values or deposition thresholds that may have been utilized by the NPS or FWS prior to the development of these DATs. The NPS and FWS will work closely with permit applicants to implement these DATs, and applicants are encouraged to contact the NPS or FWS at all stages of the application process.

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