Response to
Comments on "Scoping Study for Regional Haze in the Upper Midwest"

General

Referring to best and worst visibility days on the basis of $PM_{2.5}$ concentrations is not appropriate. Rather, a visibility index (e.g., light extinction or deciviews) should be used. Either refer to these 20% best and 20% worst days on the basis of concentration, or, preferably, calculate the appropriate visibility index and resort the days accordingly.

As recognized on page 1-1, we need to be concerned with both visibility impairment in the two Class I areas in northern Michigan, and visibility impairment in downwind Class I areas which are impacted by our five states. Although this "two-headed" problem is addressed in some places in the report (e.g., modeling domains), it is not in other places (e.g., transport processes). Suggestions are provided below to remedy this deficiency.

We have calculated the best and worst visibility days using b_{ext}. The meteorological analysis using EPA's wind clusters has addressed the above issues.

Executive Summary

p. E-2 (Temporal variability of $PM_{2.5}$): Further work is needed to examine the seasonal variability of $PM_{2.5}$ (and light extinction), as well as the meteorological conditions associated with the 20% best and 20% worst days (see Section 2 below). Also, as noted above, the report should refer to these days on the basis of concentration, or, preferably, the appropriate visibility index. (Note, this will help eliminate confusion with the IMPROVE 2000 Report, which states that $PM_{2.5}$ concentrations are highest in summer [p. 2-10], but light extinction is highest in winter [p.3-9] due to higher relative humidity during winter [p.5-38].)

Re-sorting good and poor visibility days by light extinction leads us to conclude that poor visibility days can occur in both winter and summer, while spring and fall are associated with a larger number of good visibility days.

p. E-3: Please note that Seney is properly called Seney Wilderness Area and is part of the National Wildlife Refuge System. It is not a national park.

This error has been corrected.

Section 1. Introduction

Please note that our organization should be referred to as the Midwest Regional Planning Organization (RPO), and not the LADCO Regional Planning Body (RPB).

We have changed all reference of LADCO to the Midwest RPO in the final report.

Section 2. Conceptual Model

Overall, AER has done a good job of developing a conceptual model of high and low $PM_{2.5}$ concentration days in the upper Midwest. Several suggestions are provided below for improving the conceptual model (e.g., focusing on high and low visibility days, and addressing downwind Class I areas impacted by our five states). In addition, it may be helpful in communicating with policy types if there was a "picture" of the model.

Figure 2-12 has been added to provide an overall "picture" of the conceptual model.

p.2-1 (and 2-28, 2nd paragraph): Please note that in September 2000 the IMPROVE network began sampling every 3rd day.

The new schedule has been noted on p.2-1 and p.2-28.

p.2-2: An NADP site was started at Seney in November 2000. Also, there are other NADP sites in the upper Midwest (e.g., WI09 and MI98).

Additional sites are mentioned in the data section. We also noted that the NADP site at Seney National Wilderness Area would provide useful data once it has been in operation for a few years.

p.2-6: Please explain the statement that the "available SO_2 is probably insufficient to sustain sulfate production on a regional basis." Many rural sites in the upper Midwest have generally low concentrations of SO_2, yet sulfate levels can be significant. Also, it may be more appropriate to assume background SO_2 levels in the upper Midwest on the order of 0.8 (1998 CASTNet data for Voyageurs) - 1.6 ug/m^3 (1998 CASTNet data for PRK134), rather than 0.4 ug/m^3.

We are postulating here that sulfate production takes place at least in part in upwind locations. Therefore, sulfate particles are transported into the Upper Midwest rather than produced in the region. Low SO_2 concentrations accompanying high sulfate in rural areas can be interpreted as evidence to support our hypothesis. The CASTNet data from Voyaguers National Park for SO_2 (0.8 $\mu g\ m^{-3}$) and sulfate (1.2 $\mu g\ m^{-3}$) are added to the discussion in the report.

p.2-9 (Spatial Variability): Further work is needed on how well Boundary Waters data represent conditions for Isle Royale. The draft report presents correlations between Isle Royale and Voyageurs, and Boundary Waters and Voyageurs, and then draws some inferences between Boundary Waters and Isle Royale. Perhaps some graphical depictions of the correlations could be provided (e.g., time series plots for the two pairs of data for coincident time periods), or Voyageurs and Isle Royale could be included in the "initial" meteorological analysis discussed below.

Voyageurs and Isle Royale are both included in the "initial" meteorological analysis. Figure 2-3 has also been added to illustrate the time series behavior at these sites.

p.2-16 (Table 2-5): Bondville is in IL, not OH.

This error has been corrected.

p.2-19 (Transport Processes): As directed by my December 8 letter, please include the "initial" meteorological analysis that you discussed at the December 6 - 7 meeting. Namely, converting to light extinction, sorting the days into the 20% best and 20% worst groups, and then classifying these 20% best and 20% worst days using USEPA's

meteorological strata. This analysis should consider each of the following Class I areas: Boundary Waters, Great Smokies, Shenandoah, and Acadia, as well as possibly Voyageurs and Isle Royale (see comment above). (If possible, this analysis should include precipitation as one of the key variables.)
A discussion is added regarding the classification of "dirty" and "clean" days using EPA's meteorological clusters. This analysis classified meteorological regimes by wind patterns only. Precipitation is not included as an independent variable.

Also, contrary to the statement in the report, according to the IMPROVE 2000 Report, visibility at BWCA is worse in the winter. This statement will likely get corrected here based on use of a visibility index to classify days, and the meteorological analyses noted above.
According to our analysis of "dirty" and "clean" days by calculating the extinction coefficients, the frequency of "dirty" days is highest in winter (32%), closely followed by summer (30%). This conclusion is somewhat sensitive, however, to the choice of F(RH), a factor to correct for water uptake by sulfate and nitrate, e.g., using F(RH) defined in the IMPROVE report vs. EPA's HAZECALC program. We have modified the Transport Process section to reflect these findings.

p.2-24 (Vertical mixing): It is our belief that during the summer, mixing heights in the Midwest are 1000 - 1500 m (or more) on hazy/high ozone days, which is inconsistent with the statement in the report that the boundary layer is "quite shallow" on the worst air quality days. Please reconcile.
The text has been modified in this section to clarify the mixing layer height observed on hazy days.

p.2-27 (Adequacy of Visibility-related Monitoring Network): Please address the adequacy of the planned IMPROVE and $PM_{2.5}$-speciation networks in the CENRAP region. (I will provide further details about these plans after a meeting on December 20 concerning these networks.)
We have not received further details on the CENRAP network

Please note that the recommendations for monitoring sites in the upper Midwest may change based on the results of the meteorological analyses noted above.
The recommendations for monitoring sites did not change as a result of the new meteorological analysis.

Please provide some cursory suggestions on how we might want to use our two aircraft to collect aloft measurements. Currently, these aircraft are instrumented to collect: (1) Wisconsin plane - continuous ozone and NO_y, continuous wind/temperature/pressure, VOC/carbonyl grab samples, and $PM_{2.5}$ filter pack (which is analyzed for organic carbon, elemental carbon, sulfate ion, nitrate ion, and ammonium ion); and (2) Purdue plane - continuous ozone, pressure, and VOC/carbonyl grab samples.
Suggestions are provided in Section 4.3 under data needed for modeling.

Please note that the new IMPROVE site will actually not be on Isle Royale, but at Eagle Harbor, Michigan on the mainland.
The location of the Isle Royale site is noted in the text.

p.2-28 (top of page): Change “National Parks” to “Class I areas”.
This has been changed.

p.2.24 (Data Needs): Please verify the following priorities for additional sampling:

- Establish as many rural/regional sites with speciated measurements as possible.
- Collect ozone on a continuous basis and speciated VOC data (including terpenes) for a 24-hour period every sixth day at Isle Royale (actually, Eagle Harbor) or Seney. These measurements should be collected for at least one 12-month period.
- Collect (in order of priority) NO, NO_y, HNO_3, NH_3, SO_2, and H_2O_2 at Isle Royale (actually, Eagle Harbor) or Seney. These measurements should be collected for at least one 12-month period.

We agree, with the exception that SO_2 measurements in the last bullet item should be higher in priority than NO and NO_y.

Also, to better assess the impact of emissions from the Midwest RPO States on downwind Class I areas, what additional sampling should be performed in these downwind Class areas?
We have identified meteorology types that are conducive to transport from the Midwest RPO to downwind Class I areas. The same measurement recommendations would apply under those meteorology. Recommendations for a comprehensive field program in the East (Section 4.3.4) are also provided.

Section 3. Emissions Inventory

This section should emphasize more the interrelationship between ambient monitoring data (and associated data analyses), modeling, and emissions inventories. Section 2 (Conceptual Model) and 4 (Air Quality Modeling Needs) do a good job of this, but Section 3 (Emissions Inventory) could use some strengthening and, possibly, some rearranging. In particular, the $PM_{2.5}$ composition (p.2-2), along with light extinction composition, should help identify the pollutants and source categories of most importance.

Section 3 has been rearranged to reflect the priorities in terms of emissions inventory based on the conceptual model.

Please provide a discussion on the need for micro-inventories. As noted in the Grand Canyon Report:

> A greater emphasis should be placed on micro-inventories of emissions for areas in and near Class I Areas and other areas of concern, such as tribal lands. Modeling indicates that nearby sources may have a greater impact on visibility than sources at a greater distance on a per ton basis. As such, comprehensive micro-inventories are needed for the near-field around Class I areas. Without them, it will be impossible to reliably identify that portion of the contribution to visibility impairment caused by long-range transport of regional haze.

In light of this recommendation, please identify specific inventory improvements for the northern Michigan Class I areas (e.g., for Isle Royale, shipping-related emissions on Lake Superior).

The statement in the Grand Canyon Report is applicable to any Class I area. Areas of focus in the development of microinventories are discussed in Section 3.

The need to make future year projections is obviously critical for regional haze modeling. As such, the report should address available growth factors (e.g., see "Evaluation of Emission Projection Tools and Emission Growth Surrogate Data" on the USEPA's EIIP web site http://www.epa.gov/ttn/chief/eiip/project.htm.)

The Projections Committee of the USEPA's Emissions Inventory Improvement Program published a report on emission projections. The focus of this report is to provide information and procedures to State and local agencies for preparing future year emission inventories for point, area, onroad, and nonroad sources.

Based on the draft scoping study report (and several other documents), LADCO has prepared a list of inventory improvement projects (see attachment). Your comments on this list would be appreciated.

We agree with the recommendations provided in the attachment. LADCO may want to consider conducting work on soil NH_3 emissions with the work on soil NOx emissions that are listed. The revised SJV inventory will include emissions from this category, however we are no longer referring to them as "soil" emissions. Rather, we are considering emissions from the soil and plant canopy system as a whole. Work conducted primarily in Europe has shown that these systems can act as either net NH_3 sources or sinks.

Also, biomass burning in general is an area where significant improvements are needed for regional PM/haze modeling (i.e., wildfires/prescribed burns; agricultural burning; and residential wood

burning). For example, NH_3 emissions can be significant from wildfires (ratios of NH3:NOx on the order of 5:1 have been measured). Currently, NH_3 emissions from these sources have not been estimated in U.S. inventories.

In addition to NH_3 emissions, proper spatial and temporal allocation of all emissions is needed. It might be best to wait until specific modeling scenarios are selected to perform this work, however. For example, wildfire/prescribed burn emissions from large fires burning during the scenario(s) could be modeled as individual sources and allocated spatially via information from the USFS or satellite imagery.

p.3-1 (Introduction): Although LADCO's Grid M inventory is referenced, it appears that the only emissions data used in this section are from USEPA's 1996 NET inventory. Please clarify.

Emissions data are from the 1996 NET. The 1996 NET was used as it was our judgement that since GRID-M is based upon the 1996 NET, this data base provided a good point of reference for the scoping study. The recommendations for improving the inventory for regional haze modeling are based on improvements to the 1999 NEI, and it was not clear whether the revisions embodied in GRID-M were already incorporated in the 1999 NEI.

Also, please provide a simple tabular summary of the 1996 NET emissions data (which were apparently used to produce the pie charts in this section) for each of the five Midwest RPO States.

Tabular emissions are included in Appendix A for the Midwest RPO region. Detailed emissions for each of the five Midwest RPO States are provided electronically.

p.3-9 (Section 3.4): The title (and content) of this section seems redundant with Section 3.3. Please modify, as necessary.

This section has been consolidated into the discussions of VOC/NO_x and SO_2/PM.

p.3-18 (1996 emissions): The value of a 1996 inventory is unclear. Because there will be a version of the 1999 NET available when we are ready to start modeling in next year or so, we believe that it is more appropriate to focus on that inventory.

This portion of the discussion has been deleted.

p.3-19 (BART Sources): Please identify the 26 BART source categories. Also, please include the preliminary list of fossil-fueled boilers potentially subject to BART in an appendix. The list should include all relevant information (e.g., state and county ID, facility ID and name, boiler and unit ID, stack ID, emissions, in-service date, etc.).

A new Table 3-2 lists the BART sources. The BART boilers are listed in Appendix B for the Midwest RPO States.

p.4.6: The suggested modeling domain includes a large portion of several Canadian provinces. Please include a discussion of the availability and quality of Canadian emissions data.

Canadian emissions data are available and should provide good quality information (M. Deslauriers, Environment Canada, private communication, 2001). A brief discussion is added in Section 3.1.

Section 4. Air Quality Modeling Needs

p. 4-1 (Grid-based source models): Please provide a brief discussion of Lagrangian models and their utility for $PM_{2.5}$/regional haze modeling.

This discussion is provided in Section 4.1.

p. 4.6: Please revise the recommendation on modeling domains, as necessary, based on the results of the meteorological analysis noted above. This recommendation should also take into account the three domains currently being used by USEPA in their CMAQ/MODELS3 "Proof of Concept" modeling. Given the difficulty with meteorological modeling in complex terrain, please comment on the advisability of us limiting the western extent of our domain to the Rocky Mountains and relying on information available from any WRAP modeling as boundary conditions.

No revision of the modeling domain was necessary from the meteorological analysis discussed under Section 2.5.4. The relationship with and utility of other modeling exercises are discussed under Section 4.2.1.

p.4-8: Are there any efforts underway to develop a plume-in-grid algorithm for $PM_{2.5}$/regional haze models? What efforts should the Midwest RPO undertake to support the development and inclusion of such an algorithm?

EPA plans to incorporate plume-in-grid in the fall release of Models-3 in 2001.

p.4-8 (Receptor modeling): If the primary component is not a significant fraction of $PM_{2.5}$, then should CMB analyses be performed? As an alternative, Rich Poirot, et al (2000) recently applied two multi-variate mathematical models, in conjunction with two ensemble backward trajectory techniques, to identify possible upwind locations with high contributions to fine particle concentrations in the Northeast. Although not without its limitations, this type of analysis would seem to be more useful.

We added a discussion of the application of factor analysis type receptor models to regional haze in Section 4.2.2.

p.4-11: Please address the need for a comprehensive field program to support $PM_{2.5}$/regional haze modeling in the eastern half of the U.S. Most of the existing field programs are in California and, as such, the results may be of questionable applicability to our part of the country. A very brief outline of a recommended field program in the eastern half of the U.S. should be included.

An outline is provided for a comprehensive field program designed to address regional haze in Section 4.3.4.