Comments from CASAC NO_X & SO_X Secondary NAAQS Review Panel on EPA's *Draft Scope and Methods Plan for Risk/Exposure Assessment: Secondary NAAQS Review for Oxides of Nitrogen and Oxides of Sulfur* **(March 2008)**

Comments received:

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Dr. Praveen Amar

This write up provides comments in three areas, as requested by Dr. Ted Russell, the Panel Chair. These three areas relate to:

1. Adequacy of how well the REA (Risk/Exposure Assessment) covers some of the "additional" issues such as maple decline, ammonia air deposition, etc. The exact charge question #11 related to "additional effects" is reproduced here :

   Additional ecological/welfare effects due to NOx and SOx emissions that we do not currently anticipate evaluating in detail in this review include the following:
   - *Nitrogen saturation,*
   - *Maple decline,*
   - *Ammonia air deposition and toxicity to native mussels,*
   - *Relationship between acidity/nutrient enrichment and mercury methylation,*
   - *Sensitive areas for acidity/nutrient enrichment impacts, identified from biogeochemical characteristics, and*
   - *Climate change effects due to N_2O.*

   Does the Panel agree that these represent lower priority effects for the current assessment? If not, what does the Panel recommend?

2. Sections 2.3.2 (overview of nitrogen deposition) and Section 2.3.3 (overview of sulfur oxides and sulfur deposition), and
3. Overall general comments on the complete Scope and Methods Document

First, a general comment about the whole document. I think it is generally written better than the ISA (one reason is that it is short!). However, various chapters can and should be improved for more clear communication. It is understandable that various sections have different authorships. These sections and chapters would therefore benefit from the services of an expert technical/scientific editor resulting in a more readable document that more clearly communicates what the proposed Risk/Exposure Assessment is expected to accomplish.

<u>Charge Question # 11</u>

The Scope and Methods Document currently proposes to assess the areas mentioned above under Charge question #11 in a qualitative manner (Page 15; Appendix A.2, etc.). My sense is that some of these areas are of greater importance than others. For example, understanding of the relationship between sulfur deposition and enhanced methylmercury (MeHg) production in aquatic systems has serious policy implications as a number of mercury control programs from many industrial sources (coal-fired power plants, municipal waste combustors, steel mills, industrial boilers) are being put in place in the US at the same time major SO_2 reduction programs are being implemented (e.g., CAIR). To the extent sulfur deposition levels would be changing in the US at the same time Hg deposition levels would be changing, this "integrated" assessment needs to be indeed "integrated."

I do not have the expertise on the direct toxicity of ammonia on mussels, however, this Risk Assessment would benefit greatly from more emphasis on *all* science-related issues related to ammonia: better quantification of its emissions, its atmospheric chemistry and physics, its fate and transport, wet and dry deposition of ammonia and its products, and ecological effects. As other members of this CASAC Panel have noted in their comments, the ISA as well as the S and M document simply seem to address the role of ammonia as an afterthought and do not address the issue of ammonia at a level it deserves.

I suggest that the areas in Charge Question #11 (at least some of them) be given more attention than what is being proposed. For example, instead of addressing them in any future Risk/Exposure Assessment document in an Appendix, they be addressed in the body of the report itself as short and separate chapters. It is recognized that some of treatments might be more qualitative or empirical. That does not make them less important.

Sections 2.3.2 and 2.33 (nitrogen and sulfur deposition):

Sections 2.32 and 2.3.4 are short. I do not think they provide true "overview" of nitrogen deposition, or for that matter, sulfur deposition. Section 2.3.2 mostly covers the history of how N_2O was addressed in previous standards review and then notes that it will not be covered in a quantitative way in the current assessment. It is important, as I note above, that all the "additional issues" including the role of N_2O as a greenhouse gas be covered in this document in a clear and well-referenced manner (for example, the recent 2007 IPCC reports). One suggestion is that a revised S and M document remove these sections from their present location and integrate them more effectively with other sections.

Overall General Comments on the Document

Page 1, Line 7: "… deposition of ambient particles, GASES, AND ACIDS, that can.."

Page 3, Line 12 " THOUGH" is an awkward way to start this sentence.

Page 5, Second Para: "welfare *effects* identified should be PROTECTED from adverse *effects*." Need to rewrite.

Page 6, Section 2.2: Please be very careful when using the words *uncertainty* and *variability* in the same sentence unless you explain their clear and very different meanings. Many people take them to mean the same thing and they simply are very different concepts, both in science and in policy-setting.

Page 8, Last paragraph: "this assessment would focus on ecological quality and its effects from acidification…" This is the first and the only time this document uses the words "ecological quality." What exactly is meant? Also, the sentence needs to be rewritten for clarity.

Page 9, Line 8, Please change to "precursors NOx and volatile organic COMPOUNDS.."

A General Comment: I would very much like to reinforce what Dr. Cowling noted in his comments on the September 2007 Draft Plan. These words speak more clearly than anything I have seen relative to what needs to be done in this assessment for the joint secondary standard(s) for revising/modifying/establishing a new/ standard(s):

i) *"What scientific evidence and/or scientific insights have been developed since the last review to indicate if the current public-health based and/or the current public-welfare based NAAQS need to be revised or if alternative levels, indicators, statistical forms, or averaging times of these standards are needed to protect public health with an adequate margin of safety and to protect public welfare?"*

ii) *"What scientific evidence and/or scientific insights have been developed since the last review to indicate whether, and if so, what particular ecosystem components or other air-quality-related public welfare values, are more or less sensitive than the populations of humans for which primary standards are established and for this reason may require a different level, indicator, statistical form, or averaging time of a secondary standard in order to protect public welfare?"*

Page 11, Second Paragraph, ".. Framework to analyze alternative *air quality standards* …" Why not also include deposition standards as well as critical loads here? A quick review of this document also makes it clear that critical loads as an *organizing principle* for establishing standards need to be paid more attention to (just like the role of ammonia needs to be paid more attention to).

Page 24 (also other places): I suggest that this document be clearer about ecosystem services, valuation, valuation methods (both quantitative and non-quantitative). Since these areas are covered in the environmental economics and decision analysis areas, it would be a very good idea that they are described more clearly for the general audience of this assessment.

Page 25: The "Seven-Step Process" to undertake REA: I do not claim expertise, but Steps 5, 6, and 7 ("when feasible, scale up case studies…", assess the current ecological conditions, assess alternative levels of protection…", etc.) do not seem as rigorous as they would need to be to lead to a defensible standard(s).

Page 28: I am not so certain that 'organic acids are common NATURAL sources of acidity in surface waters." I would think that many VOCs do lead to secondary organic aerosols (SOAs) and then to organic acids that are not "natural."

Dr. Andrzej Bytnerowicz

The document describes the Problem Formulation, which is the first phase of the Ecological Risk Assessment (ERA) for ambient NOx and SOx. As such the documents should describe the end points, conceptual models and analysis plan. This draft document focuses on the last component of the Problem Formulation Phase - the Analysis Plan. As such, the Analysis Plan is logically structured and described in seven clearly described steps. The plan presents interesting ideas for development of the secondary standard for NOx and SOx. Description of end points and conceptual models is provided but with much less detail than the analysis plan.

In the beginning of the documents a clear statement is made that for evaluating ecological effects, total reactive N (both in the oxidized and reduced forms) will be considered since the reduced N compounds may cause many of the effects caused by the oxidized N. This is obvious and clear from the point of view of the present scientific knowledge. However, this is a long stretch from NOx (NO and NO2) and SOx which are the criteria pollutants for which secondary standards are being considered. I believe that legal considerations of such an expansion of the NOx/SOx term should be discussed upfront. If not, it can be expected that problems with various stakeholders during public discussion may take place.

Compared to the main ISA document, transitional ecosystems are not mentioned. For consistency this document should also treat them separately (especially since these ecosystems are especially sensitive to the N inputs).

Diagrams used in the document greatly help a reader to visualize the planned risk assessment process envisioned by the authors. Figures 2-5, 3-1, or 3-5 are most useful.

A discussion of how the climatic conditions, or climate variability, could affect the proposed risk assessment process is lacking. Meteorological variability is menntined, but this is not sufficient.

More emphasis should be placed on how other co-occurring stressors, such as tropospheric ozone, drought, pests, diseases or catastrophic fires that affect N cycling and N deposition biological effects will be dealt with.

Are the CMAQ estimates of N deposition updated? If I recall the CMAQ simulation for the western US, the latest model runs were done for 2002 (Gail Tonnessen, personal communication).

Seems that CL is the key to linking deposition and ecological effects to the future secondary standard. For that a national network of monitoring sites, similar to the European ICP Forests and ICP Vegetation, should be envisioned. I did not find such a statement indicating a need for such activities. Based on the existing efforts, secondary standard for NOx and SOx could be considered only for a small portion of the country.

Specific comments:

Remark – it would greatly help to have lines numbered!

Page 1, first paragraph. A sentence "As discussed in the Integrated Review Plan (U.S. EPA, 2007a), this was done in recognition of the important linkages between ambient nitrogen and sulfur leading to deposition of ambient particles that can have significant impacts on environment". This is only partially true considering that particles have only very small effects on the total N or S deposition. Gases or dissolved ions are much more important. Therefore, I suggest deleting "of ambient particles".

Pages 7 through 9, Section 2.3. I found this section little confusing and I suppose that other readers may have a similar experience. As I have stated in the beginning of my comments, this document is supposed to represent the Problem Formulation Phase. As such I would expect that end points and conceptual models would get the same ranking as the Analysis Plan. Although conceptual models are described in section 2. "Background and Overview", specifically in section 2.3.1, discussion of endpoints is not easily found. Sections 2.3.2. "Overvew of nitrogen deposition" and 2.3.3. "Overview sulfur oxides and sulfur deposition" are too short to present a good review of the problem. I suggest skipping them completely and referring a reader to the comprehensive review of these probelms in the main ISA document.

Page 19, Table 2.1. The proposed schedule of the reviewing process is tight and very ambitious. The CASAC public review of the REA document in October is very early considering that the draft will be released in August. In my particular case, due to a very active schedule of conferences in August, September and October and summer vacation, that does not leave enough time for a thorough review. Therefore, I recommend moving the CASAC review to November 2008.

Page 27, Table 3-1. For aluminum mobilization, terrestrial ecosystems (T) should be added. In the same table, for N concentrations, also terrestrial ecosystem are affected.

Page 31, 3.2, Step 2 (Define sensitive areas) and page 35, 3.3, Step 3 (Select risk/exposure cases study assessment area within a sensitive area) - use of natural gradients of N and S deposition should be considered.

Page 32, first two lines. I would argue that areas with good linkages to larger ecoregions should be also considered for new case studies. Results from such area could be extrapolated by means of geostatistics into much larger areas.

Page 35, last paragraph. I would like to suggest that "new N" could be called reactive N species, such as ammonia or nitric acid. "Old N" would be N stored in ecosystems as NO3-.

Page 38, first paragraph. Again – use of natural gradients for selection of the appropriate assessment areas should be considered.

Page 38, I would also suggest palcing a special emphasis on some Californian areas, such as the San Bernardino Mountains, coastal sage and desert ecosystems that have been intensively studied and are sensitive to N additions.

Page 40, Table 3-6. Western US are under-represented. Please see my comment above.

Page 43, bullets. More appropriate would be using terms of nitrate and ammonium deposition. Ammonium would result from dry deposition of NH3, particulate NH4+ and water dissolved NH4+ deposition.

Responses to the assigned questions:

Question 8. In the seven-step approach to the current conditions risk/exposure assessment, Step 5 (Section 3.5) discusses how to scale up case study areas to more spatially extensive sensitive areas, where appropriate. Does the Panel agree with this approach or can they suggest alternatives?

The proposed approach seems to make sense as long as the extrapolations are done within the same ecoregions. However, distribution of concentrations of the key drivers of N dry deposition, specifically nitric acid vapor and ammonia may dramatically change between the urban and agricultural sources and the receptor areas due to their high reactivity and high deposition to vegetation and other surfaces. Therefore the on-ground determinations of patterns of their distribution is recommended. Passive samplers offer a relatively simple and reliable method for determining pollution concentrations. Results of such monitoring efforts aided by geostatistics may be used for generation of concentration surfaces of these pollutants. For estimates of dry deposition of these gases inferential methods could be used at large geographic scales. In addition, complexity of soils characteristics have to be also taken into account in proposed scaling-up excercises.

Question 9. In the seven-step approach to the current conditions risk/exposure assessment, Step 6 (Section 3.6) outlines a path to assess the current conditions of sensitive ecosystems. How well does the Panel agree with the approach outlined for calculating response curves and utilizing mapping and ecosystem services to characterize current conditions or can the Panel recommend alternative approaches?

This is a valid approach. Response curves from controlled experiments or natural gradient studies encompassing wide ranges of deposition levels would provide databases needed for estimates of current conditions and models simulating future changes. Critical loads analyses (performed with steady state, empirical or dynamic models) have been used in the NE USA and Canada for many years. In Europe, CL have also been successfully measured on the ICP Forests and ICP Vegetation networks. The ICP Modeling and Maps converts that information to maps representing annual levels of CL and exceedances for N and S deposition and acidity. The Regional Air Pollution Information and Simulation (RAINS), uses those results for controlling of the internationally agreed quotas of emissions for individual countries. A similar approach could be tested and possibly used in the U.S. as well. Instead of individual countries (as in Europe), states or air quality management districts could be used as the administrative units of control.

a. How well does the Panel agree with using ecosystem services to provide a common metric for comparing ecological risks due to nitrogen and sulfur deposition effects?

This could be very useful approach for integrating effects of deposition of N and S on ecosystems. By presenting examples of what services are affected, potential stakeholders would be able to better comprehend implications of the adverse effects of elevated N and S deposition. That could bring more attention and potential support from the general public, NGOs and other stakeholders which would help in development of the secondary, welfare effects based standard.

b. How well does the Panel agree with collecting current valuation studies to understand the value of bundled ecosystem services? Can the Panel recommend additional or alternative approaches?

I generally agree with this approach. A holistic approach to the variously affected services seems to be logical. However, it should be evaluated if these new complex new attributes of changes would not complicate the entire process of secondary standards development. Maybe as the first step towards development of a new standard the well tested European approach (CL and RAINS combined) should be initially considered. The idea of ecosystems services (including their bundling) could be considered as the next step leading to further improvement of the standards.

Question 10. In the seven-step approach to the current conditions risk/exposure assessment, Step 7 (Section 3.7) describes an approach to assess degrees of protection/levels of effects under alternative forms and levels of ambient NOx and SOx standards. This approach attempts to describe how the methods, models, and results of the current conditions risk/exposure assessment can inform our evaluation of the appropriate form(s) and levels(s) of a national standard. How well does the Panel agree with the approach outlined in this section, the issues presented, and the 9 steps outlined to assess potential forms and levels of the standard? Please sugggest any additional or alternative steps we should take into consideration?

The section presents an interesting plan for defining and describing ecological changes caused by N and S deposition and an attempt to associate them with the NOx and SOx concentration-based standards. Although not easy to implement on a national scale, the critical loads (CL) methodologies could be used for defining levels of the acceptable deposition of N, S and acidity. Maps of CL exceedances, as it has been done for the NE United States, eastern Canada and Europe, can be very useful in showing the areas where the unacceptable deposition has taken place. Such information aided by appropriate models could lead to recommendations of where the N deposition reductions are needed in order to prevent deterioration of sensitive ecosystems. While it may be possible to use such information for recommending emission reductions, as it is being done in Europe under the Convention on Long-Range Transport of Air Pollution (please see my remarks above), a direct link to ambient NOx or SO2 concentrations would be extremely difficult, if not impossible, to establish.

Plan presented in Section 3.7 establishes a framework of the logically alligned steps (activities) that are supposed to lead to a new, scientifically sound, concentration-based standards for NOx and SOx.

Here are some remarks for this section:

Page 57, first paragraph. After establishment of the baseline conditions, more advanced modeling techniques (dynamic models) would have to be used. Such models are able to take into account time effects and may be useful for ecological risk assessment. During the last few years such models have been used by the ICP Modeling and Maps in Europe.

Same paragraph. While particular loading "X" can cause a certain negative effect "Y", it would be very difficult to translate it to ambient concentration of a pollutant (especially if NO and NO2 are concerned). That effect "Y" would result from deposition of multiple N species. Is CMAQ, or other models, able to specify what concentrations of individual pollutants are responsible for the loading "X"? Maybe checking how the RAINS model used in Europe deals with such issues is necessary at this step of the analysis planning?

Pagte 57, "What adverse effects are we trying to protect agains?" Best approach would be to look at multiple sensitive indicators (like sensitive lichens, C/N ratio, N foliar levels, mycorrhizae colonization). Use of single indicator could be misleading. However, for practical reasons and large-scale estimates, a single, easy to determine indicator (such as NO3- in soil solution) should be considered as a good initial step.

Next bullet – information on contribution of oxidized vs. reduced forms of N is still poor. More intensive field campaigns and long term monitoring using some new techniques is urgently needed. A key problem is a need for a beter understanding of ammonia concentrations in remote areas.

Effects do occur due to different forms of N. Effects of gaseous N species (NO, NO2, NH3 or HNO3) are very different among each other, and quite different from the effects of particulate or water-dissolved NO3- or NH4+.

How should alternative levels be selected? Combination of various methodologies is needed (controlled experiments, field exposures including natural gradients, others).

What are the correct temporal and spatial scales for the ambient air indicator? Ideally hourly values should be available. However, considering a lack of proper monitroing equipment that could be used at large scales, the weekly, bi-weekly or even monthly averages of the key deposition drivers would greatly help our abilities to model deposition. In such cases, passive samplers for gaseous pollutants could be used. Information on particulate component of dry deposition is poor, and its contribution to the total deposition may greatly vary in space and time.

Spatial coverage would depend on the chemical and tepographic complexity of the area of interets. There are new geostatistical methodologies available that may help in optimizing monitoring networks and adequate spatial coverage.

Large-scale monitoring of throughfall could be used for integrative measure of wet and dry N deposition. However, use of the throughfall analysis methodology in arid and semi-arid ecosystems is questionable.

Comments on using 9 steps to determine the appropriate level and a form of a standard:

Generally this is a logical and well defined plan.

Point 1 – portion of dry deposited N, both in gaseous and aerosol forms, is not well characterized.

Point 2 – OK.

Point 3 – here, contribution of the main contributors to dry deposition of N, ammonia and nitric acid, have to be much better characterized.

Point 4 – the most sensitive indicators, and sets of various indicators, have to be considered. Although I generally agree with a need for determining ecosystem services and bundling them in order to find comarisons between locations, I am not sure if that would not complicate the establishment of a link between effects, deposition, ambient concentrations and emissions.

Point 5 – OK

Point 6 – I suggest considering collaboration with the European scientists and modelers experienced in using RAINS model. Impacts of meteorological (climatic) variability are of a very high importance.

Point 7 – critical loads concept would be very useful.

Point 8 – intuitively I agree. However, I have to get acquinted better with the available literature to say more.

Point 9 – OK.

Comments on bullets (page 59)

Consideration for alternative secondary standards to ambient concentrations of NOx and SOx should also be addressed. For N, all forms of reactive N should be considered as part of the secondary standard. NOx (NO and NO2) is only a small portion of the problem, however, theoretically it could be possible to relate secondary pollutants such as HNO3 or particulate NO3 to primary pollutants (NO and NO2). Ammonia is the key pollutant for which concentrations and spatial and temporal distribution should be better characterized.

Options such as “cap and trade”, or emission reduction goals for specific administrative areas (states, counties, air quality management districts) should be addresses and considered. What was accomplished for the reductions of the SO2 emissions in the Midwest and Northeast based

on the requirements of Title IV of the CAAA or what is presently being done in Europe under the auspices of the Convention on Long-range Transboundary Air Pollution (CLRTAP) could be used as examples of the alternative approaches and possibilities (although such measures may be politically difficult to be accomplished). However, a note of caution – successful reduction of the SO2 emissions was relatively easy considering that its sources are mainly large point emitters. For NOx such possibilities could be difficult to accomplish considering complexity of the N chemistry and multiple sources of emissions.

Ms. Lauraine Chestnut

Draft comments on Draft Scope and Methods Plan for Risk/Exposure Assessment. March 31, 2008

One general comment: There will undoubtedly be limitations in data for this assessment. I want to recommend that there be an effort throughout the process to define data that will improve this assessment the next time around. Collection of some of these data may be ongoing, but there may not yet be enough to answer the quantitative questions: the need for these monitoring and data collection efforts to have continued support needs to be articulated. There may be further monitoring and data collection that would be helpful. These need to be defined and prioritized so that resources are put to their best use and support is generated for more monitoring and data collection.

Section 2.4
1. It seems really important for this assessment to address the question of whether both SOx and NOx have to be reduced to obtain benefits, or are they causing separate effects that are essentially additive? This speaks to whether the standards for the two need to be linked.

2. On page 18, I don't understand the question about whether long-term effects and cumulative loadings are relevant to the NAAQS review. If they are important for understanding the effects on ecosystems, why would they not be relevant?

Charge question 4:
The issue of defining what is an adverse effect needs to be considered right at the beginning when the indicators are reviewed and selected. It is important that the selected indicators be able to be linked to changes in deposition, but also to changes in ecosystem services. There may be a threshold or a continuous relationship between levels of the indicators and adverse effects on ecosystem services. Either way, it is important to ask whether a given change in the selected indicator can be interpreted as showing an existence or a change in an adverse effect. For example, do we know at what level for each indicator the ecosystem looses capacity to support some species that would normally be expected to live in this system?

Charge question 9b:
Once the losses in ecosystem services at current deposition rates are quantified (or otherwise characterized) then it will be useful to search for available valuation studies that provide relevant information. It does not seem useful to try to determine total values for all ecosystem services even in the selected case study areas, because the policy relevant valuation issue for these pollutants is probably not a total loss in services, but a marginal change in quality or quantity of some services.

Charge question 11:
I think EPA has selected the right categories of effects to focus the quantitative risk assessment efforts. This list of other effects needs to be included and described. In some cases the

assessment might provide partial quantitative information. For example, will it be possible to say what the expected changes in ambient concentrations of N_2O might be expected as a result of alternative standards? I agree it is not appropriate to expend resources here to try to quantify the associated climate change effects.

Dr. Ellis Cowling

Before plunging directly into my specific assignments to critically review the "Key Policy Relevant Questions" in Section2.4 and answer Charge Questions 3-7 in preparation for the April 3, 2008 CASAC Consultation, let me emphasize how pleased I was to see in this Draft Scope and Methods Plan how much EPA appears to be progressing in its willingness to think in a more holistic way about:

1) Multiple pollutants and multiple effects of airborne pollutants that often occur in the same air parcel and frequently act together to cause similar, different, and/or sometimes more pronounced effects than single pollutants acting alone.

2) Broadening the "Indicator of Concern" for the secondary NAAQS for "Oxides of Nitrogen" to include chemically reduced and organic forms as well as oxidized forms of "total reactive nitrogen,"

3) Recognizing that NAAQS designed to protect ecosystems from adverse effects of air pollutants often require different pollutant indicators, levels, averaging times, and statistical forms than NAAQS designed to protect human health.

4) The multiple similarities and advantages rather than just the differences among "NAAQS," "Critical Loads" and "Target Loads" for nitrogen and sulfur air pollutants.

5) How "the words we choose often reveal the quality (and sometimes also the limitations) in our understanding" about various phenomena in nature. Useful examples in the current Draft Plan include the significance of such words as "ecosystem services;" "acidification," "nutrient enrichment," "nitrogen saturation," "NOx/SOx," "NOx/NHx/SOx," "total reactive nitrogen," "acid precipitation," "acidifying deposition," "wet plus dry acidifying deposition," Etc.

Please note a few additional comments below regarding some of these important matters and especially the Resolution displayed on page 3 of these Individual Comments after it was passed by the Integrated Nitrogen Committee of the EPA Science Advisory Board for Communication on October 31, 2007 to our CASAC NAAQS Review Panel on the Secondary Standards for Oxides of Nitrogen and Oxides of Sulfur.

My Specific Assignments in this CASAC Consultation on the Draft Scope and Methods Plan for the Risk/Exposure Assessment Secondary NAAQS Review for Nitrogen Dioxide and Sulfur Dioxide

My specific assignments in preparation for our April 3, 2008 CASAC Consultation on the Draft Scope and Methods Plan as outlined in Chairman Ted Russell's memo of 11 March 2008 are:

1) Key Policy Relevant Issues. These topics are summarized in Section 2.4 in the Draft Scope and Methods Plan, and

2) Charge questions 3-7 – Ecological Effects Characterization. These Charge Questions are listed in Lydia Wegman's memo to Kyndall Barry dated 5 March 2008.

Chairman Russell also gave the first of these two assignments to six other CASAC panel colleagues – Douglas Crawford-Brown, Paul Hanson, Naresh Kumar, Myron Mitchell, Kathleen Weathers and Lauraine Chestnut. He also gave the second assignment to three other CASAC Panel members – Charles Driscoll, Myron Mitchell, and David Shaw. Thus, I am very much looking forward to comparing notes with all of these other people during our Consultation on April 3rd!

Assignment 1) -- Critical Review of section 2.4:"Key Policy Relevant Questions"

Both the current Chair of CASAC, Dr. Rogene Henderson, and others among the Statutory Members of our Clean Air Science Advisory Committee have written in recent months about the Need for Policy Relevancy as the Dominant Concern in the New NAAQS Review Processes.

In these carefully structured review processes, the most critical and overarching policy question that needs to be answered is:

> ***"What scientific evidence and/or scientific insights have been developed since the last review to indicate if the current public-health based and/or the current public-welfare based NAAQS need to be revised or if alternative indicators, levels, statistical forms, or averaging times of these standards are needed to protect public health with an adequate margin of safety and to protect public welfare?"***

And similarly, especially with regard to the present integrated [simultaneous] review of the Secondary Standards for NOx and SOx, the most critical and overarching Key Policy Question is:

> ***"What scientific evidence and/or scientific insights have been developed since the last review to indicate whether, and if so, what particular ecosystem components or other air-quality-related public welfare values, are more or less sensitive than the populations of humans for which primary standards are established and for this reason may require a different indicator, level, statistical form, or averaging time of a secondary standard in order to protect public welfare."***

With the latter overarching Key Policy Question in mind, we now have the considerable advantage that a much more complete focus can be achieved on **critically important scientific findings** that are **as directly relevant as possible** to this overarching Key Policy Question. To achieve this more complete focus, it is desirable that each chapter of the **Integrated Science Assessment**, the **Risk/Exposure Assessment**, and the **Policy Assessment/Rule Making** documents for each criteria pollutant should contain a summary section composed almost entirely of **very carefully crafted summary statements of conclusions and/or scientific findings**. These carefully crafted summary statements should:

1) **Contain the distilled essence of the most important topics covered in each chapter, and**
2) **Be as directly relevant as possible to the overarching Key Policy Question written above.**.

Section 2.4 of the present *Draft Scope and Methods Plan* contains a series of 17 policy relevant questions to which carefully crafted scientific answers could be developed. But these mostly policy relevant questions need to be better organized and coordinated so that the answers to these questions can be used to build a coherent series of linkages between the major **acidification and nutrient enrichment effects of concern** and the **nitrogen and sulfur secondary NAAQS standards** that will be necessary to avoid these ecological effects.

My most serious reservation about the 17 policy relevant questions listed on pages 17 and 18 of Section 2.4 is that chemically reduced forms of nitrogen (NHx), organic forms of nitrogen (NCx), and total reactive nitrogen (TNr) all are not included in either the specific wording or the written context of any of these 17 questions. Only the first sub-part of the sixth question listed on page 17 deals explicitly with ammonia, ammonium ion, and/or total reactive nitrogen as alternative "indicators" of nitrogen pollution.

> "Should the current standards for NO_2 (as an indicator for NOx) and SO_2 (as an indicator for SOx) be retained, revised, or revoked and/or replaced with alternative standard(s) having different indicators to provide the required protection from known or anticipated adverse welfare effects?"

I hope that these 17 policy relevant questions can be adjusted, revised, reorganized, and/or augmented in order to further increase their value in optimizing the quality of **summary statements of scientific findings** that will be as relevant as possible to the overarching Key Policy Question printed above in bold italic type.

In this connection, please also note once again the attached

Resolution from the Integrated Nitrogen Committee of the Science Advisory Board for Consideration by the CASAC Secondary NAAQS NOx and SOx Review Panel

During the ongoing meeting of the EPA Science Advisory Board's Integrated Nitrogen Committee (INC) -- meeting at SAB Headquarters in Washington DC on October 29-31, 2007 -- the several members and Chair of the INC, Dr. James Galloway of the University of Virginia,

asked me (as the CASAC-designated liaison person to the Science Advisory Board's Integrated Nitrogen Committee) to present the following Resolution (which was developed and approved by the INC) for consideration during the CASAC review of the NAAQS for NOx and SOx during our CASAC Conference Call Consultation on October 30, 2007.

Resolution

The current air pollution indicator for oxides of nitrogen, NOx, is an inadequate measure of reactive nitrogen in the atmospheric environment. The SAB's Integrated Nitrogen Committee recommends that inorganic reduced nitrogen (ammonia plus ammonium) and total oxidized nitrogen, NOy, be monitored as indicators of total chemically reactive nitrogen.

Assignment 2 – Charge Questions from OAQPS

My comments are organized below in response to each of the several Charge Questions posed in Lydia Wegman's memo to Kyndall Barry dated 8 March 2008. As you will see much more detailed attention has been given to Charge Questions 3-7, to which Chairman Ted Russell asked me to give special attention.

1. **In outlining the scope of this risk/exposure assessment, we have created a flow diagram that represents how nitrogen and sulfur compounds move from 'source to dose' in the environment (see Figure 2-1). How adequately does this conceptual model for evaluating risks due to deposition-related ecological effects characterize what should be covered in the scope of this assessment?**

   This conceptual model seems very adequate as an initial frame of reference for deposition-related ecological risks

2. **The main ecosystem effects areas we anticipate evaluating in this risk/exposure assessment are:**

   (1) risks to terrestrial ecosystems from nitrogen enrichment effects,

   (2) risks to aquatic ecosystems from nitrogen enrichment effects (eutrophication),

   (3) risks to terrestrial ecosystems from acidification effects (nitrogen and sulfur), and

   (4) risks to aquatic ecosystems from acidification effects (nitrogen and sulfur).

   We also plan to qualitatively discuss the role of sulfur enrichment on methylmercury production and the role of nitrous oxide in climate change. What key effects areas, if any, have been overlooked by this approach? Should the assessment plan be modified to include other effects?

   Especially considering the court ordered time constraints under which this Risk/Exposure Assessment must be completed, it seems very reasonable to concentrate on these the four major aspects -- nutrient enrichment and acidification in terrestrial and aquatic ecosystems but to also include some assessment of the other two effects of sulfur enrichment on methylmercury production and N_20 influences on climate change.

3. **Due to the complexity of conducting a nationwide risk/exposure assessment for welfare effects due to NOx and SOx, we have outlined a strategy designed to identify sensitive ecosystems and a range of harmful/adverse effects (see Figure 3-1). The seven steps are to**

   (1) identify documented biological, chemical and ecological effects and potential ecosystem services,

   (2) define sensitive areas using GIS mapping,

   (3) select risk/exposure case study assessment areas,

   (4) evaluate current loads and effects in case study assessment areas,

   (5) scale up the case study assessment areas to larger sensitive areas where feasible,

   (6) assess current ecological conditions in those areas, and

   (7) assess alternative levels of protection under different ambient scenarios.

Does the Panel agree with this general approach? Should it be improved or modified?

Yes, I agree that this general approach is sound, But it certainly can be improved and modified in its presentation and implementation within the Risk/Exposure Assessment for which this is a Draft Plan.

As indicated on page 2 of these Individual Comments, my major reservation about the general approach outlined in this Draft Scope and Methods Plan is that it remains unclear if EPA is really willing and interested to include reduced (especially ammonia and ammonium) and organic forms of nitrogen (amino acids and volatile amines) as well as oxidized forms of nitrogen in the crucially important "indicators" being considered in this integrated (simultaneous) review of the present "NOx" and "SOx" NAAQS secondary standards.

It was reassuring to read in several parts of this Draft Scope and Methods Plan:(for example) on page 22 that:

> "The risk exposure assessment will focus on ecosystem welfare effects that result from the deposition of total reactive nitrogen " and also on page 26 that:
>
> "To assess the impacts of total reactive nitrogen and sulfur loading we plan to identify adverse terrestrial and aquatic effects …"

But it was also discouraging to see that the schematic diagram chosen for inclusion on page 12 of this Draft Scope and Methods Plan deals only with oxidized forms of nitrogen and includes no mention or pictorial illustrations of the huge (mostly agricultural) sources of reduced and organic forms of reactive nitrogen.

If EPA is serious about dealing with both "nutrient enrichment" and "acidification" of ecosystems induced by atmospheric deposition of total reactive nitrogen, the agency will have to learn how to sustain its recent success in learning to think more holistically (in part by learning how to write more holistically) about ammonia, ammonium ion, NHx, and NCx, and TNr about "ecosystem services" "critical loads," and "multiple pollutant/multiple effects" approaches in air quality management.

What a different impression this Draft Scope and Methods Plan would have created if:

- the more inclusive abbreviation "NOx, NHx, and SOx) had been used instead of just "NOx and SOx," or
- the words total reactive nitrogen" and "total nitrogen loading" were used more frequently and more appropriately:
  - In formulating the Key Policy Relevant Questions listed on pages 17 and 18,
  - In the captions of the tables and figures on pages 12, 16, 19, 28, and 29, as well as
  - In preparing the major subheadings and topic sentences of paragraphs on pages 7, 15, 16, 19, 21, 22, 27, 49,55,56, 59, and A-3.

4. In the seven-step approach to the current conditions risk/exposure assessment, Step 1 (Section 3.1) describes an approach to identify the documented effects, biological, chemical and ecological indicators, and potential ecosystem services related to acidification and nutrient enrichment. Does the Panel agree with this approach or can they suggest alternative approaches we should consider?

I think you did very well in devising the seven step approach presented in Figure 3.1 -- the first step of which is described more fully in the text in Section 3.1.1 on pages 26-30. Thus I encourage your continuing use of this first step approach so long as you keep in mind that reduced and organic forms of nitrogen may be even more important than oxidized forms of nitrogen in many of the sensitive areas to which this approach is intended to be applied.

5. **In the seven-step approach to the current conditions risk/exposure assessment, Step 2 (Section 3.2) outlines a path to define areas sensitive to total reactive nitrogen and sulfur inputs. Do the Panel members agree with this approach or are there better alternatives that should be considered?**

   Once again, I think your step 2 approach makes sense. I was especially pleased to see that your intention is to use GIS mapping as a tool to further analyze and interpret the strengths and limitations of similarities and differences among these selected sensitive areas.

   a. **We are attempting to characterize the risks to ecosystems from sulfur and nitrogen deposition nationwide by clustering sensitive ecosystems where possible and by using the linkages between these areas at different scales. Please comment on the adequacy of this approach.**

   I have only very limited personal experience in using these kinds of clusterting analytical tools, thus I am not well qualified to assess the adequacy of these methods of analysis.

   b. How appropriate are the datasets and GIS maps listed in Table 3-4 for identifying ecosystems sensitive to nitrogen and sulfur and/or are there others that have been overlooked?

   The array of general types of ecosystems listed in Table 3-4 seems very adequate to me except for the lack of near-coastal oceans waters.

6. **In the seven-step approach to the current conditions risk/exposure assessment, Step 3 (Section 3.3) outlines a path to identifying risk/exposure case study assessment areas. a. Table 3-5 provides an initial list of indicators, mapping layers and multimedia models that may be used to assess ecosystem risk and exposure.**

   a. Please comment on the appropriateness of these and suggest alternatives that may be better suited for this analysis.

   Over the past 20 years, I have had some interactions with the principal investigators involved in about half of these studies of ecosystem effects, possible indicators, and the mapping layers and modules used in these kinds of terrestrial and aquatic problem areas. From these interactions, I have the general impression that these problem areas are appropriate for use in Step 3 and I have no suggestions of other methods that would be more suitable for this kind of analysis.

   b. **Please comment on the list of potential case study assessment areas in Table 3-6 and Table 3-7 and make recommendations or suggest any alternatives.**

   As in my response to the issues raised in Charge Question 6a, I have had some interactions with the principal investigators involved in about half of these studies and believe that the array of possible case study areas listed in Tables 3-6 and 3-7 is reasonable and is likely to be fruitful for the purposes of this Risk/Explosure Assessment and evaluation of benefits that are likely to occur from decreases in atmospheric loading of total reactive nitrogen. My experience is much more limited with respect to sulfur and mercury loading.

7. **In the seven-step approach to the current conditions risk/exposure assessment, Step 4 (Section 3.4) outlines a path to assess current nitrogen and sulfur loads and their effects on case study assessment areas. Does the Panel agree with how we have described our approach to identifying datasets, gaps, and uncertainties?**

   The task of identifying useful data sets is challenging but the associate tasks of identifying gaps and characterizing uncertainties is even more complicated and challenging The approach you have planned to use seems very sensible. I am also particularly pleased that you plan to stretch even further and attempt to characterize uncertainties in the context of current understanding of total

reactive nitrogen impacts on ecosystem services rather than the more familiar measures of ecosystem growth, stability, and productivity.

a. We have initially identified the primary chemical indicator that is most suitable for assessing ecosystem acidification effects as acid neutralizing capacity (ANC), with alternatives depending on data availability (see section 3.4.1 and Appendix B). Does the Panel agree with this selection, or can they suggest alternative/additional key indicators?

I presume that you mean that atmospheric-deposition induced losses in ANC" rather than just ANC itself is "the most suitable chemical indicator for assessing ecosystem acidification effects. With this small adjustment in the phrasing of your question, I agree that ANC is probably the indicator of choice for assessing acidification effects in aquatic ecosystems. I know of no indicator that would be more suitable although maybe loss of cation exchange capacity might be worth some consideration. Charles Driscoll will be better able to answer this question more authoritatively than I am able to do.

b. We have described the models being considered for this analysis (see section 3.4.2 and Appendix C). Does the Panel agree with the choice of these models, and can they help prioritize them for modeling the responses of the indicators recommended in Step 1 (Section 3.1)?

I have no experience on which to base an informed judgment about the comparative merits of these models.

8. **In the seven-step approach to the current conditions risk/exposure assessment, Step 5 (Section 3.5) discusses how to scale up case study areas to more spatially extensive sensitive areas, where appropriate. Does the Panel agree with this approach or can they suggest alternatives?**

   I have no experience on which to base an informed judgment in response to this question.

9. **In the seven-step approach to the current conditions risk/exposure assessment, Step 6 (Section 3.6) outlines a path to assess the current conditions of sensitive ecosystems. How well does the Panel agree with the approach outlined for calculating response curves and utilizing mapping and ecosystem services to characterize current conditions or can the Panel recommend alternative approaches?**

   I agree that the approach outlined in Section 3.6 is appropriate for your assessment of the current condition of ecosystems. As indicated in my response to Charge Question 7 (above) I am very pleased that you are planning to base your assessment on the magnitude of atmospheric deposition impacts on ecosystem services.

   a. **How well does the Panel agree with using ecosystem services to provide a common metric for comparing ecological risks due to nitrogen and sulfur deposition effects?**

      Once again, I am very pleased that you are planning to use ecosystem services as the base for your assessment of comparative risk due to total reactive nitrogen and sulfur deposition effects.

   b. **How well does the Panel agree with collecting current valuation studies to understand the value of bundled ecosystem services? Can the Panel recommend additional or alternative approaches?**

      I am not sure what is meant by "bundled ecosystem services" thus I have no basis on which to offer an informed judgment in answer to this question,

10. **In the seven-step approach to the current conditions risk/exposure assessment, Step 7 (Section 3.7) describes an approach to assess degrees of protection/levels of effects under alternative forms and levels of ambient NOx and SOx standards. This approach attempts to describe how the methods, models, and results of the current conditions risk/exposure assessment can inform our evaluation of the appropriate form(s) and level(s) of a national standard. How well does the Panel agree with the approach outlined in this section, the issues presented, and the 9 steps outlined to assess potential forms and levels of the standard? Please suggest any additional or alternative steps we should take into consideration.**

    I am very pleased to see that you plan to do what appears to me to be a very thorough and effective analysis of alternative forms and levels of ambient "NOx and SOx" standards (by which I presume you also mean alternative "NOx, NHx, NCx" or "total reactive nitrogen" standards").

    The nine step approach you have outlined seems very sensible to me although I could not figure out how step 1 and 3 are different from each other, I was also puzzled about why you included the "levels and forms" of alternative standards and not also the associated "averaging time and statistical form" of alternative standards. Maybe the latter two aspects are so much less important than the first two that the latter two are not essential for the purpose of this analysis.

11. **Additional ecological/welfare effects due to NOx and SOx emissions that we do not currently anticipate evaluating in detail in this review include the following:**

    - **Nitrogen saturation,**
    - **Maple decline,**
    - **Ammonia air deposition and toxicity to native mussels,**
    - **Relationships between acidity/nutrient enrichment and mercury methylation,**
    - **Sensitive areas for acidity/nutrient enrichment impacts, identified from biogeochemical characteristics, and**
    - **Climate change effects due to N_2O.**

    Does the Panel agree that these represent lower priority effects for the current assessment? If not, what does the Panel recommend?

    I agree that all of these effects are of lesser importance than the four main topics that are planned for inclusion – nutrient enrichment and acidification effects on both terrestrial and aquatic ecosystems. But would encourage some reconsideration of both "nitrogen saturation" -- which is hard to avoid since it is the "limiting case" when you are already dealing with nitrogen enrichment effects.

    I feel similarly about keeping climate change effects caused by N_2O emissions in the present assessment plan --mainly because climate change effects are so likely to become very much more important in the future of our country's concerns about human induced changes in the chemical and physical climates of our planet..

Dr. Paul Hanson

The plan contains appropriate general principals, but the presentation and terminology could be improved as outlined in the following comments. Policy relevant background levels of NOx and SOx exposures, acidification, N or S deposition should be discussed or planned to be discussed somewhere in this document (see page A-8 for an exception). Adding line numbers to this document would facilitate its review.

Specific comments:

I would add definitions for the following terms used in the documents to the "Key Terms" pages:

- Adverse Effect/Change – See possible definitions in text on page E-1.
- Criteria pollutant
- Dose – see use on page 10.
- Ecological quality – used on page 8
- Indicator – This term is used two ways in this document. On the one hand it is used (I think correctly) in terms of the definition of a possible Secondary NAAQS. In other places it is used to describe a measure of change driven by NOx and SOx pollutants. The authors need to choose the preferred use.
- Multimedia Modeling – Why isn't this just ecological or process modeling?
- Sensitive Ecosystem

On page vii within the definition of Total Reactive Nitrogen the last line might include the phrase 'N-containing organic compounds'.

Page 2 (top of the page): I'm not convinced that the authors should conclude that a more robust database will be available after another 5-year cycle. Does EPA have plans to fund significant new research? Are other agencies or organizations planning investments in N and S deposition effects research?

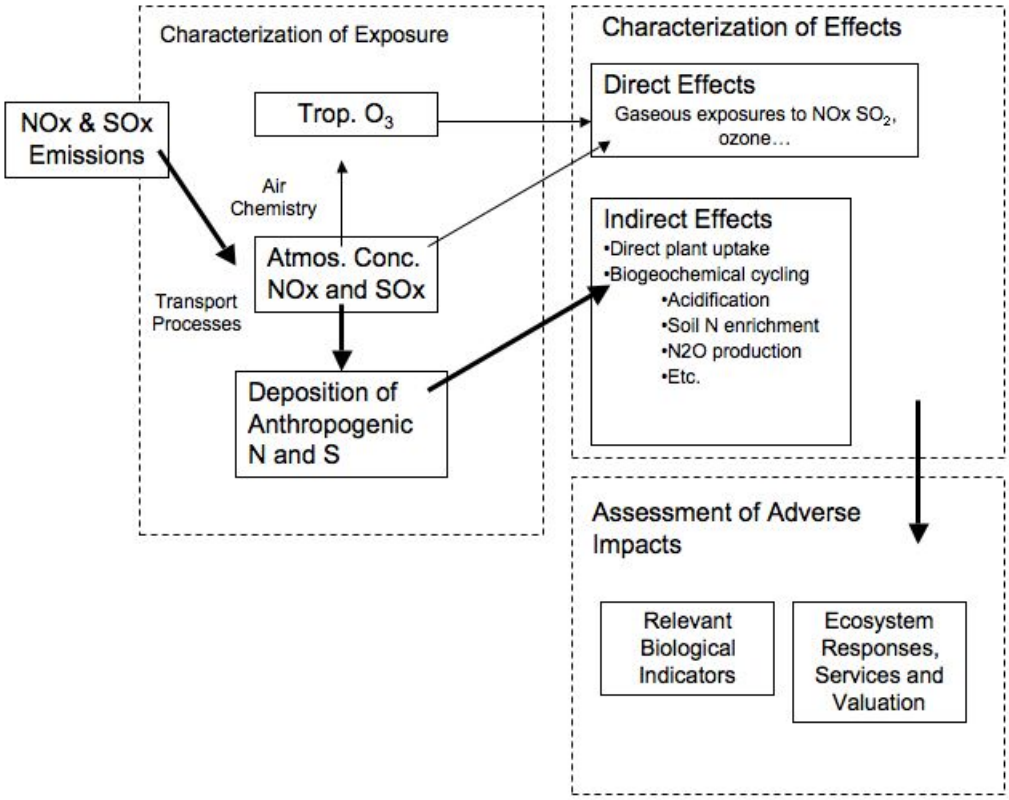
Page 2 (middle): The regulatory authority for addressing NOx and SOx as criteria pollutants is well described. More detail on how this authority translates to the subsequent extended discussion on N and S deposition effects (acidification, N enrichment) would be appropriate. A brief comment to this issue is added at the top of page 3.

Page 6: The previous NOx ACQD published in 1995 was not limited to a discussion of ambient air effects of NO_2 on vegetation. It included a large amount of data summarized from the acid rain literature on N deposition effects (or potential effects).

Page 8: The connection between NOx emissions, subsequent deposition and the direct generation of N_2O solely from the anthropogenic N inputs is not strong. Should it really be included here? References or direction to the ISA could also be used at the bottom of page 8.

Page 9 second paragraph: The primary effect of NOx and SOx would be a direct effect on vegetation function/survival or a direct impact on a material surface. I would classify all of the effects discussed in this plan as secondary. The N and S deposition effects are at least one step removed from the form of the primary pollutant. After rewording, however, I would retain this paragraph. For complete appreciation of the impacts of NOx and SOx on public welfare, their contribution to the generation of atmospheric particles and tropospheric ozone is worth mentioning.

The figure may reflect the proposed assessment process, but it doesn't illustrate the complexity of the problem in my opinion. I would use something like the following:



Page 11 4th line from the bottom: Should the word "reduced" be oxidized?

Top of page 12: The word "or" might be 'and'.

Page 15: In the first bullet, Risks should probably be associated with 'adverse nitrogen enrichment effects'.

Figure 2-5: This is a much better figure than Figure 2-1. It might be moved forward and used together with Figure 2-1. It might also include other dashed ovals showing additional known effects of NOx and SOx that are simply not dealt with in this document (e.g., tropospheric ozone and aerosols).

The bottom full paragraph on page 16 needs a reference.

Bullets on page 17:

1 Good
2 May not be enough information
3 Good
4 Good

5 Critical
6 Current standards provide little protection nor do they inform the phenomenon of acidification or N enrichment highlighted in this document.
7 It isn't clear how anthropogenic NOx from atmospheric pollutant sources can be distinguished from other forms of N inputs (i.e., agricultural fertilizer).

Bottom of page 17: Ecosystem characteristics will be critical. This is a key issue.

Page 18: The bullet questions and key issues outlined on this page are very good. At the bottom of the page it may not be clear what is intended in the discussion of long-term impacts (weeks, months, years, decades??). A statement on the need to understand background levels of N and S deposition and natural processes of acidification in a regulatory context should probably be included.

Page 22: In the third paragraph 2nd line, please eliminate the word adverse. Not all effects are adverse.

Section 3.1.1: To avoid confusion with the use of the word 'indicator' as a term to describe the nature of the regulated pollutant (e.g., NOx and SOx atmospheric concentrations), I would change the use of indicator throughout this section to something like 'measures of response/change'.

Page 29: As a measure of nutrient enrichment, throughfall N deposition (Table 3-3) will fail to measure the component of rainfall N absorbed by the canopy. I favor the use of total N deposition as an indicator of pollutant exposure.

Page 30: A measure of ecological or biological change resulting from acidification or N enrichment will be difficult to isolate from trends in other biogeochemical cycling drivers (temperature, soil water status, herbivory outbreaks….).

Middle of page 35: The suggestions of the EES are well thought out and should be the basis for this evaluation. It will be critical to show that the anthropogenic source of the driver for adverse ecological changes is the cause for any perceived adverse effects. Can this be done?

Bottom of page 35: Can new and old N really be distinguished (or need to be distinguished) in the context of the N and S biogeochemical cycles? Perhaps from isotopic studies, but such observations will not be available for EPA's analysis across the US.

Page 45: As an indicator of the pollutant I would favor combined wet and dry N deposition. Using throughfall would underestimate total N additions (i.e., the canopy is a good filter for the extraction of N from rainfall).

Page 47: Of the monitoring networks mentioned on this page, several seem to be unrelated to air pollution (e.g., agricultural runoff modeling). They may be needed to calculate total N enrichment effects, but they will not inform air quality issues themselves.

Page 47: Add a reference for the "National Atlas".

Bottom of Page 55: The point made at the bottom of this page is really important. I don't, however, know how one will define a national standard specific to regional areas.

Page 57: Application of modeling for the purposes proposed by EPA in this document tends to assume that the models have validated mechanisms that 'get it right'. This may not actually the case. EPA should be careful not to apply models validated for one area/region to other areas without appropriate

attention to their utility in those regions.

Page 58 Bullet #5: Are sufficient data actually available to support the development of these relationships.

Page 58 Bullet #7: Where the effects from loadings are anticipated to accumulate over long time periods (i.e., years), it may be important to begin to also evaluate the potential implications of climate change on such relationships.

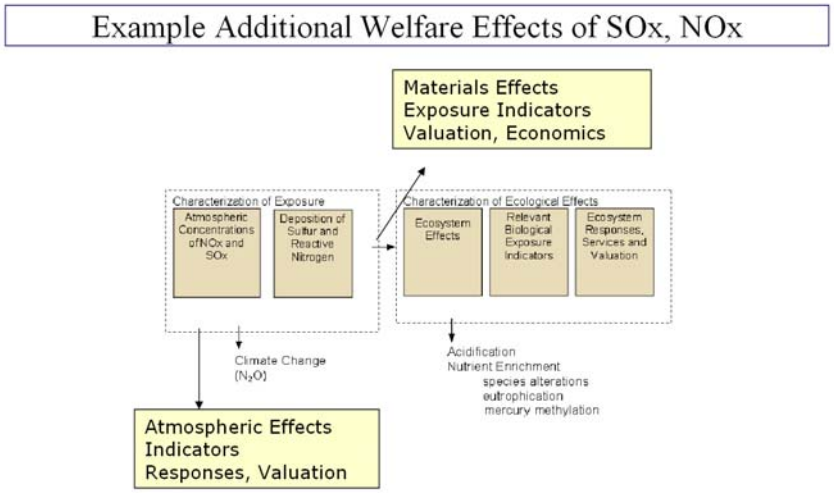
Dr. Rudolf Husar

Overall, the draft plan, Scope and Methods section is for the Secondary NAAQS for NOx and SOx is thorough and executable. In particular, expanding the scope by combining NOx and SOx is commendable. The combined review plan is consistent with the intertwined and multifaceted nature of welfare impacts. However, there are several serious concerns regarding some aspects of the Scope and Methods sections:

Question 1: Conceptual Model of the Welfare Risk

Consideration of other Welfare Effects of NOx/SOx.

The primary NAAQS is focused on protecting human health, while NAAQ Standards are to protect and minimize the **welfare** effects of pollutions. The planned scope of the NAAQS review document review is focused almost exclusively on the ecological effects of SOx & NOx. The known welfare effects such as perturbations to the atmosphere (weather, climate, optics), and the economic/esthetic effects on man-made materials are not covered.



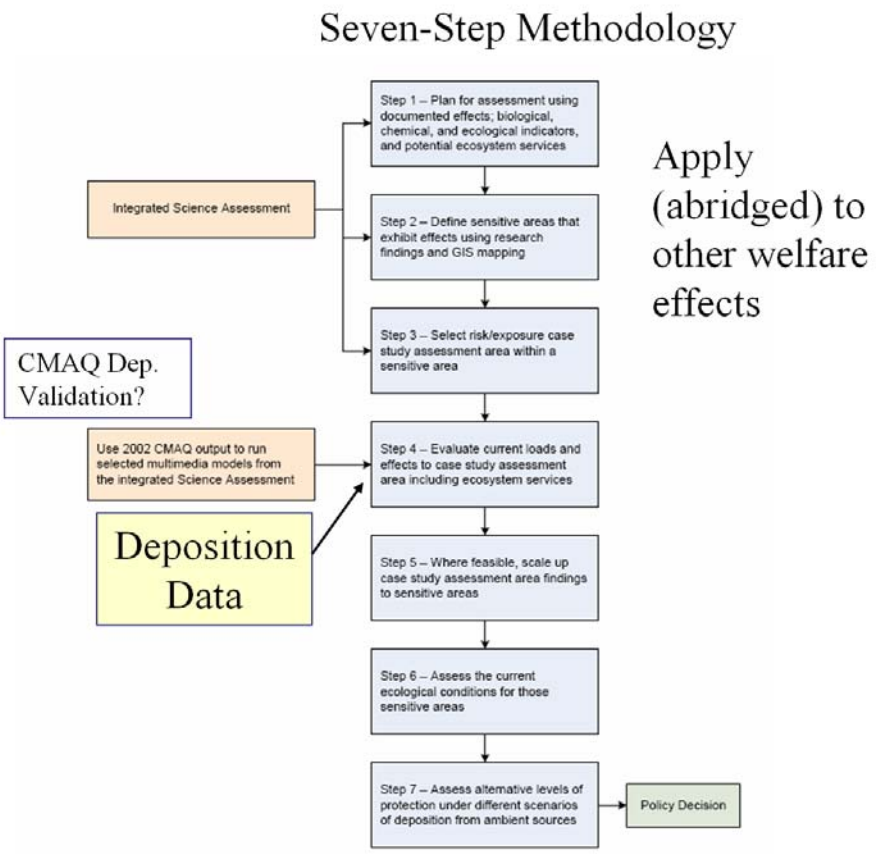
Marginalizing these non-ecological welfare effects will omit a significant rationale for mitigating SOX/NOx emissions. This omission is also inconsistent with the recent trend toward integrated assessment of interlinked pollutant systems: While Sox and NOX are considered as a combined set of interacting pollutants, their combined effects are treated incompletely in piecemeal fashion. This limits the ability of the document to provide a full rationale for acting on welfare effects.

It is recognized that some discussion of welfare effects of Sox/NOx have been incorporated in the NAAQS Criteria document for PM. If deemed desirable, this document could make references to the specific sub-sections of the PM Document. However, the key findings relevant to the welfare effects should be present in this document, so as to provide a complete assessment. Also, as stated below, most other documents do not treat the question of indicators adequately.

Question 2: Seven-Step Methodology

Apply Abridged 7 Steps to Non-Ecological Welfare Effects

The seven-step methodology proposed for the ecological effects is sound and executable. The same methodology, suitably abridged for each welfare effect should be applied to the other welfare effects. This would give consistency and scientific robustness to the document.



Elaborate versions of Steps 3, and 5 may not be necessary for some effects. However, the development of sensitive areas, indices, current conditions would be desirable for these welfare effects.

2.3.2 Overview of Nitrogen Deposition

This section gives appropriate general exposition of NOx chemistry, concentrations and deposition. In this overview, (including in Fig 2.2) it would have been helpful to indicate that

- NOx deposition is primarily through gaseous HNO3
- Total deposition is dominated by dry deposition

The inclusion of N2O in this scoping document discussion is puzzling. It is stated that N2O is a greenhouse gas but also that. “Since that is outside the scope of this review, it will not be a quantitative part of this assessment”. So, how was the scope defined? What is the rationale for omission?

2.3.3 Overview of Sulfur Oxides and Sulfur Deposition

This section gives appropriate general exposition of SOx chemistry, concentrations and deposition. It is not clear what is meant by “Due to known acute effects on plants, in previous NAAQS reviews, SO2 served as the chemical indicator for SOx species.” For the reviews over the past 30+ years, SO2 and SO4 have been clearly separated when presenting their concentrations and deposition. In what context was SO2 a surrogate?

Pertaining sections 2.3.2 and 2.3.3, there is a general comment regarding the use of the CMAQ model. The heavy reliance on CMAQ model for (concentration and) deposition estimation is of concern. The CMAQ model performance for Sox is documented and for ambient SO4 concentrations, it seems adequate. However, the marginal performance of CMAQ for Sox wet deposition and for non-sulfur species suggests considerable room for improvement. Additional effort directed toward CMAQ validation should be included. The direct use of observational data in estimating deposition (Step 4) and for extrapolating the case study areas (Step 5) should be considered.

3.2.2 GIS Mapping

This activity is commendable. This section outlines a very ambitious plan to generate many of ‘GIS layers’ for use in the assessment. In particular, **Table 3-5** summarizes the current plan for GIS mapping layers and models to be applied in the risk/exposure assessment of targeted sensitive ecosystems. These layers originate from a variety of sources and they represent very diverse content. The preparation of each layer and the integration of the layers to support the seven steps is a technically and scientifically challenging task.

It would appear useful to

- Prioritize the preparation of data layers
- Test the layer integration methodologies on simple data fusion analyses

Finally, the credibility of this would be enhanced if the GIS data layers prepared for the Review would be documented, cataloged, published and made available for re-evaluation and re-use by the regulatory and scientific community.

Dr. Dale Johnson

General Comments

As in my last two reviews, I stress the need for looking at all points of view, especially with respect to nitrogen deposition. As in the other documents, the focus is on the negative effects, which leaves this document open for severe criticism once it is released. This is especially true for the potential effects of nitrogen deposition on carbon sequestration in US forests – this could in fact be a negative effect of reducing N emissions! Once again, I do not advocate excusing air polluters on this basis, but I think a fair and complete assessment requires that this side be discussed. To fail to do so risks losing credibility for the entire effort.

Question 4. How well are the major effects of NOx and SOx on ecological acidification identified and characterized? To what extent do the discussions and integration of evidence across scales (e.g., species, communitied, ecosystems, and regions) correctly represent and clearly communicate the state of the science?

The effects of NOx and SOx on ecological acidification are fairly well characterized – that is not the problem. The problem is the scope of this assessment – namely, the focus on acidification. Nitrogen is the limiting nutrient for most terrestrial ecosystems and therefore there is the distinct possibility of beneficial effects as well. I believe that it is a both a scientific and strategic mistake to ignore the potential benefits of N deposition to the national C budget while at the same time considering only one part of the greenhouse situation by including the negative effects of N2O. I daresay that climate change is potentially a much larger environmental issue than acidic deposition or N saturation is – at least it certainly looms much larger in the media and the mind of the public these days. Nadelhoffer et al. (1999) dismiss the potential benefits of N deposition on forest growth largely on the assumption that most deposited N is immobilized by microbial uptake in the forest floor and soil and only a small proportion (20% in their studies) is recovered by trees. This is in fact typical of previous forest fertilization studies which show that microbes typically outcompete trees for N. However, the argument is disputed by Jenkinson et al (1999) find their argument unconvincing because it ignores foliar uptake: most atmospherically-deposited N first impinges on the foliage, not the forest floor, as in fertilizer studies and in the studies cited by Nadelhoffer et al (1999), and microbial competition in the forest canopy is considerably less than in the soil. At a minimum, the arguments by Nadelhoffer et al (1999) imply that greater rates of N deposition would lead to greater rates of forest C sequestration, an argument also implied by the analysis of Hungate et al (2003). Finally, a recent study by Pregitzer et al (2008) has conclusively demonstrated that experimental inputs of N at relatively low levels (30 kg ha-1 yr-1) caused significant increases in C sequestration in live trees and forest floor in forests in Michigan.

Again, I emphasize that the point of delving into this issue in some detail is not to justify increases in N deposition but to fully ventilate both sides of that issue. The potential contribution of N deposition, especially at higher levels, to N deficient forests has not unresolved and needs some experimentation and careful analysis. The current proposed methods include only those

sites where N deposition has proven to have negative effects or is likely to have negative effects, and these sites are simply not typical of forests in the United States which are mostly N-limited rather than N saturated. Furthermore, the results from these arguably unusual N-saturated sites, which do not reflect the normal N limited condition of forests in the US, will then be extrapolated, apparently to represent N effects over the entire country. This is bias in the extreme – case studies need also to include chronically N deficient sites where growth and indeed even ecosystem health might improve with increased N deposition! I believe that such an analysis should be a part of the plan for assessing the effects of atmospheric deposition in the document being reviewed. It makes no sense to partition out the acidification effects of air pollution from the potential effects of C sequestration.

5. How well has the ISA characterized the relationship between acidifying deposition levels of NOx and SOx and environmental effects?

All of the comments made above apply to this question as well. The ISO has some technical problems in the way acidification is hangled, as noted in my review, but the major problem is the complete focus on acidification and the lack of perspective on the larger C budget and global climate issues looming ahead.

6. How well characterized is the relative importance of the oxidized and the reduced forms of nitrogen on ecosystem acidification?

There is some lack of clarity on this in the ISA document, as noted in my detailed review on p. 4-12, lines 2-9. Ammonium is acidifying whether it nitrifies or is taken up by plants or microbes (in the latter case, causing the release of H^+ during uptake). The oxidized form of N, nitrate, is not in itself acidifying – in fact, uptake of nitrate should cause the release of OH^- to maintain charge balance in the plant or microbe.

Specific Comments:

p. 2. paragraph 2: Effects on climate are mentioned here – such effects must include the potential increases in C sequestration associated with N deposition from pollution in order to be a complete picture.

p. 14, last paragraph: "can be characterized as a positive or negative effects…" Only negative effects are sought in the case studies proposed in this document. No mention is made of potential positive effects on the bullet list on p. 15.

p. 26, top: "we plan to identify adverse terrestrial and aquatic effects.." Why only adverse effects? Positive effects were mentioned earlier – was this only lip service? Where is the balance?

p. 26, bottom: "focused on what soil features should be tracked, including how organic matter affects microbial processes." I do not understand what is meant here by how organic matter affects microbial processes nor how it relates to the problem at hand.

p. 27, Table 3-1: Carbon budget, growth, etc are highlighted here – but this will apparently be assessed only in sites specifically selected to show the most adverse effects in the case study assessment. Furthermore, the results from these arguably unusual N-saturated sites, which do not reflect the normal N limited condition of forests in the US, will then be extrapolated, apparently to represent N effects over the entire country. This is bias in the extreme – case studies need also to include chronically N deficient sites where growth and indeed even ecosystem health might improve with increased N deposition!

p. 30, paragraph 1: among ecosystem services, the example or primary production is given. See comments directly above. Assessment of primary production appears to be limited to sites where N effects are known to be negative.

p. 31, paragraph 1: Most ecosystems in the US are sensitive to N deposition in the sense that growth increases might occur. In some cases this will be "bad", as in exotic species invasions, and in some cases this will be "good" as in commercial forests.

p. 32, GIS mapping: I firmly believe that the GIS mapping exercise should also include a thorough analysis of potential effects of increased N deposition on C sequestration.

p. 36, Table 3-5: Indicators should include foliar N concentration and should be stratified by species. We have reasonably good data on foliar N levels for deficiency, and even toxicity levels for many species. Foliar N should be included in the indicator list.

p. 38: The list of prospective sites here should include fast growing forests of the southeast (loblolly pine, for example) where N inputs may well cause greater growth and C sequestration. Also should included the San Bernardino sites in southern California where N saturation is extreme. San Bernardinos are buried in Table 3-7, but should be included here. This list is biased toward sites with negative effects and incomplete.

p. 44: Lake Tahoe should include forest effects, were forests are thought to be typically N limited. Lake Tahoe is also somewhat unique in that much of the pollution enters the lake directly since ratio of land to water in the watershed is very low.

References:

Hungate, B.A., J.S. Dukes, M.R. Shaw, Y. Luo, and C.B. Field. 2003. Nitrogen and climate change. Science 302: 1512-1513.

Jenkinson, D.W., K. Goulding, and D.S. Powlson. 1999. Nitrogen deposition and carbon sequestration. Nature

Nadelhoffer, K.J.,. B.A. Emmett, P. Gunderson, O.J. Kjonnas, C.J. Koopmans, P. Schleppl, A. Tietma and R.F. Wright. 1999. Nitrogen deposition makes a minor contribution to carbon sequestration in temperate forests. Nature 398: 145-148.

Pregitzer, K.S., A.J. Burton, D.R. Zak, and A.F. Talhelm. 2009. Simulated chronic nitrogen deposition increases carbon storage in Northern Temperate forests. Global Change Biology 14: 142-153.

Dr. Myron Mitchell

Draft Comments on:

Draft Scope and Methods Plan for Risk/Exposure Assessment: Secondary NAAQS Review for Oxides of Nitrogen and Oxides of Sulfur

General Comments

More consistency is needed throughout the document on the different definitions and forms of chemical species including the grouping of these chemical species into classes. The linkage of acidification with cation nutrient depletion and the mobilization of toxic cations (e.g., aluminum) needs to occur earlier in the document so that the total ramification of acidification is clearer. The document needs considerable work with respect to consistency and the use of precise descriptions. Some statements lack clarity. The criteria for selecting case studies are discussed, but an unambiguous delineation of the importance of specific criteria in making these selections is needed. Throughout the document there are statements about the needs for data. It would be better to state that "information" is what is required. Data availability without previous interpretation and analyses are less useful than those data sets that have been evaluated. Those data sets that have been evaluated by multiple approaches would be especially useful. Some reference to the European experiences in developing methods for Risk/Exposure Assessment might be insightful including the relatively wide application of the MAGIC model at various European sites.

Within these proposed scope and methods in some instances the plan seems very ambitious and I am not certain that completion is possible within the time frame of the assessment and with the resources available to do these tasks. This issue may be especially important in evaluating impacts on ecosystem services.

Specific Comments

Page	**Comment**	
2	It is not clear whether N_2O is included with the definitions of "oxides of nitrogen" and or "nitrogen oxides." On page 11 it is stated that "the family of nitrogen oxides includes any gaseous combination of nitrogen and oxygen, e.g., NO_2, NO, N_2O, N_2O_3, N_2O_4, and N_2O_5."	
6	Change to:	in previous NAAQS <u>reviews on nitrogen or sulfur</u>
11	Change to:	In an analytical <u>approach</u> unconstrained by data and <u>other</u> resource limitations, one could envision a comprehensive risk assessment covering all potentially affected ecosystems and all scientifically supported effects <u>on those ecosystems in the United States.</u>

11 The identification of the N chemical species provided below needs to be better aligned with the definitions of N chemical species given on page 2: "The sum of mono-nitrogen oxides, NO_2 and NO, typically are referred to as nitrogen oxides (NO_x) in the atmospheric science community. More formally, the family of nitrogen oxides includes any gaseous combination of nitrogen and oxygen, e.g., NO_2, NO, N_2O, N_2O_3, N_2O_4, and N_2O_5. Total reduced nitrogen (NO_y) includes all nitrogen oxides as well as gaseous and particulate nitrate species such as HNO_3, PAN, and aerosol phase ammonium nitrates. Reduced atmospheric nitrogen species include ammonia gas (NH_3) and ammonium ion (NH_4^+), the sum of which is referred to as NH_x."

13 The following statement is confusing with respect to how N_2O is treated in this assessment: "Since the definition of "welfare effects" includes effects on climate [CAA Section 302(h)], we will include N_2O within the scope of this review. However, it is most appropriate to analyze the role of N_2O in anthropogenic climate change in the context of all of the greenhouse gases. Since that is outside the scope of this review, it will not be a quantitative part of this assessment."

13 I don't believe that generally the SO_2 or SO_x includes particulate sulfate particles as stated: "SO_2 is one of a group of substances known as SO_x, which include multiple gaseous (e.g., SO_2, SO, SO_3, S_2O_3, S_2O_7) and particulate (e.g., ammonium sulfate) species (**Figure 2-4**)."

21 Is this statement really necessary: "In addition to these four effects, we plan to address, as appropriate and within our time constraints, impacts associated with nitrous oxide (N_2O) and the influence of sulfur enrichment on methylmercury production."

22 This statement needs to be reworded to clearly suggest the challenge associated with making an assessment of impacts on a diverse set of ecosystem types over a range of atmospheric inputs: "The anticipated spatial extent and diversity of ecological effects due to deposition of nitrogen and sulfur do not facilitate a nationwide analysis."

24 Change to: case study areas, data <u>may not be sufficient</u> to perform a quantitative assessment for each

28 In Table 3-2 why are K and Na not included with Ca and Mg as base cations?

28 Change to: "exchange capacity (CEC) are more widely available at the present time than <u>information on</u> biological indicators"

28 The following statement implies that CASTNET underestimates dry deposition of nitrogen. If this is the case, further explanation is warranted: "This creates complications in developing estimates for total nitrogen deposition levels because dry-deposition data sources will likely be underestimated."

29 The following statement is not true since there is a linkage with Ca availability and tree species (e.g., sugar maple) that produce litter this has higher N mineralization and nitrification rates: "For terrestrial ecosystems, low calcium to nitrogen ratios in soils are commonly related to increased nitrification and potential increases in soil acidity and releases in NO_3 to receiving waters; however, these measurements are not always widely available." Literature examples include:

Christopher, S.F., B.D. Page, J.L. Campbell and M.J. Mitchell. 2006. Contrasting stream water NO_3^- and Ca^{2+} in two nearly adjacent catchments: the role of soil Ca and forest vegetation. Global Change Biology 12:364-381.

Page, B.D. and M.J. Mitchell. 2008. Influences of a calcium gradient on soil inorganic nitrogen in the Adirondack Mountains, New York. Ecological Applications. (In Press)

29 Change to: For aquatic ecosystems, the indicators for "nutrient enrichment" effects reflect a combination of inputs from <u>various sources</u>

29 Not sure what "are encouraged" implies in the following: "are encouraged for inclusion in numeric criteria as part of EPA-approved state water quality standards (U.S. EPA, 2000)".

29 Clarification is needed on the "data-fusion approach."

29 In table 3-3 change to: "Reflects a combination of inputs from <u>various sources</u> (air, discharges to water, diffuse runoff, and groundwater inputs)".

29 In table 3-3, the following statement (Repeated twice) is confusing: "Relative role of air deposition should ideally be compared with air deposition data and also with available (preferably multi-media) models."

How can the models be separated from air deposition data since the models are needed to calculate deposition?

30 Is it correct to include within ecosystem services "cultural services including spiritual or religious values, aesthetic values?"

30 What is meant by "type of environmental system?"

30 It is not clear how the following approach will produce the needed outcome: "**Identify Databases of Indicator Conditions:** The indicators selected will relate to available compendiums of literature abstracts or actual database systems (as stand alone files or accessed through Web portals) to provide readily available and transparent ways to document the nature of the indicators and the indicator conditions used to define the environmental impairments."

"Compendiums" should be "compendia."

30 Change to: **Identify and Address Temporal Issues:** Different ecoregions, landscapes, biological provinces will have differing degrees of susceptibility to impairments or differing recovery potential, depending on edaphic characteristics, past land use and/or pollution histories.

30 For the following statement, be more explicit on the actual times needed for recovery (fairly rapid and much longer recovery times need some approximate values):

"Some ecological systems may be capable of fairly rapid recovery responses once pollutant loadings are significantly abated; other systems, such as larger estuarine aquatic systems, may require much longer recovery times."

31 Provide better description versus the following jargon: or at least define these terms "potential near-field and far-field linkages."

31 The terms in Figure 3-2 should be reflected in the text.

31 Change to: Inland acid-sensitive waters in the eastern United States and nitrogen-sensitive ecosystems in the Rocky Mountains and other parts of the western United States may require large-scale, special-area assessments.

31 Clarify why this area is special (Is this different from the sensitivity of other areas?):

"Ecosystem effects in special areas"

31 How could linkages not be geographically significant? Note the statement: "If the linkages are geographically significant"

32 Why this specific example: (e.g., local research of MeHg formation in Devil's Lake, WI).

If this example is used, at least a citation is needed.

32 Change to: Of special interest will be the characterization of linkages that can be used for synthesizing results for the entire U.S.

32 Why "may" in the following statement: "Information that deals with special case study areas (e.g., the Adirondack Mountains or special alpine and subalpine"

Previous statements have suggested the importance of focusing on sensitive systems.

32 For heading "3.2.2 GIS Mapping" delete mapping; this is redundant.

32 Reword for clarity and precision: "To describe the national picture, we plan to map the locations of those sensitive ecosystems identified in Section 3.2.1 and identify the characteristics of the biological and biogeochemical properties that create the sensitivity."

32 By “unmapped areas” does this imply areas in which an appropriate GIS is not available?

32 There are different issues associated with scale and defining the boundaries of a GIS. Clarify the following statement: “Sensitive areas can be identified at different spatial scales by using different approaches for defining the boundaries of the mapped units.”

32 The description under 3.2.2 needs considerable modification to clarify how GIS will be applied to this assessment.

33 The linkages need to be made more explicit in some components of: Figure 3-3. Documented biological, biogeochemical, and physiographic linkages.

34 Provide further details on the source of the “ESRI 8.3 data disks.”

35 It is stated that “Where case study or ecosystem-specific data are available, a subset of maps for the case study assessment area may be created.”

Are only “data” needed rather than information associated with the interpretation of these data?

35 It is suggested that “Complementary to these efforts, we may use a statistical cluster analysis to group ecosystem units into similar sets. Clustering ecosystems might reduce the number of locations that need to be modeled to adequately characterize the variability in ecosystem response to changes in nitrogen and sulfur deposition.”

It would also be helpful to identify key ecosystem attributes that are most critical in the classification and grouping of these ecosystems with respect to effects of N and S pollutants.

35 It is stated that “In selecting areas to assess ecological effects from air deposition, the SAB Ecological Effects Subcommittee (EES) suggests consideration of (1) clear quantifiable ecological effects due to air pollution, (2) the degree to which a significant component of ecological effects are attributable to air pollution, (3) the responsiveness of ecosystem services to changes in air pollution, (4) the cumulative impacts of multiple air pollutants, (5) the abundance of ecological effects and economic benefit cost analysis, and (6) the visibility to the public and value of resources at risk (U.S. EPA, 2005). While these recommendations were made in the context of a prospective cost-benefit analysis, many of these recommendations are sound in the context of our NAAQS risk analysis.”

Having some hierarchy in these selection criteria would be useful since there could be distinct differences among ecosystems on the relative value of each of these criteria.

35-37 In addition specific recommendations are provided from the ESS regarding selection criteria. These factors need to be blended into a more cohesive set of criteria for selection.

45	The following statement is weak: “Depending on the adequacy and abundance of data for areas, the evaluation may entail computer modeling, statistical analysis, or qualitative analysis.”
	Clearer criteria of the importance of the type and amount of information available need to be provided in selecting case study sites.
45	I am not sure that the following indicator is useful due the role of canopy exchange processes in markedly affecting the concentration and fluxes of N chemical species in throughfall: “Nitrate, ammonia, organic nitrogen throughfall deposition for terrestrial ecosystems.”
46	It is stated that: “We plan to evaluate the spatial adequacy of available monitoring data including GIS mapping of documented data to identify any meaningful spatial gaps.”
	What will be done if these spatial gaps are found?
46	It is stated that: “For each ecosystem effect, we plan to determine if there is a temporal dimension to exposure.”
	Isn’t there always a temporal dimension to exposure? Aren’t more critical issue aspects associated with non-linearities, thresholds, lag-times, etc.? Some of this is discussed in the following sentences.
46-47	Each of these sources of loading information has limitations. Including some details on the errors of these estimates would be helpful
47	In discussing the “CMAQ Deposition Modeling” the issues related to uncertainties associated with the calculation of deposition velocities as a function of surface types needs some mention with respect to the overall confidence in the predictions.
48	In discussing acidification the importance of the contribution of mobile anions (sulfate and nitrate) to the loss nutrient and toxic cations needs more emphasis. The pH effect is only a small part of the impacts.
50	An important criterion for selecting regions to model should include availability of previous modeling efforts.
50-51	Further clarity is needed in the section on “Assess Uncertainty in Loading and Exposure Computations.” For example does resolution include both temporal and spatial considerations? What is meant by “differing complexities?” Does this mean landscape complexities, complex processes, or something else? If more inventories of reactive N species are needed for the modeling, how will these inventories be done in the context of this effort?

51 Is it feasible to determine “the contributions from air deposition sources can be analyzed relative to all other major anthropogenic or natural sources for sensitive ecosystems across the country?”

51 How will the assessment balance the needs of doing rigorous analyses in one or possibly few regions with the greatest level of accuracy and precision versus a broader range of regions with lower accuracy and precision?

52 Be more specific in which parameters will be evaluated with respect to “response curves.”

52 More clearly differentiate how the Calculate Desired Exposure Endpoint compares with the determination of critical load including the criteria used in these determinations.

53 The following approach is quite vague and ambiguous: “The specific methods used to evaluate adversity will depend on the availability of data and methods for the indicators of interest related to acidification and nutrient enrichment and on an assessment of the appropriateness of each type of quantification in comparing different levels and forms of the standards. In our initial assessment of the available data, given the timeframe for this NAAQS review, we have determined that the most useful approaches will be those focusing on quantifying the link between changes in ecosystem indicators and ecosystem services.”

Can some priorities be suggested on which indicators would have highest priority?

53 Doing the following is certainly a daunting challenge: “Thus, when ecosystem services are quantified and their ecological response functions to NO_x and SO_x are modeled, it is imperative that the entire bundle of services be evaluated, and that the linkages and tradeoffs among ecosystem services are included in the quantification (i.e., ecological tradeoff functions [ETFs]).”

54 Is it feasible to do the following within the time frame of this assessment? “Therefore, at this time, data mining will be central to developing at least a preliminary assessment of potential impacts of NO_x/SO_x deposition and acidity on ecosystem services. In the current plan, process-based models are being considered to be used to (1) synthesize/link the suite of ERFs and ETFs and (2) generate maps and summaries of ecosystem services and tradeoffs in response to current and future ambient air indicators for NO_x and SO_x. The collection of response and tradeoff functions will aid in the valuation of the services at risk to these criteria pollutants where possible.”

55 To accomplish the tasks that are stated might require a very selective choice of a region or a few regions where the available information is sufficient to do this work within a relatively short time:

1. Identify areas/regions of the country receiving high levels of NOx/SOx deposition and acidity impacts.
2. In those regions, identify ecosystems sensitive to elevated levels of nitrogen and sulfur, using some common selection criteria.
3. In those sensitive ecosystems, ask what ecosystem services are expected to be prevalent and "valued" (i.e., some subset of all potential services).
4. In those areas, identify what data are available to develop ERFs and ETFs, at least to a qualitative degree that would enable production of spatial and temporal maps to identify different degrees of protection that would exist under alternative secondary NAAQS. Chan et al., (2006) produced such maps for several ecosystem services in the Central Coast ecoregion of California. The linkage and comparison of multiple ecosystem services in the region would provide information for consideration of tradeoff value of one service versus another.

A-1 The susceptibility of the ecosystems to the depletion of nutrient cations should also be an important factor with respect to evaluating sensitivity.

A-2 The quantification and analyses of ecosystem services in the context of this assessment will be a major challenge.

A-5 to A-6 The role of sulfate and MeHg interactions is mostly attributed to wetlands. Wetlands are different than aquatic systems and possibly a separate section is warranted on the importance of wetlands in relationship to the assessment.

A-6 It would be helpful to identify those specific tree species such as sugar maple which have been shown to be particularly sensitive to Ca availability.

A-8 In discussing "maple decline" the actual species needs to be identified (e.g., sugar maple) because other maple species are much more tolerant to atmospheric pollutants and nutrient depletion.

B-1 to B-2 The importance of N_2O emissions is due to its role as a green house gas. It may not be feasible to address fully the importance of this factor in this assessment without spending considerable effort integrating green house gas discussion into the document.

C-1
to
C-4 Some consideration is needed on the accuracy and precision of the estimates associated with the use of the CMAQ MODELING. How will the uncertainties associated with the modeling of the atmospheric deposition of sulfur and nitrogen affect the ability of the assessment to predict the effects of spatial and temporal patterns.

Mr. David Shaw

General Comments

Outcome of REA

Is this REA the same one that is described as due August 2008 (Table 2-1)? The REA Plan is difficult to assess in terms of what outcome to expect because it has so many uncertainties built-in, for instance "depending on available data", or "if feasible" is used a lot. Also, who will do the actual assessment work, over what time period? What funds are available for the work? Who is the audience?

Adopting a Longer View

From what I have looked at so far, I think it is safe to say that most of the environmentally sensitive areas do not have adequate monitoring in place to track the changes that we will need to quantify when the next review of the these pollutants become due in 5 -10 years. It seems appropriate to make it a requirement that this REA make specific recommendations on what needs to be in place to make the next assessment more adequately quantitative or populated with data. We don't want to see more sophisticated models with the same poor data. We do want to see a stronger data record of results on the ground.

This longer term view (5 to 10 year) is also an opportunity to examine in this REA what metrics would be more useful that simply going with those that are currently available, e.g. the base cation surplus is a better indicator than ANC or pH where DOC is changing like in the Adirondacks.

Reliance on Modeling

A model like CMAQ certainly can produce estimates of dry deposition, but one of the drawbacks is that there is no way to assess if these estimates are reasonable. For this reason, it probably makes more sense to emphasize those measurements and model predictions that we have the most confidence in, namely wet deposition. (Section 3.4.2, pages 46-47)

Using five years of model results certainly is better than relying on a single modeling year. Were these five years modeled in a consistent fashion – same version of MM5, consistent emission inventories, consistent CMAQ features/parameters, etc.? Have they been evaluated against all available ambient concentration and deposition measurements, both for individual years and for the entire five-year period? (Appendix C)

Data Certainty

Few, if any, of the references to existing data provide the years of data availability. The length and current-ness of records are critical to any assessment especially because the last decade has

been a time of significant emissions/deposition changes and ecosystem response signals have been detected.

Missing from the document is a discussion (with maps) of the documented areas of the US where sensitive ecosystems and high deposition rates of N and S have been identified (e.g. NAPAP Biennial Report to Congress: An Integrated Assessment, May 1998, Figure 19, page 55).

PM & Ozone

I feel it is important to address particulate matter and ozone in this ISA as well as the PM and ozone ISAs.

The omission of particulate phase NO_x and SO_x appears to limit the potential for setting standards in the future using both PM and oxides of Nitrogen and Sulfur standards. Furthermore, PM plays a significant role in nitrogen and sulfur deposition.

Also, separating out the effects of gas- versus aerosol-phase S/N will be difficult, since wet and dry deposition can include both phases, and atmospheric chemistry and transport affect both phases. The ISA clearly states that "particulate NO_x and SO_x will be addressed with the secondary PM NAAQS review," and it therefore becomes crucial that these two review process tracks are highly consistent with each other. One cannot proceed independently of the other track.

Climate Change

Climate change discussion appears to be limited to N_2O. I feel that the climate change issue may be addressed more appropriately by including foliar injury data (USDA).

Section 2.3.1, Figure 2-1, page 10: Consider amending this figure. Climate change may affect the "Characterization of Exposure" and "Characterization of Ecological Effects," so consider putting arrows from "Climate Change" to these boxes. Suggest changing "Climate Change (N_2O)" slightly to "Climate Change (N_2O, etc.)."

Charge Questions

The 7 step approach seems thorough, but I do not feel that the gaps and uncertainties are properly described.

Identifying documented effects seems appropriate, but I feel that not all indicators are identified. Specifically, foliar injury (USDA) and base cation surplus.

Specific Comments

Section 2.3, page 8: Why is the document disregarding damage to materials, including decay of buildings, statues, and sculptures that are part of our national heritage this time around?

Section 2.3.2, pages 11-13: Although N_2O is included in this review process, it is not part of NO_y. Nor does it play a role in N deposition, so while it could be included elsewhere in this document it does not really belong in this section.

Section 2.4, last bullet on page 17: Is it necessary to be able to distinguish NOx from total reactive N? Isn't the purpose of this to examine all oxides of N?

Section 3.1.1, page 28: add 'base cation surplus' to Table 3-2. Key indicators of nutrient enrichment. This first paragraph is about deposition and applies generically to both acidification and nutrient enrichment issues.

Section 3.3, page 36-37: Table 3-5 More detail needed on the indicator data. Add dates of the mapping layers, whether point or polygon data, the number of data points or polygons in the study area (maybe the whole US), and the resolution of the base data.

Section 3.3, page 38: I feel that including the Catskills of New York will provide important information and data.

Section 3.4.1, page 45: Selection of ANC as an indicator. Have all sensitive regions and case study areas been evaluated independently for selection of best indicators? Just because ANC is most widely available, it may not necessarily be the best, e.g. see discussion on using base cation surplus for Adirondack streams in the ISA. Also the three first bullets of indicators are not really indicators (see page A-4 para for indicators).

Section 3.4.2, page 47: The maps are too small.

There are many acronyms throughout this document, and not all of them are commonly used. Please include a listing of these.

Dr. Kathleen Weathers

This is a useful document for catalyzing discussion and getting feedback from the committee. The approach relies almost exclusively on process-based and spatial modeling analysis. A short discussion of what—if any—other types of analytical and assessment tools are available would be useful.

Specific and general comments, questions and suggestions are listed below.

Section 2.3.1

I applaud the use of a conceptual model and framework.

Explicitly missing from the conceptual framework, however, is the key link (flow arrow) between concentrations and deposition. Also, the significance of the arrows and boxes should be identified (e.g., what's the distinction between the dotted and solid lines surrounding boxes. And the arrows?

What's the difference between ecosystem effects and ecosystem responses, or services (in boxes), for that matter?

I think that it would be helpful to define general ecosystem functions (e.g., productivity, nutrient cycling, etc.) and then point to places where the deposition of S and N has been demonstrated to alter them.

Page 1: Consider altering the sentence beginning with "Our plan..." to: "...and the levels of deposition," *and the environmental effects on ecosystems of this deposited material*."

Page 1: "Along with these case studies, we plan to conduct statistical and spatial characterizations..." Are these analyses intended to be new work/research?

Section 2.1: The legislative mandate reads to me as the request for determination of critical loads, albeit within a narrow range.

Section 2.2, page 6 awkward phrase: ....importance of acid neutralizing capacity in surface water acidification.

Page 8, 2nd para: *tropospheric* ozone

Page 8, last para: "Against this broad background..." awkward and, in places incorrect.

Page 9, "In this current review...appropriateness of NO2 as an indicator..." I'm not sure what this means.

Words such as harmful (page 11) should be modified by ecological or environmental.
The consideration of critical load analysis as an ecosystem-type specific risk may be more useful than considering it as a site-specific risk.

Page 11, the paragraph beginning with “Each component of the framework...” isn’t clear.

Fig 2-2 might note explicitly the formation of ammonium sulfate, since both N and S are of interest here.

2.3.3. The first couple of sentences are awkward. Also, acidification of the environment should include lowering the natural pH of rain, water bodies and/or terrestrial ecosystems.

2.3.4: are the deposition of NOx and SOx meant to infer the deposition of nitric and sulfuric acids? If not the second sentence is not right.

2.3.4: Be specific, for example: “Nitrogen and sulfur enrichment represents a continuum of effects...and it can be characterized as positive (increase in environmental parameter y with enrichment, or additional N or S, or with incremental additions of N or S) or negative (decrease in environmental parameter y with increase in N or S, etc)

Say clearly why methylmercury is being considered here vs other linked biogeochemical interactions (the effect of sulfur on phosphorous release/availability in aquatic systems, for example).

Figure 2.5: consider depicting feedbacks and linked processes

Section 2.4:

Clarify...”rather than on the effects of aerosol NOx and SOx that remain in the atmosphere.”

Page 17, second bullet: responses = effects? and variability is meant to be spatial and temporal, correct?

Page 18, second set of bullets:
Identifying important chemical species in the atmosphere? Important means relative to other species, because they can cause environmental effects? Over space and time?

Page 18, last bullet: Changes in land use might be added to the meteorologic and climate considerations

Section 3: Seven-step approach

The 7-step approach is appealing. It uses both spatial and mechanistic models to explore inputs of N and S across the US as well as the effects of N and S deposition. I remain concerned, however, that (1) the data that are necessary for many of the analyses do not exist or (2) available data are not at an appropriate spatial or temporal scale and/or cannot readily or reasonably be linked together or extrapolated using geostatistical or other tools.

(3) Finally, I cannot tell whether or how experimental data, for example N or S or combined N and S additions would be used to inform this analysis.

Since both the use of biogeochemical process models in new geographic locations as well as the creation of GIS-based models and analysis are active areas of scientific research, to what extent is it necessary that these model analyses and extrapolations appear in peer reviewed publication before they can be effectively used in this assessment? In addition, the steps that will be used to validate or verify model results should be identified.

Under *Key Indicators of Nutrient Enrichment*: What's the basis of the suggestion that wet-deposition monitoring stations can provide more... an extensive range of nitrogen species than is possible for dry-deposition monitoring stations?

As mentioned in my review of the science assessment, throughfall N may not reflect N deposition levels. Also, C:N in soils have been related to nitrate in surface waters draining watersheds.

Table 3-3: Technically, there aren't "dry deposition monitoring" networks, rather there exist air concentration monitoring networks and those data are used to estimate dry deposition.

See comment above about indicators and throughfall. Sulfur has been used successfully as an index of wet+dry deposition in the eastern US.

Recovery should be defined clearly and carefully for the purposes of this assessment.
What's the operative definition of a multi-media model?

Step 5 (Section 3.5):

The spatial extrapolation of case study areas is an interesting approach; my answer to whether I agree with the approach depends upon answers to several questions. It is not clear to me the basis upon which case study areas could be scaled, or whether the interpolation techniques alluded to are appropriate spatial extrapolation tools. Presumably deposition output from the CMAQ model will be mapped on to the sensitive areas, for instance. Are the spatial scales comparable?

Step 6 (Section 3.6):

The goal of creating response curves needs more explanation. Is the goal to identify thresholds, or identify inflection points? What's a desired exposure endpoint?
How will, or how could, published loading experiments be used to help identify response curves?

An example of "quantifying the link between changes in ecosystem indicators and ecosystem services" would make easier a discussion on the utility of this approach.

I concur with the idea of using the Millennium Ecosystem Assessment's definition of ecosystem services.

I think that parts of the mapping steps identified on page 55 are a good start:

It makes sense to me that the first data layer should be a total (wet + dry) S and N deposition map, apparently generated from CMAQ.

The acidity impact datalayer is presumably derived, but from which data or datalayers?
And, from here on out with the mapping exercises, the devil is in the details. For example, what are the common selection criteria? How will the prevalent ecosystem services be identified? A highlighted example from the Chan et al. 2006 paper would aid this discussion.

The valuation of ecosystem services is out of the realm of my direct expertise, but it seems to me that there is always the danger of undervaluing ecosystem services, especially when considering biogeochemical cycling of multiple, interacting elements.

Step 7 (Section 3.7):

Based on the heterogeneity in S and N loading, ecosystem sensitivity and responses across the United States, I think it very important to include as part of the secondary NAAQS a "form that allows for consideration of regional heterogeneity."

Resilience (and recovery) will need to be defined.

The need to relate ambient concentrations with actual deposition loads appears again in this section.

In the list of associated issues, "If total nitrogen..." concentration, content in what?

I agree that it will be most fruitful to do intensive analyses on smaller regions.

Will the proposed analyses be done on watersheds? Or on ecosystems with some other boundary and if so, what and why? It would be useful to define boundaries for these assessment areas.

Many, if not all, of the 9 steps entail significant analysis (which is evident to those who will be working on this document, of course). Are all steps equally important to come to policy relevant conclusions? Is it possible to identify what the most "sensitive" steps are, meaning which ones have the greatest influence on the policy-relevant conclusions. What is the relative importance of assessing the impacts of meteorological variability on loadings and exposures across the US (presumably) vs analyzing the relationships between NOx, SOx and other reactive forms of N (in the atmosphere?)? My assessment of the approach depends, in part, on answers to these questions.