**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**
**WASHINGTON D.C. 20460**

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

December 7, 2004

EPA-SAB-05-004

The Honorable Michael Leavitt
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Subject: Advisory on EPA's Draft Report on the Environment 2003

Dear Administrator Leavitt:

A Panel of the EPA Science Advisory Board (SAB) met on March 9-12, 2004 to review the Agency's Draft Report on the Environment 2003 (ROE). The SAB Review Panel, known as the Advisory Panel on EPA's Report on the Environment, was composed of twenty scientists selected to provide expertise in the broad range of topics addressed by the ROE. The enclosed SAB report addresses EPA's charge questions to the Panel, and provides recommendations for improvements in future versions of the ROE to make the document more useful to EPA and other intended audiences.

The SAB finds that the ROE is a critically important document, providing EPA's first national assessment of the environment in a context of human and ecological health. There is an urgent need for this kind of regular assessment. The SAB therefore encourages continued significant effort in developing and improving the ROE and believes that EPA is the appropriate agency to lead this effort. The SAB stands ready to provide advice to EPA on a regular basis as the Agency develops future Reports on the Environment.

In this regard, the SAB recommends that the ROE be produced on a regular basis as a recurrent assessment report, and that EPA should:

- **Allocate funds and staff to ensure that the report is continued on a regular basis.** In order to sustain this important effort over the long term, the SAB recommends that the EPA dedicate resources and a permanent team of staff to synthesize appropriate indicators and data for the next and future reports. The team should include statistical expertise, and should be assigned the ongoing tasks of pooling and analyzing data for the ROE and conducting more analysis and synthesis than was included in the draft ROE.

The SAB emphasizes that without allocation of funds and personnel needed to sustain development of the ROE on a continuing basis, most of the recommendations in this SAB report cannot be implemented.

- **Keep the ROE free of conclusions about the impacts of specific policies or other government initiatives, except in cases where a policy or program is the obvious and undisputed explanation for a significant trend or status.** The ROE should be maintained as a recurrent Report on the Environment that reviews the status and trends of environmental conditions in the United States.

- **Include indicator data relevant to global climate change.** Omission of global climate change in relation to anthropogenic air pollution, and its health and ecologic implications, is a major defect in the draft ROE. Climate change is both a confounding and primary driver of the state of the environment. Therefore, lack of coverage of any aspect of climate change greatly hampers the presentation and interpretation of many indicators and topics in the draft ROE. Future versions of the ROE should recognize that global climate change will have first order impacts on a wide range of environmental indicators, and through them on human health and environmental conditions. Indicators related to global warming, such as changing air and water temperature patterns, changing ice formation and thawing patterns, trends in global concentrations of primary climate change gases, trends in U.S. emissions of these gases, and trends in scattering and absorbing aerosol particle concentrations, are very important and should be included in future ROE documents.

In summary, the SAB was impressed by EPA's effort to develop the draft ROE and strongly urges that the EPA effort be continued with some refinements. The continually updated ROE should provide the information and analysis necessary to evaluate the status of environmental protection of the United States. This information is essential for U.S. efforts to support sustainable use of natural resources for future generations.

Sincerely,

/s/

Dr. M. Granger Morgan, Chair
EPA Science Advisory Board

/s/

Dr. Virginia Dale, Chair
Advisory Panel on EPA's Report on the Environment
EPA Science Advisory Board

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# 1.0 EXECUTIVE SUMMARY

The Science Advisory Board (SAB) Panel on EPA's Report on the Environment was charged with reviewing *EPA's Draft Report on the Environment 2003* (ROE). The draft ROE was developed by EPA to describe what the Agency knows, and does not know, about the current state of the environment at the national level and how the environment has changed as a result of human actions. The draft ROE is presented in two volumes: a detailed *Technical Document*, and a somewhat shorter more general *Public Report*. The two volumes pose questions about the environment and human health on a national scale and provide answers to those questions in cases where EPA has determined that scientifically sound indicators and high-quality data to support them are available.

EPA sought the SAB's review of: the approach and process used to develop the draft ROE; the scientific and technical soundness of the indicators, data, and conclusions in the report; and the scale of indicator data used in the report. EPA also requested advice from the SAB on how measurements of impacts on human health and ecological condition could be more effectively addressed, and how the presentation of information in the report could be enhanced. Specifically, the EPA gave the following five charge questions to the SAB Panel:

**Question 1**
Please comment on the approaches, processes, or frameworks used in describing the environmental status and trends and how to measure and manage for environmental results. Do you have any suggestions to enhance the scientific analysis and presentation of the information?

**Question 2**
Do the discussions of indicators in the *Technical Document* accurately portray the current state-of- the-science? Are the conclusions supported by the scientific information provided given the existing data gaps and limitations?

**Question 3**
Conventional Agency practice has been to measure and reduce emissions and subsequent exposure to pollutants. Can you suggest how measurements for human health and ecological condition impacts resulting from environmental perturbation could be more effectively addressed?

**Question 4**
The draft ROE focuses on indicators at the national scale. Regional indicators are highlighted in a few case studies. How useful are national indicators in presenting information on the quality of the environment? How much consistency is necessary in indicator measurements and data quality across the country? Should more detailed regional data and indicators be accommodated in a national overview of the environment, and how could these regional data be accommodated?

**Question 5**
The *Public Report* is intended to summarize the *Technical Document* for a broad, non-technical public audience. Does the *Public Report* accurately and adequately reflect the technical content, including the gaps and limitations, of the *Technical Document*?

In this advisory report, the SAB provides specific recommendations and comments in response to each of these charge questions.

The SAB finds that the ROE is a critically important document, providing EPA's first national assessment of the environment in a context of human and ecological health. The SAB notes that there is an urgent need for this kind of assessment. It can have an important impact on improving the state of the environment by synthesizing useful information from many sources. This information can be used by EPA, other federal and state agencies, Congress and state legislatures, and academic and private sector organizations for the development of effective environmental policy and protection programs. The SAB also notes that the ROE can provide the public with essential information about environmental status and trends and their relevance to public health and ecological condition. The SAB therefore encourages continued significant effort in developing and improving the ROE and believes that EPA is the appropriate agency to lead this effort.

The SAB provides a number of recommendations for improvements in future versions of the ROE to make the document more useful to EPA and other intended audiences. The SAB finds that EPA should:

- **Allocate funds and staff to ensure that the report is continued on a regular basis.** In order to sustain this important effort over the long term, the SAB recommends that the EPA dedicate resources and a permanent team of staff to synthesize appropriate indicators and data for the next report. The team should include statistical expertise, and should be assigned the ongoing tasks of pooling and analyzing data for the ROE and conducting more analysis and synthesis than was included in the draft ROE. The SAB emphasizes that, without allocation of funds and personnel needed to sustain development of the ROE on a continuing basis, most of the recommendations in the SAB report cannot be implemented.

- **Keep the ROE free of conclusions about the impacts of specific policies or other government initiatives, except in cases where a policy or program is the obvious and undisputed explanation for a significant trend or status.** The ROE should be maintained as a Report on the Environment that reviews the status and trends of environmental conditions in the United States.

- **Develop an expanded introduction to the ROE, defining the purposes of the document, describing the rationale behind the approach, and explaining the indicators and conceptual framework behind the structure**. The organizational focus of the draft ROE on questions and indicators is basically sound. However, the draft ROE fails to communicate a consistent and clear purpose or to provide an overarching framework for the document. This deficiency has had wide ranging effects on the document, including varied and inconsistent approaches to indicator selection, and uneven treatment of indicator reliability. The expanded introduction should include a discussion of how the indices and data presented in the report relate and merge into the overarching themes of interest in the document: human health and ecological condition. The expanded introduction should provide a better explanation of the criteria for selecting the questions that are asked in the succeeding chapters, explain the concept of an indicator, explain what indicators were selected and why they were selected, and distinguish among different and expanded categories of data available for the selected indicators. The SAB suggests that reasonable criteria for selecting all indicators might include scientific defensibility, quantifiability, transparency, and consistency.

- **Reorganize the report to: provide greater consistency among the air, water, and land chapters; address linkages between exposure and human health in the human health chapter; and organize the ecological condition chapter around synthesis questions, with specific indicator data relocated to other chapters.** The chapter on human health impacts of pollution should devote greater attention to the linkages between exposure and health effects. Some environmentally linked health effects are well established and should be presented as such without equivocation. Other effects, which are suspected but less well established, can also be discussed. However, cataloging all causes of morbidity and mortality, most of which are not known or suspected of being related to the types of environmental exposures described in the air, water, and land chapters, seems less useful. The SAB commends the use of vignettes or case studies focusing on specific pollutants (e.g., lead). The approach to assessing ecological health should be restructured to move away from reporting on isolated indicators such as the extent of forest land. The approach should integrate indicators from across different locations (e.g., air, water, and land) to assess different essential ecological attributes (EEAs), and then integrate multiple EEAs to assess health with respect to key ecological conditions. The SAB notes that a framework for reporting on the condition of ecological resources has been developed by the SAB's Ecological Processes and Effects Committee (U.S, EPA Science Advisory Board, 2002). This framework contains a set of EEAs and associated component categories and subcategories that can be used to guide the development of an approach for reporting information about ecosystem condition. Questions addressing ecological health such as the status of biodiversity, fisheries health and sustainability, and element cycling could also be used as organizing themes. Regional and local data should be used to convey an accurate picture of trends and knowledge gaps. In addition, the effect of ecologic changes on human disease (e.g., Lyme disease, West Nile viral encephalitis) should be discussed.

- **Incorporate regional indicators into the report when they can provide insight on national conditions.** Much can be inferred from data available at local and regional scales. National indicators can be built from local and regional data and measures. Also, some environmental changes are best understood by considering regional impacts (e.g., air quality). Therefore, indicators in the next version of the ROE should not be limited to those for which data are available at the national level.

- **Strengthen the report by adding certain key missing indicators and providing additional information about indicators that are currently included in the report.** Future versions of the ROE should distinguish between emitted (primary) pollutants and environmentally synthesized (secondary) pollutants and discuss the concept of secondary pollutant precursors. Water quantity information should be added to future versions of the ROE. Full coverage of the hydrologic cycle is needed to complete the assessment of status and trends in water quality and other water-related aspects of the environment. Information about groundwater, large scale water availability, and human water use and demands are missing from the draft ROE. The water and land chapters of future reports should contain indicators that address both the extent and quality of different land and water ecosystem types. Contaminants in food and diet are also a critical component of environment as it relates to human health and should be included in future versions of the ROE. EPA should also rethink the indicator gap and limitations approach presented in the draft ROE. The indicator gap and limitations sections of the draft ROE contain an

assortment of qualifiers that either inappropriately discourage the reader from believing the data presented, or lead the reader to correctly conclude that the indicator is unsuitable as it is configured. Some water indicators presented in the draft ROE, such as dissolved oxygen, chlorophyll, water clarity, and index of biotic integrity, were not useful as developed in the report. The report appropriately discourages readers from believing the data presented on these indicators. As stated below, future versions of the ROE should include indicator data relevant to global climate change. Future versions of the ROE should also identify useful indicators of either human or ecological health for which only regional data, or no data, are currently available.

- **Include analyses and presentations of much greater statistical rigor.** General lack of statistical analysis in the draft ROE seriously limits the presentation and interpretation of status and trend information. Future versions of the ROE should incorporate much more rigorous statistical analyses of human health and ecological condition indicator data in order to: develop informative syntheses and spatial displays, identify patterns, and depict trends. Greater statistical rigor is also needed in the description of pollution sources and post-emission transformations and transport. In future versions of the ROE, EPA should not aggregate data into national averages and trends when such aggregation leads to a loss of information. Rather than using the work summaries of others, EPA should conduct more in-depth data analyses and present summary data, ranges, measures, and trends. In addition, arbitrary measures of conditions such as "good" or "poor" should not be used in future versions of the ROE unless these measures are the established norms in the indices used and are valid conclusions that compare indicators on a national scale. Uncertainties in data and interpretation should also be discussed.

- **Include indicator data relevant to global climate change.** Omission of global climate change in relation to anthropogenic air pollution, and its health and ecologic implications, is a major defect in the draft ROE. Climate change is both a confounding and primary driver of the state of the environment. Therefore, lack of coverage of any aspect of climate change greatly hampers the presentation and interpretation of many indicators and topics in the draft ROE. Future versions of the ROE should recognize that global climate change will have first order impacts on a wide range of environmental indicators, and through them on human health and environmental conditions. Indicators related to global warming, such as changing air and water temperature patterns, changing ice formation and thawing patterns, trends in global concentrations of primary climate change gases, trends in U.S. emissions of these gases, and trends in scattering and absorbing aerosol particle concentrations are very important and should be included in future ROE documents.

- **Revise the draft ROE *Public Report* to include more graphics and make it user friendly.** The draft ROE *Public Report* is a long but largely abstracted presentation of the draft ROE *Technical Report*. The *Public Report* should be revised to present information and summarize findings in a format that can be easily understood by non-technical audiences. The *Public Report* should be shorter, and it should contain clearer graphics as well as maps showing geographic trends.

In summary, the SAB was impressed by EPA's effort to develop the draft ROE and strongly urges that the EPA effort be continued with some refinements. The SAB recognizes that a considerable amount of additional work will be required to implement the recommendations in

this SAB report. It is suggested that this work could be accomplished by developing the ROE as a web-based recurrent assessment and updating specific parts of the report, not the full ROE, each year. The continually updated ROE should provide the information and analysis necessary to evaluate the status of environmental protection of the United States that will allow sustainable use of natural resources for future generations.

## 2.0 INTRODUCTION

This report transmits the advice of the U.S. Environmental Protection Agency (EPA) Science Advisory Board (SAB) Panel on EPA's Draft Report on the Environment 2003 (ROE). The draft ROE was developed by EPA to describe what the Agency knows, and does not know, about the current state of the environment at the national level and how the environment has changed as a result of human actions. This analysis can inform the Agency about deficiencies in current knowledge of environmental status and trends. Publication of the draft ROE was the first step in EPA's Environmental Indicators Initiative. This is a multi-year process directed at developing better indicators that EPA can use to measure and track the state of the environment and to support improved environmental decision-making at EPA and elsewhere. The draft ROE is presented in two volumes: a detailed *Technical Document*, and a somewhat shorter more general *Public Report*. The two volumes pose questions about the environment and human health on a national scale, and provide answers to those questions in cases where EPA has determined that scientifically sound indicators and high-quality data to support them are available. EPA has stated that it does not intend to revise the current draft of the ROE, but has conducted a Science Advisory Board review of the document in order to obtain advice for use in developing future Reports on the Environment**.** The SAB supports EPA's expressed intent to incorporate SAB comments on the draft "ROE 2003" into future Reports on the Environment. Because EPA does not intend to revise the draft "ROE 2003" document, the SAB notes that the word "draft" should continue to appear in the title of the document. In order to inform readers of the limitations of the draft "ROE 2003" document, it is also recommended that EPA make copies of this SAB advisory report available with any public release of the draft document.

In developing the draft ROE, EPA framed environmental quality issues by: 1) identifying key questions; 2) identifying an initial set of indicators; and 3) reviewing and selecting the indicators and the supporting data to be included in the report. Historically, EPA has used a set of indicators to measure progress in reducing environmental pollution through its major regulatory programs. These traditional measures for air, water and land conditions are discussed in the first three chapters of both the draft *Technical Document* and *Public Report*. EPA, together with its Federal, state, and tribal partners, is moving toward supplementing these traditional measures with indicators that provide a better understanding of status and trends in human health and environmental condition. Chapter Four of the *Technical Document* and the *Public Report* presents key information on exposure to pollutants and the status of human health that can be used to develop environmental public health indicators. Chapter Five of the *Technical Document* and the *Public Report* similarly describes essential attributes related to a synthesized view of ecological condition. Chapter Six of the *Public Report* identifies key challenges in the development and implementation of better indicators of human health and environmental status and trends.

The SAB Panel enthusiastically supports this effort. It sees the draft ROE as an extremely important document and commends EPA for its foresight in taking such strong initiative to develop the Report on the Environment. The SAB encourages continued significant effort in developing such reports and thus supports an increase in national environmental analyses and syntheses of environmental indicators. We recognize that many of the areas addressed in the draft ROE are not part of EPA's responsibilities, but the Panel believes that EPA is the appropriate agency to lead this effort. Our comments below are quite lengthy, a reflection of the Panel's view of the importance of this activity. Our overall response to the draft ROE is that it is of critical national importance and must be continued and improved.

We provide a number of recommendations for improvements in future versions of the ROE to make the document more useful to EPA and other intended audiences. The SAB recommends that EPA reorganize the framework of the ROE to enhance the analysis and presentation of information in the report. The ROE should contain an opening chapter that clearly lays out the purpose and vision of the report and sets forth the criteria for selecting the indicators and questions in the report. The ROE should contain important data and indicators that are available at local and regional scales, as well as analyses of greater statistical rigor. In addition, EPA should develop a working conceptualization of how different parts of the ROE can be integrated. Health impacts resulting from environmental pollution should be addressed in Chapter Four (Human Health) through a more rigorous and systematic consideration of linkages to exposure. Chapter Five (Ecological Condition) of the draft ROE should be devoted to synthesis of information. Therefore, much of the information currently in Chapter Five should be moved into other appropriate chapters.

## 3.0 CHARGE TO THE REVIEW PANEL

EPA sought the SAB's review of: the approach and process used to develop the draft ROE; the scientific and technical soundness of the indicators, data, and conclusions in the report; and the scale of indicator data used in the report. EPA also requested advice from the SAB on how measurements of impacts on human health and ecological condition could be more effectively addressed, and how the presentation of information in the report could be enhanced. The EPA gave the following five charge questions to the SAB Panel.

**Question 1**
Please comment on the approaches, processes, or frameworks used in describing the environmental status and trends and how to measure and manage for environmental results. Do you have any suggestions to enhance the scientific analysis and presentation of the information?

**Question 2**
Do the discussions of indicators in the *Technical Document* accurately portray the current state-of- the-science? Are the conclusions supported by the scientific information provided given the existing data gaps and limitations?

**Question 3**
Conventional Agency practice has been to measure and reduce emissions and subsequent exposure to pollutants. Can you suggest how measurements for human health and ecological condition impacts resulting from environmental perturbation could be more effectively addressed?

**Question 4**
The draft ROE focuses on indicators at the national scale. Regional indicators are highlighted in a few case studies. How useful are national indicators in presenting information on the quality of the environment? How much consistency is necessary in indicator measurements and data quality across the country? Should more detailed regional data and indicators be accommodated in a national overview of the environment, and how could these regional data be accommodated?

**Question 5**
The *Public Report* is intended to summarize the *Technical Document* for a broad, non-technical public audience. Does the *Public Report* accurately and adequately reflect the technical content, including the gaps and limitations, of the *Technical Document*?

## 4.0 REVIEW PROCESS

To establish the ROE review panel, the EPA Science Advisory Board Staff Office published a Federal Register notice requesting nominations, and identified a subset of the nominees for consideration as panelists. The final panel was selected after requesting public comments on the nominees and further evaluating them against EPA Science Advisory Board selection criteria. The members of the review panel included health and ecological scientists.

The review was conducted by an administrative conference call, a public conference call, and a three and one half day public meeting. During the administrative conference call the structure of the review was discussed and panel members were assigned lead responsibilities for reviewing various sections of the report. During the public conference call, EPA answered questions from the panel about the report and the review charge. At the public meeting, the review panel heard presentations from EPA on each of the draft ROE chapters and deliberated on the charge questions. Panel writing groups developed charge question responses for each chapter, and these responses were integrated in the development of the final SAB report.

# 5.0 RESPONSE TO THE CHARGE QUESTIONS

## 5.1 Response to Charge Question 1

Charge Question 1: Please comment on the approaches, processes, or frameworks used in describing the environmental status and trends, and how to measure and manage for environmental results. Do you have any suggestions to enhance the scientific analysis and presentation of the information?

### 5.1.1 Key Recommendations in Response to Charge Question 1

The ROE is critically important in providing the first EPA assessment of the environment in a context of human and ecological health. The SAB notes that there is an urgent national need for this kind of assessment. It can have an important impact on improving the state of the environment by synthesizing information from many sources that can then be used by EPA, other federal and state agencies, Congress and state legislatures, and academic and private sector organizations for the development of effective environmental policy and protection programs. The ROE also can provide the public with essential information about environmental status and trends and their relevance to public health and ecological condition. That said, the SAB notes a number of general and specific concerns and recommends that they be considered by the Agency in the next iteration of the ROE. Generally, the SAB finds that EPA has not applied a consistent approach in the development of the draft ROE. In some sections the draft ROE is primarily a report on the Nation's environment, but in a few places it appears to be more of a report on EPA's environmental initiatives. For example: 1) in the draft ROE *Technical Document*, the introduction on page xi says that the ROE should ensure EPA accountability to the public; 2) page 5-3 of the draft ROE *Technical Document* introduces the synthesis chapter by talking about EPA measuring outcomes, the fact that EPA seeks to protect air land and water, EPA's statutory authority, and the fact that EPA can monitor stressors; 3) the summary box on page iv of the draft ROE *Public Report* talks about EPA's role in protecting land; 4) page v of the draft ROE *Public Report* talks about EPA's mission; and 5) page vii of the draft ROE *Public Report* indicates that the ROE will "enable EPA to better manage for results". The SAB encourages EPA to clearly make the next iteration of the ROE an overall report on the environment and not a "report card" for EPA, and recommends that this perspective be set forth clearly at the beginning of the document.

As an overall report on the environment, the next ROE should not only address indicators that are available at the national scale, but also consider and include regional or local indicators where appropriate. Whenever possible, an explanation of the context, current status, and trends to date for each indicator should be provided and supporting data should be included or referenced, as appropriate. EPA should avoid reporting indicator status or indicator trends without linkages to supporting data.

In order to sustain this important effort over the long term, the SAB recommends that the EPA dedicate resources and a permanent team of staff to identify appropriate indicators and data for the next report. The team should include statistical expertise, and should be assigned the ongoing tasks of pooling and analyzing data for the ROE and conducting more analysis and synthesis than was included in the current ROE.

SAB recommends that EPA reorganize the framework of the ROE to enhance the analysis and presentation of the information contained in the report. This should include:

1. An initial chapter that presents the purpose and vision of the report and clearly articulates the criteria for selecting the indicators and questions that are included in the report. In the initial chapter EPA should also clarify the meaning of "national-level indicator." Quite a large amount of data in the draft ROE appears to be derived from state sources, and it is not clear whether EPA requires data for the entire United States for a national-level indicator. EPA should strongly consider using data sets that are not national in scope. The opening chapter also should indicate that the report is not intended to provide an assessment of how environmental regulation or policies have led to current environmental conditions.

2. A clearer indication and discussion of why some indicators and data sets were included in the report and others were not, and a broader discussion of data gaps. It is very important to list the data gaps, and the draft ROE does so to a certain extent. However, the definition of data gaps in the draft ROE is too restrictive because the gaps discussed in the report are only those reflected by the known indicators. The listing of data gaps should also include indicators or linkages for which regional or national data may not exist. Appendix B of the draft ROE *Technical Document* should be expanded to include a better explanation of why indicators and data sets were selected, or not selected, for use in the draft ROE. The sources of the data presented in the ROE must be specified and criteria used for excluding as well as including data also must be explicitly defined. The SAB notes that it would be valuable to include questions, which cannot be answered with currently available indicators as a means to identify potential programmatic gaps.

3. ROE chapters on air, water, and land that focus on current conditions, and an ecological condition chapter that is a synthesis of information addressing the overall ecological health of the United States. Much of the information currently included in the ecological condition chapter should be moved to the water or land chapters (Chapters 2 and 3 respectively).

4. The report should contain an index. Without an index, the draft ROE has limited usefulness as a reference work.

5. Indicators related to global warming. Apart from one or two brief sentences in each of several chapters, the issue of global warming (and its relevant impacts on the environment and human health in the United States) is missing from the draft ROE. Climate change is an issue that applies to all chapters of the draft ROE. The SAB notes that indicators related to global warming, such as changing air and water temperature patterns, sea level rise and carbon dioxide levels, are very important indicators inextricably linked to human health and ecological condition. The SAB therefore emphasizes that these indicators must be included in the ROE in order to ensure the scientific integrity of the document. In addition, more examples of the use of indicators to illustrate ecological, biological, and biochemical principles that directly apply to the environment should be included in the ROE.

### 5.1.2 Specific Comments in Response to Charge Question 1

*Introduction to the draft ROE*

The discussion of purposes and approach presented in the draft ROE introduction is not well developed. The introductory chapter of the report should provide an overall framework for the report by defining what the environment is, what the report addresses, and what issues are not considered. Future ROE versions should therefore start with a clear and concise introductory statement to intended audiences telling them why they should care about the state of the environment, and why the ROE is an important document to read. This statement should invoke a fundamental obligation to maintain the planet's habitability for future generations, and indicate why clean air, clean water, productive land, viable ecosystems, and a healthy population are critical to achieving this goal. The purpose of the ROE should also be clearly stated in the first chapter using an appropriate analogy that will be meaningful to the general population as well as policy makers and environmental professionals. One possible analogy is a "report card" on the status and trends of environmental quality in the United States and its effect on the health of our citizens and on the condition of critical ecosystems. For example, the ROE should provide indicators of environmental health that are analogous to indicators of human health, such as environmental health equivalent to: a healthy young human, a likely candidate for a heart attack, or even a post-cardiac patient. As noted previously, the SAB report, "A Framework for Assessing and Reporting on Ecological Condition" (EPA Science Advisory Board, 2002) provides useful guidance for assembling and reporting information about the health of ecological systems. The SAB does not, however, advocate that the ROE become, in any way, a report card on EPA's role as an environmental regulatory and research agency.

The SAB recommends that the ROE initial chapter present an expanded introduction that should serve as a road map for all readers of the report. It should include a discussion of how the indices and data presented in the report derive from information presented in the air, water, and land chapters and build towards what the SAB considers to be the overarching themes of interest in the ROE: human health and ecological condition (currently Chapters Four and Five). The draft ROE does not clearly present the criteria used to select the indicators that were included in the report. It is unclear, for example, whether the indicators in the draft ROE are defined as measures that can track environmental conditions over time, measures that reflect conditions at one point in time, or both. The expanded introduction should serve as the place to better explain the criteria for selecting the questions that are asked in the succeeding chapters, to define the concept of using indicators to answer those questions, and to distinguish among different (and expanded) categories of data available for the selected indicators. The SAB encourages EPA to first define the critical questions to be answered and then find the indicators to answer those questions; it is important to not let the availability of data/indicators drive the questions. The SAB suggests that reasonable criteria for selecting indicators should first include whether the indicator will reveal an environmental condition that will help answer a specific ROE question. The indicator should also be scientifically defensible, quantifiable, transparent, and consistent in application over time. Readers of the revised first chapter should be able to clearly see that the ROE was developed to serve as a report on the status of the environment in the United States with respect to both human health and ecological condition (or ecological "health") and to understand the characteristics that are used in the report card to assess health and ecological condition. The reader should be able to understand that the ROE is intended to be an on-going effort that will help the American people see how and where progress is being made toward better ecological conditions and human health as it relates to those conditions, as well as areas where new or additional efforts may be needed.

The SAB also recommends that the introduction be explicit about what is outside the scope of the ROE. While acknowledging that air, water and biological resources of the United States flow across national boundaries, the report should focus on the ecological condition of the United States. Comparisons between conditions in the United States and those in other nations or regions should be included when they provide the necessary context for understanding conditions in the United States; for example, Chapter 4 provides comparisons of a number of human health indicators in the United States with other nations. Similar comparisons would be helpful in chapters on air, land and water. The ROE should not attempt to link current environmental and health conditions and trends to specific policies or programs, except in cases where a policy or program is the obvious and undisputed explanation for a significant trend or status. In such cases, EPA is encouraged to show how environmental conditions and trends have been altered by specific policies. The ROE should not, however, suggest policy and program solutions to the problems described.

*Chapters 1-3*

The first three chapters of the current draft ROE should focus on air, water, and land conditions and trends as they relate to human health and ecosystems. The air chapter should make clear the differences between primary air pollutants generated from emission sources and secondary and tertiary air pollutants that are synthesized in the atmosphere from directly emitted precursors. The primary sources of air pollution and the processes of conversion, accumulation, dispersion, transport, and deposition (including acid rain) should be outlined. The cross-chapter linkage between atmospheric sources of pollutants addressed in the air chapter and lake acidification effects addressed in the chapter on water should be discussed and referenced in the chapter on ecological condition. It would also be useful to include relevant indicators from other chapters on the indicator list in the air chapter. The chapter on water should include an overview of general water budget and hydrologic principles. The land chapter should be reformulated and expanded to better reflect symmetry with the air and water chapters. The SAB recommends that the land chapter be focused on land use, and that the chapter's introduction explain this focus. This chapter should provide information about developed land areas (including areas with high industrial and waste impacts), as well as non-developed land. The air, water, and land chapters should all be re-titled without qualifiers because the current titles do not accurately reflect information in the chapters. For example, the current title of Chapter Three, "Better Protected Land," while reflecting EPA Administrator Whitman's motivating interest, is inherently imprecise. The SAB suggests that the title, "Land Use" would be preferable. Chapters One and Two should be re-titled "Air" and "Water" respectively.

*Chapters 4-5*

Chapters Four and Five of the ROE should continue to focus on environmental effects on human health and ecological condition, respectively, in future editions. However, the ecological condition chapter should be reformulated and organized around key questions such as: "what is the status of biodiversity?", "what is the status of global warming trends?", and "what is the status of element cycling?" This reformulation of the ecological condition chapter would require that EPA move many of the questions and indicators in the present chapter to the air, water, and land chapters. Questions about the extent of terrestrial communities should be placed in the chapter on land. Similarly, questions and indicators related to the extent of aquatic communities should be moved into the chapter on water.

*Other recommendations*

The current ROE is devoid of statistical analysis. The report can be greatly enhanced by the use of appropriate statistical procedures for assessing changes over time (e.g., longitudinal analysis or time series analysis). Averaging of data over time or across a group of more-or-less simultaneous observations at different loci was used to evaluate and report trends in the draft ROE. This is a useful way of making large data sets manageable and presentable. However, a great deal of information is necessarily lost. For example, annually averaged ozone levels are much lower than the averages restricted to the summer months; daily data over a year are not normally distributed, so arithmetic averages alone may be misleading. If the primary data are normally distributed, standard deviation and standard error of the mean can be reported. For non-normally distributed data, means, medians, and ranges might be reported. Time trends (vectors) are subject to various forms of error. Vectors derived from two points are particularly suspect and non-linear relations are not adequately expressed with slope and intercept. When trends are reported in the ROE, slopes of linear relations should be assessed for significance of the difference from zero (i.e., no change over time) and for the fit of the data points to the trend. The SAB notes that individual data points in some data sets used for trend analysis in the draft ROE may themselves represent the mean of multiple observations and therefore incorporate some quantifiable uncertainty. Changes in measurement methods, changes in a population base, and changes in a category assignment can also lead to errors of representation and interpretation. Methods such as meta-analyses, space-for-time substitution, use of rolling averages, and locally weighted scatter plot smoothing functions (LOWESS) should be applied to evaluate trends. The SAB also notes that the draft ROE does not explicitly address the area of uncertainty. There are many approaches to addressing uncertainty, ranging from quantitative (e.g., Monte Carlo analysis and sensitivity analysis) to qualitative (e.g., data gaps). The EPA should explicitly address the area of uncertainty in future Reports on the Environment.

The SAB recommends improvements in the draft ROE to enhance presentation of the information. Some of the data presented in plots appear to be grouped arbitrarily. Where feasible, plots should show all of the available data, and additional captions or appendices are required in the *Technical Document* to indicate what is being plotted. For example, in Exhibit 1-1 of the air chapter in the *Technical Document*, the methods used to aggregate the data are not clearly presented. In this exhibit, primary and secondary air pollutants are lumped together, and the implied emissions of secondary pollutants are not meaningful. The exhibits included in the ROE should provide information indicating the baseline from which changes or trends are assessed, the number of monitoring sites, and other relevant information. When possible, the use of a common baseline for the exhibits would be helpful (e.g. Exhibits 1-1: 1970, Exhibit 1-4: 1988, and Exhibit 1-6: 1982 all use the same data).

## 5.2 Response to Charge Question 2

Charge Question 2: Do the discussions of indicators in the Technical Document accurately portray the current state-of- the-science? Are the conclusions supported by the scientific information provided given the existing data gaps and limitations?

### 5.2.1 Key Recommendations Response to Charge Question 2

The SAB provides the following key recommendations regarding indicators and conclusions in the Air, Water, and Land chapters of the draft ROE.

*Chapter One "Cleaner Air"*

1. As previously noted, it is important to clearly distinguish between primary emissions and secondary air pollutants, particularly for "criteria pollutants".

2. Emission trend plots should clearly state whether they are presenting direct primary emission data or precursor emission data.

3. Plots of decreases in "total national emissions of the six criteria pollutants" have little meaning because no clear distinction is made between primary pollutants that are emitted directly into the atmosphere and secondary pollutants that are synthesized in the atmosphere from precursor species. In the United States, total airborne concentrations of only two ($SO_2$, and Pb) of the six criteria air pollutants are dominated by primary emissions. Of the remaining four criteria air pollutants: ozone ($O_3$) concentrations are almost completely determined by secondary production; while the remaining three, $NO_2$, CO, and PM, have very substantial secondary sources. Thus, there is no scientifically meaningful way to combine the "emissions" of criteria air pollutants. It should be noted that concentrations of pollutants in specific regions of the atmosphere can be impacted unevenly by various sources. For instance, ground level CO levels during urban rush hours are usually dominated by vehicle emissions, while CO concentrations in the free troposphere over rural areas will often contain a large amount of CO produced from the in-situ photochemical oxidation of organic compounds.

4. Statements in Exhibit 1.2 of the draft ROE indicating that there are "no category 1 or 2 indicators" are misleading because many environmental issues have intrinsic characteristics that make national indicators either inaccessible or irrelevant. It is the opinion of the SAB that such statements may be misinterpreted as lack of knowledge, when in fact indicators of differing temporal or spatial scales, other assessment documents, and primary literature provide useful information. The SAB notes that this recommendation is also pertinent to Charge Question 4.

5. Time trend plots in the ROE should extend as far back in time as practical, be as current as possible, use linear axes, and avoid starting on anomalous years (e.g., 1988 for ozone) if percentage changes are presented.

6. Airborne toxics are an increasingly important issue that should be included in the ROE. The SAB recommends that data from the National Air Toxics Assessment and new monitoring programs be included in future versions of the ROE.

7. Indoor air is a primary determinant of human exposure (and therefore, health effects) for many air pollutants. Because there are no national scale data to assess indoor air pollutant levels (with the exception of radon), the SAB recommends that future versions of the ROE provide information on the relationship between outdoor and indoor concentrations for key pollutants. Future reports should use the available primary literature to identify key indoor pollutants and assess their levels.

8. The SAB notes that climate change will have a fundamental impact on future air quality, as well as on a wide range of other environmental indicators. The SAB therefore finds

the presentation and discussion of trends of air quality indicators to be scientifically indefensible in the absence of an assessment of climate change. As noted previously, the topic of climate change must be included in the next ROE.

*Chapter Two "Purer Water"*

1. The ROE water chapter should contain a much more detailed discussion of trends and status in national and regional water demand, supply, and quality.

2. The ROE water chapter should also provide a temporal and spatial perspective for the indicators presented in the draft ROE. In addition, regional analysis of water indicators is needed to understand national conditions. Regional status and trends should be reported for additional areas of the United States where data sets are available.

3. A more consistent and complete description of the methodology used to collect data and analyze indicators in the water chapter is also needed. In particular, a more complete description of the timeframe for data collection and of the derivation of the "good," "fair," and "poor" descriptors is needed.

4. The SAB notes that some of the criteria and benchmarks used in the water chapter, particularly the wetland indicators, reflect outdated science. Improved wetland indicators can be found on some of the websites are listed in Appendix A of this document. The National Water Quality Assessment and sediment concentration data in the draft ROE should be compared to appropriate target criteria in order to reflect levels of concern, not simply the presence or absence of chemicals of concern. It may in fact be more appropriate to use regional criteria and benchmarks, such as the Great Lakes Water Quality Initiative criteria, to analyze some of the water data.

5. The SAB recommends that indicators be developed to report the following information: groundwater quantity and quality; the effects of global climate change on sea water chemistry, sea level, and stream flow; changes in water temperature; changes in total dissolved solids and salinity over time due to human activities, quality of irrigation water (e.g. salinity, nutrients, and toxics); and detection of emerging pollutants in water supplies across the United States. The SAB recognizes that assessing the effects global climate change on seawater chemistry requires consideration of global greenhouse gas emissions. Although the U.S. contribution to global greenhouse gas emissions is significant, it will be difficult to relate changes in U.S. emissions to changes in global ocean composition.

The SAB notes that important available national data are omitted from Chapter Two of the draft ROE, and recommends that the following information be included in future reports: drinking water information regarding types and severity of violations, sources of contaminants, and health effects; fish advisory information regarding types and severity of violations; Clean Water Act section 303(d) list of impaired waters; and National Pollution Discharge Elimination System information regarding trends in pollutant loads and toxicity. The SAB recognizes that providing this additional information will significantly expand the ROE. It is therefore important that the information be presented in a clear and understandable form.

*Chapter Three (Better Protected Land)*

1. The SAB recommends that future versions of Chapter Five (Ecological Condition) of the ROE be devoted to synthesis of information found in the air, water, and land chapters. Much of the information in Chapter Five of the draft ROE should therefore be moved into future land chapters (or water chapters if related to water). For example, information on extent and management of forest area, forest age class, population representation of forest species, and soil compaction should be moved from Chapter Five to Chapter Three. There are also stark differences in the current ROE between the land chapter and the air and water chapters. The nature of the questions about the condition of land should parallel that presented in the air and water chapters.

2. The SAB recommends that a broader range of indicators be used in future land chapters of the ROE. Indicators such as extent of roads should be used to provide information about habitat fragmentation, human use of land, and fragmentation of ecosystem types. Other indicators such as socioeconomic distribution of human population in relation to land use and community composition of animal and plant species (biodiversity) should also be reported in Chapter Three.

3. EPA should consider using a greater number of ecosystem types than are currently described in Chapter Three of the draft ROE. Using only the aggregated measures of ecosystem types assessed in the draft ROE (e.g., forests, grasslands, croplands, etc.) does not provide important insight about region-specific ecosystem types such as endangerment of tall grass prairie in the Midwest. For this reason, while the SAB acknowledges that the ROE will primarily report indicators developed by others, it is recommended that EPA not simply adopt the aggregated ecosystem types presented in the Heinz Foundation's report on the State of the Nations Ecosystems. EPA is encouraged to develop the most useful taxonomy of ecosystem types for answering the ROE-specific questions, and then use original data sources for appropriate indicators.

4. It is important to clarify differences between indicator gaps and limitations associated with the inability to answer specific questions, and the gaps and limitations related to data availability and quality needed to complete regional and national assessments. It is inappropriate to state that indicators do not exist when in fact, the ROE usually means that sufficient representative regional data are unavailable to calculate national indicators. In cases where indicators to answer questions truly do not exist, the ROE should indicate the scale of reference (e.g. there are no national indicators, or no regional indicators, or no local indicators).

5. It is important to provide uncertainty estimates for indicators in the ROE when this is possible. The SAB notes that many indicators can be derived from multiple data sources that provide varying estimates of condition. EPA should use such information strategically by estimating confidence limits for the indicators.

The SAB recommends that EPA rethink the indicator gap and limitations (IGL) approach presented in all chapters of the draft ROE. In the current draft of the ROE, the IGL sections contain an assortment of qualifiers that often inappropriately discourage the reader from believing the data presented. The SAB feels that this is largely a result of poor definition of the IGL section, and an apparent need to include information in the IGL section for each indicator,

or the selection of an inappropriate indicator or measure for that indicator. This is discussed below in more detail.

### 5.2.2 Specific Comments in Response to Charge Question 2

*Outdoor air – criteria pollutants*

Exhibit 1.1 plots "aggregated criteria pollutant emissions", but there is no indication of what data are actually aggregated. As noted previously in our response to the charge question, an aggregation of data across dissimilar pollutants is not very meaningful. As previously noted, a clear presentation of the difference between primary and secondary air pollutants is required. The critical precursors for secondary criteria pollutant formation should also be clearly identified. Such clarification will emphasize the importance of $NO_x$ and volatile organic compound (VOC) emissions data for $O_3$ formation, and the impact of $SO_2$, $NO_x$, and VOC emissions on particulate matter (PM) formation.

Although the current set of questions in Exhibit 1.2 addressing criteria air pollutants are valid and meaningful, additional important questions should be asked in future reports. For example, questions should be included such as: 1) What are the important sub-classifications of $PM_{2.5}$ (ultrafines, organic carbon, black carbon, toxic metals, etc.) in terms of health, ecosystem and climate impacts, and what data are available on primary emissions and/or secondary precursor pollutants? 2) What photochemically generated oxidized organics (e.g. aldehydes, ketones, organic acids, organic nitrates, peroxyorganic nitrates, DMSO, $DMSO_2$, etc.) or inorganics (e.g. HONO, $HNO_3$, etc.) may have significant potential human health impacts, and what data are available on their atmospheric concentrations?

*Outdoor air – air toxics*

Air toxics are important pollutants, and EPA is to be commended for including them in the draft ROE. There are no national data available for most air toxics, beyond data for some volatile organic compounds (VOCs) like benzene, but future reports on the environment should identify and track recent efforts to begin collecting these data. The National Air Toxics Assessment (NATA) estimates of ambient air toxics concentrations can be used to provide indicators for the ROE. These data sets are largely based on models, and therefore may not satisfy criteria for category 1 or 2 indicators. However, NATA estimates are useful because they are national in scope and they provide a means for assessing aggregate exposure and risk. The draft ROE includes benzene in results for 95 sites from 1994 to 2000 (Exhibit 1-14). The SAB recommends that EPA expand this analysis to include other air toxics measured at these sites. EPA should also consider including other sites where trend data are available for extensive periods of time in areas known to have significant emissions (e.g., Houston). These data might be presented by source type (mobile source, area sources, etc.). The SAB also notes that air toxics trend data are available from the Integrated Atmospheric Deposition Network (IADN) of the Great Lakes. These data have been collected for more than ten years at sampling sites chosen to represent background concentrations of air toxics entering the Great Lakes by long-range transport (Environment Canada, 2004). Care should taken to avoid obvious errors when presenting concentrations information. The SAB notes, for example, that benzene is not a criteria pollutant so that the indication of a National Ambient Air Quality Standard (NAAQS) in Exhibit 1-1 should be removed. The SAB encourages EPA to consider presenting mercury deposition data from the National Acid Deposition Program (NADP) network either in the air or

land chapters of future reports, and notes that the environmental databases of other agencies may provide useful information in this regard. It is also noted that many air pollutants (e.g., PM, air toxics) are emitted by indoor sources, and that these source emissions tend to dominate exposures so that current status and trends relevant to health are not are not captured by outdoor air measurements. EPA should identify these data gaps and limitations. SAB also notes that, although it is discussed in the air chapter of the draft ROE, lead has little relevance as an air indicator linked to human health since most of the lead exposure and associated human health effects are driven by ingestion of contaminated dust, soil and/or paint. The atmospheric sources of lead are now very limited.

*Acid deposition*

Although the discussion of acid deposition in the draft ROE is basically sound, Exhibits 1-22 and 1-23 are difficult to interpret and reproduced at too small a scale. A better presentation graphic should be developed for future reports. The "no category 1 or 2 indicators identified" notation for the third acid deposition question should be eliminated and replaced with a reference to the relevant National Acid Precipitation Assessment Program (NAPAP) assessment documents.

*Indoor air quality*

Indoor air is a major microenvironment that can contribute significantly to inhalation exposures, frequently exceeding the contributions from outdoor air inhalation. Indoor air quality is insufficiently treated in the draft ROE. When inhalation exposures to airborne contaminants are dominated by outdoor source contributions (e.g., ozone, sulfur dioxide), ambient concentrations are a reasonable indicator of exposure and potential health effects. Conversely, for many pollutants (e.g., PM, $NO_x$, CO, HONO, toluene, chloroform, formaldehyde) exposure results from a combination of both indoor and outdoor sources. For many such pollutants, ambient measurements provide a poor indicator for both exposure and health impact. For some pollutants (e.g., PM, formaldehyde) indoor levels often significantly exceed outdoor levels and therefore dominate exposure. Some discussion and literature citations about major sources of important indoor air pollutants ($NO_2$, HONO, $H_2CO$, $CHCl_3$, and others) should be included in future reports. In addition, the question, "Is ambient air pollution an adequate surrogate for human exposure?" should be added to the list in Exhibit 1-2 and addressed in future report versions. The "no category 1 or 2 indicators identified" notation for the current indoor air quality question three should be replaced with references to relevant archival reviews or primary literature.

*Stratospheric ozone*

The presentation in the draft ROE on stratospheric ozone depletion is sound. Exhibit 1-28 displaying trends in U.S. industrial production of ozone depleting chemicals contains only chlorine compounds and should be expanded to include halon 12, halon 13, and methyl bromide since, on a molar basis, bromine released in the atmosphere is about fifty times more effective than chlorine in catalytically destroying ozone. The captions for Exhibits 1-27 and 1-29 should note that they include both chlorinated and brominated compounds, suitably weighted. The "no category 1 or 2 indicators identified" notation for the third and fourth stratospheric ozone question should be eliminated and replaced with a reference to the relevant World

Meteorological Organization (WMO) and National Aeronautics and Space Administration (NASA) assessment documents or primary literature references.

*Climate change*

As we have stressed previously, climate change will almost certainly have a fundamental impact on future air quality (and vice versa). Climate change also has the potential to drive major changes in human health and ecosystem viability. Thus, scientific relevance requires that a significant discussion of climate change issues and indicators be included in future versions of the ROE. The SAB recommends that future reports on the environment address air-related climate change questions such as: 1) What are the trends in global concentrations of primary forcing greenhouse gases ($CO_2$, $CH_4$, $N_2O$, CFCs, PFCs, $SF_6$)? 2) What are the trends in U.S. emissions of primary forcing greenhouse gases? 3) What are the trends in tropospheric ozone over North America? 4) What are the trends in scattering aerosol particles over North America? 5) What are the trends in absorbing aerosol particles over North America? 6) What are the trends in U.S. emissions of primary fine particles? 7) What are the trends in the U.S. emissions of secondary aerosol particle gaseous precursors?

*Atmospheric particulate matter (PM)*

The SAB recommends that future versions of the ROE continue to contain information on atmospheric particulate matter. Particulate matter is a very complex mixture of suspended particles of varying size, shape, and chemical composition. It has taken years of research to develop and apply the instrumentation required to dissect these complexities and the work is ongoing. The PM standards have always been mass-based although such an approach affords greater "weight" to the larger particles that may be less likely to be penetrate deep into the lungs. PM in ambient air is a secondary pollutant in large measure. It was thought that a $PM_{10}$ NAAQS of 150 micrograms/cubic meter (24 hour average) furnished adequate health protection, but this turned out not to be true, and EPA has now given more "weight" to smaller particles with a $PM_{2.5}$ NAAQS of 65 micrograms/cubic meter (24 hour average). Even this newer standard neglects smaller particles (< 0.1 micrometer), which contribute so little to mass that they are quantified as number of particles per cubic centimeter. The precise mechanisms by which inhaled ambient air PM causes morbidity and mortality are still not clear. However, intensive research effort has been underway for several years and has produced support for several hypotheses. Hypotheses link effects to soluble metal compounds – notably zinc, carbonaceous diesel exhaust particles (DEP) and absorbed semi-volatile organic compounds, ultra-fine particles, and coarser particles with endotoxin-like activity. In spite of the absence of well-defined causal mechanisms and uncertainty as to the precise identity of the PM species responsible, the consistency and coherence of the observed associations has justified the imposition of more rigorous NAAQS for PM. EPA supports a PM monitoring and speciation network but the network requires continual upgrading. The SAB recommends that future reports contain data on trends in PM particle size in different regions, trends in PM particle composition, and trends in ultra-fine particle concentrations, where such data are available, to provide a broader picture of the distribution and trends in PM concentrations in this country.

*Water budget and regional water quantity/quality information*

Although the overall presentation of the state of the nation's water resources is very useful, the SAB recommends that additional information be incorporated into the discussion of

indicators in future reports. The water chapter should provide a better description of the water budget for the United States (based on recently released U.S. Geological Survey data) with a discussion of trends. The limited presentation of information on water quantity is a weakness of the draft ROE. It is also extremely important to include a discussion of regional water quantity and quality in areas like California, Arizona, and Florida where this is a significant problem, as well as in other areas where water is an important issue. The SAB notes that even in areas where water is apparently plentiful, such as the Great Lakes, water supply issues are attracting political and environmental attention (USGS, 2004). Depletion of aquifers in the State of Michigan is leading to conflict resolution legislation (Michigan Department of Environmental Quality, 2004). An indicator that measures or tracks trends in interbasin transfers of water would be useful in assessing the condition of water quantity. The general presentation in the draft ROE of the nation's "average" water supply and quality is not particularly useful and potentially misleading since it does not provide adequate information about regions of the United States where water quantity and quality are becoming increasingly critical issues.

*Temporal/spatial information about water indicators*

The SAB finds that there is a need to provide a more complete temporal and spatial view of the water indicators in the ROE. Wherever possible, trends in water quality indicators should be included in the report with spatial representation of the indicators (i.e., on a map, preferably by watersheds rather than political or administrative regions). Areas where the issues are particularly critical should be mentioned in the text. For example, the information on coastal waters is presented mostly in pie charts. These charts are not sufficiently informative to understand areas that are under stress. By providing temporal and spatial detail it will be easier to make the links to human health and ecological condition. In many cases, a regional analysis should be conducted and discussed before national analyses are presented. Regional analyses may then be integrated to produce a national indicator, if appropriate. The local information should be presented along with the regional and/or national indicators.

The SAB notes that coverage in the draft ROE is uneven with regard to available regional information. For example, in the draft ROE there is a heavy reliance on information provided by EPA's EMAP Mid-Atlantic program, leaving out of the analysis information available from other major regional studies on the condition of coastal waters (e.g., Gulf of Mexico, Pacific Coast) generated by the National Oceanic and Atmospheric Administration (NOAA) and other agencies. The absence of "easily"available indicator data should not be a constraint in providing a more complete picture. A meta-analysis approach should be considered to bring together these various datasets to present an integrative evaluation.

*Methodologies used to collect data and prepare water indicators*

The SAB finds that there is a need to be more consistent and complete in the description of the methodologies used in the draft ROE to collect data and prepare indicators. For example, in several cases, the date of the studies supporting static indicators was not included. For a number of TN, TP and eutrophication indicators, the criteria used to classify the data into "Good/Fair/Poor" are not described. In other instances, the benchmarks or criteria used for the indicators reflect outdated scientific interpretation. The wetland indicators in the draft ROE are generally out of date. Several websites, listed in Appendix A, provide additional information about standardized protocols for measuring the status and trends of Great Lakes coastal wetlands. There is also a need to recognize that regional or local criteria are often more appropriate

benchmarks than national criteria (e.g. DO, TN, TP, TOC). It is dangerous to oversimplify the analysis by classifying the data based on arbitrary breakpoints. The SAB notes that the availability of national "indicators" (e.g., water clarity in coastal zones) should not be a reason to include them in the ROE if they are not truly meaningful indicators of ecological condition. In this regard, the United States Geological Survey (USGS) National Water Quality Assessment (NAQWA) study provides a very good assessment of ambient water quality across a wide number of watersheds. However, when this information was analyzed by the Heinz Center it was presented only in terms of presence of pesticides and other contaminants. Presence is not a useful indicator without the additional qualification of the toxicity associated with the concentrations found. An important question to answer is whether there is a human health or ecological risk associated with these toxic contaminants in water. Water quality criteria are available for many contaminants and the criteria can be used to put concentrations in perspective, producing a more useful indicator. At the very least, a presentation of the available water quality criteria (e.g., Criterion Continuous Concentration, Criterion Maximum Concentration, and Maximum Contaminant Level) for the contaminants that exceed these values could be included in the description of the "presence" indicator. A similar approach could be taken with regard to contaminated sediments, using guidelines such as Probable Effects Concentrations (MacDonald, Ingersoll, & Berger, 2000) to put their toxicity into perspective.

*Omissions from Chapter Two (Purer Water) of the draft ROE*

The SAB finds that a number of important indicators have been omitted from the water chapter of the draft ROE. National datasets for these indicators are available and should be used in the next ROE. Although it is useful to know that more than 94% of drinking water suppliers are in compliance with drinking water standards, it is also important to provide information regarding the violations of drinking water quality standards. The ROE should report the severity and frequency with which different standards are violated and the spatial distribution of violations across the United States. Knowing the nature, severity, and spatial pattern of drinking water violations (e.g., pathogens, arsenic) would help identify potential sources of contaminants and help to correlate diseases with contaminated water. The SAB recommends that this information be provided in order to address two missing drinking water quality indicators: sources of contaminants and human health effects. In a similar vein, identifying the most common contaminants that lead to fish and/or shellfish advisories, as well as the severity of exceeding risk levels, would help identify sources and make linkages to human health effects.

Section 2.2.1 of the draft ROE (Condition of fresh water and watersheds) contains no discussion of Clean Water Act Section 303(d) listings. These listings reflect water body impairment and could be discussed in the ROE. The 303(d) listing information was developed based on state or federal water quality objectives for designated uses of these water bodies, and the achievement of these objectives. Although there are questions regarding both the statistical basis for listing a water body and the scientific basis for some local water quality objectives, the 303(d) lists provide a national view of the condition of watersheds. Since the 303(d) lists are based upon local and state data that may be inconsistent across political or administrative boundaries, the lists have limitations similar to those associated with beach closings and fish advisories. However, the 303(d) lists provide an important measure of the nation's progress toward achieving water quality objectives. The fact that water quality objectives reflect local values should be considered a strength, rather than a limitation because the objectives reflect criteria that are adapted to local conditions.

National Pollution Discharge Elimination System data capture nutrient, toxics, and thermal loads to water bodies, and the data are available at the national level. The SAB recommends that these data be organized and included in the ROE in order to show temporal trends. This will provide information to determine whether the loads of N, P and the most important toxic compounds to waters in the United States are decreasing or increasing. NPDES data should also be used to determine the spatial distribution of load reductions (e.g., identifying regions which are lagging in the reduction of loads, and relating loads to observed water quality and 303(d) listing).

The water chapter of the draft ROE currently contains a discussion of changes in stream flow. The SAB recommends that EPA work with data available from the U.S. Geological Survey to expand this discussion and provide information on stream flow and its relation to observed climate change. Stream flow information should also be presented spatially. It would be useful to view changes in precipitation nationally and regionally to determine how that has influenced stream flow. A related issue that should be included in the ROE is the change in global temperature and how it is affecting the timing of snow melt, particularly in the western United States, where it can have a major impact on water resources.

The SAB recommends that, in addition to the suggestions outlined earlier in this document, the following indicators should also be included in the water chapters of future reports:

- Changes in groundwater quantity and quality at a regional level, which can then be integrated to give a national perspective on the state of our groundwaters, including ground subsidence due to excessive withdrawal, increases in nitrate concentrations, and fraction of drinking water supplies affected by MTBE, PCE, TCE, BTEX and other important contaminants;

- Changes in water temperature due to point source discharges (i.e., power plants and other such uses of water) and riparian alterations of the landscape;

- Status of invasive species in aquatic ecosystems;

- Changes in TDS/salinity over time due to human activities;

- Quality of irrigation water (e.g. salinity, nutrients, toxics);

- Detection of emerging water pollutants in water supplies across the nation;

- Harmful algal blooms.

*Validity of conclusions in Chapter Two (Purer Water) of the draft ROE*

The SAB notes that despite data gaps, many of the conclusions in the water chapter of the draft ROE are supported by scientific information. However some conclusions contained in the draft ROE are problematic or need qualification. In some cases, the draft ROE presents no conclusions and data are presented without analysis. These problems are listed in detail in Appendix A of this SAB report, but a few are identified below for illustrative purposes:

1) Page 2-15: Data interpretation is confounded by the graphical presentation. In exhibits 2-6

and 2-7, the time scales are confounded by using equal spacing despite covering different periods of record. In addition, the use of different scales on the y-axis can lead to misinterpretation of trends. Although the absolute changes in exhibit 2-6 are relatively similar (ca. 5000 acres lost or gained for each wetland type between the 50s and 70s), the relative difference is much greater for shrubs (41% increase) than forested areas (10% decrease) or emergents (14% decrease). This problem needs to be corrected, either by an explanation in the figure or by using similar scales.

2) Page 2-27: Changing stream flows. The timing of this indicator is not clear. It is not clear whether the analysis was conducted by evaluating the period of lowest flow in the 1990s to see if it was the same in the 1930s-1940s. If so, ecological value of flow is not clear. Hydroperiod is important not as it is linked to dates, but to the life histories of the biota. In this sense, hydroperiodicity linked to region, as opposed to a national scale, is much more valuable. Also, the figure label deals only with high flows; it is not clear whether low flows are also included.

3) Page 2-28: The text does not accurately describe data in the figure, and vice versa. The figure relates to percent of streams, while the text refers to percent of no-flow periods. If only one day of no flow represents a no-flow period, it is possible that the percent of no flow periods could increase over time, but occur in a fewer number of streams overall. This should be clarified.

4) Page 2-35: Phosphorus indicator. It is not clear why total nitrogen is specified for the prior indicator, but total phosphorus is not specified here. This omission suggests that other forms of phosphorus are included in the analysis. The total phosphorus categories seem skewed toward the high end. Even EPA's nutrient criteria guidelines suggest that a lower standard is appropriate. This issue deserves greater attention since impairment is likely at 100 ppb. It is also not clear how often samples were collected, whether storm events were sampled, and when total phosphorus is likely to be elevated.

The kinds of information discussed in the cases listed above should be provided for other water quality indicators in the draft ROE as well.

*Indicators in Chapter Three (Better Protected Land) of the draft ROE*

The motivating questions and related indicators included in Chapter Three (Better Protected Land) of the draft ROE are, with few exceptions, good. While recognizing that the sub-themes of Chapter Three (land cover, chemicals, and waste) do not necessarily hold together coherently when viewed apart from the rest of the document, the SAB believes that their placement together is appropriate in light of the recommendations made about the structure (and recommended restructuring) of Chapter Five. One indicator that is not really helpful in Chapter Three (or anyplace else in the ROE) is "extent of forest ownership." This metric is not relevant to an understanding of environmental quality. The SAB also notes that Chapter Three is missing many important indicators. Some of them are presented in Chapter Five, and the SAB recommends that they be moved into Chapter Three. Specific indicators that should be moved from Chapter Five into Chapter Three are identified below.

A number of important land use indicators are not included in the draft ROE, and the SAB recommends that they be added to future drafts of the report. These indicators include: the

extent of roads, metrics related to sprawl, and metrics related to socio-economic distributions of the human populations in relation to various land uses and land-based sites of contamination. The SAB recognizes that the EPA may not be able to find data to apply to all of these indicators, but because the indicators are meaningful and important they should be mentioned in the report. When they are included in the ROE, these indicators should be presented in a clear and understandable form. When necessary, EPA should explain that no data are currently available for the indicators.

*Data gaps and limitations in Chapter Three (Better Protected Land) of the draft ROE*

The SAB is concerned about the tone and content of the discussion of some "indicator gaps and limitations" in Chapter Three of the draft ROE. It is not always clear whether data gaps and limitations in this chapter are identified because the indicators cannot provide answers to questions, or because few data are available to assess the indicators. Most of the gaps and limitations in Chapter Three are stated in such definitive terms that they unnecessarily convey to the reader that the data may be inappropriate or unable to answer the question. In fact, many of the data sets used for these indicators are accompanied by error estimates or assessments of confidence levels; thus the extent to which indicators are limited by data availability can be assessed. When estimates of accuracy are available for data sets, they should be provided in the ROE. The SAB also notes that some of the statements in the draft ROE about gaps and limitations are incorrect. Examples of these are included in Appendix A. Some of the stated gaps and limitations are, in fact, neither. For example, the second gap/limitation list on page 3-31 merely states that the available technology to detect residues exceeds what is needed to detect levels of residue that have health consequences. This statement does not call into question either the indicator or the data. Therefore the statement should not be included in the report.

As mentioned previously, the SAB recommends that EPA rethink the indicator gap and limitations (IGL) approach presented in the draft ROE. In the current draft of the ROE, the IGL sections in all of the chapters contain an assortment of qualifiers that often inappropriately discourage the reader from believing the data presented. The SAB feels that this is largely a result of poor definition of the IGL section, and an apparent need to include information in the IGL section for each indicator, or the selection of an inappropriate indicator or measure for that indicator. IGL segments in the draft ROE include: (1) actual data gaps (pages 3-22, 5-12); (2) actual limitations (pages 5-39); (3) descriptions of the data (pages 3-20, 5-12); (4) needless apologies for data that are too accurate (page 3-31); (5) descriptions of problems that are not problems (page 5-16, Breeding Bird Survey and volunteers); and (6) vague descriptions of things that may or may not be problems (e.g., page 5-15 states, "It is not clear that trends can be quantified with any precision"). A few segments report data uncertainty (page 5-12, end of first bullet). This assortment of qualifiers leaves the reader feeling bewildered and unnecessarily confused. If an indicator must be qualified the use of that indicator should be reassessed to insure that it is truly reliable and reportable.

The SAB recommends that indicator gaps and limitations should be provided in detail in an appendix (currently Appendix B of the draft ROE *Technical Document*) that fully describes the rationale for indicator choice, data sets used, data sets not used, and constraints on these data sets. When these descriptions are placed within the body of the technical report, they are distracting and often portray the data in an unrealistically poor light. The SAB also recommends that EPA should not label accuracy statements about data as a gap or limitation. For example, the fact that the national Pesticide Data Program (PDP) can detect pesticide residues at

concentrations below regulated levels is an asset to the data, not a limitation. Data relevance is also a critical issue in assessing data limitations that is not sufficiently interpreted in the draft ROE. For example, assessing soil erosion on undisturbed forested lands (page 5-22) seems to have little meaning when it is known that most forest soil erosion is associated with harvest.

The SAB also notes that data omitted in Chapter Three of the draft ROE is also a critical issue. Several notable data sets are used sparingly in the draft ROE (Breeding Bird Survey, NatureServe rarity ranking, Forest Inventory and Analysis [FIA] plot data). Other metrics are available from these data sets (e.g., population trends of grassland birds) and the lack of explicit detail explaining why some portions of the data sets were included in the draft ROE, and others were not, raises concern among people familiar with the data sets.

*Organizational scale of ecosystems in Chapter Three (Better Protected Land) of the draft ROE*

The SAB finds that the current draft of ROE Chapter Three addresses indicators of terrestrial ecosystem extent and condition with a taxonomy and at a scale that are not appropriate. The use of just four land use types (developed, farmland, grass/shrubland, and forest land) is not adequate to accurately inform the public about questions of national importance pertaining to the condition of land or the ecological consequences of land condition. As an example, the category of grassland/shrubland/desert lumps together numerous well-recognized ecosystem units, such as tallgrass prairie habitat, short-grass steppe, cold desert, warm desert, and many others. The problems that face different ecosystems are quite different. For example, habitat loss of tallgrass prairie, as well as most other eastern U.S. grassland types, is nearly complete (estimates generally report greater than 99% loss). A United States Department of Agriculture (USDA) report on ecosystem endangerment lists multiple endangered ecosystems that are eastern grassland. Yet, the draft ROE summarizes the extent of the broad grassland category as quite high (85-94% extant, though it does acknowledge that the quality has changed, p. 3-18). This results in a misleading interpretation of this system. In addition, threats to systems cannot be well-captured at the resolution currently described in Chapter Three of the draft ROE. A leading concern for grassland integrity of eastern tallgrass prairie is the on-going conversion of pastureland to row crops, leading to the decline of numerous grassland-dependent bird species (Herkert, 1994, 1995).

In future editions of the ROE, the EPA will face a number of hard decisions regarding classification schemes for ecosystems. Different data sets, summarizing different indicators of land condition, use differing ecosystem classification schemes. Often these different ecosystems are not easily compared. Some are based on physiognomy, others on bioclimatic zones, and still others on dominant species. This will result in difficult decisions with respect to data treatment. Future reports on the environment may be organized around the currently used types (forests, grasslands, etc.), but the SAB recommends that indicators must, wherever possible, use meaningful ecosystem classifications. These should be, as a rule, at a finer scale than the broad types currently described in the draft ROE.

The SAB offers the following five recommendations regarding selection of an ecosystem classification scheme for the ROE. 1) Choose an ecosystem classification scheme that summarizes ecosystems of the United States in approximately 20 different fundamental ecosystem units for reporting on the environment. The approximately 20 ecosystem types would include the wetlands, estuaries and marine ecosystems described in Chapter Two. The Vector Smart Map (VMAP) project uses one such scheme. 2) When using data from other studies that

use a hierarchical classification (e.g., NatureServe), trim the ecosystem classification scheme to this same level (approximately 20 units). 3) When using data that do not trim well to this order of magnitude (United States Fish and Wildlife Service [USFWS] Forest Inventory and Analysis [FIA]) data, it is possible to use summaries at a coarser scale (e.g., the order of the forest classification used in the Heinz report), but EPA should note that most rare and threatened community types reside in the category of "other forest types." Thus, statements interpreting trends in forest cover must be constrained by the fact that there is no information presented on the loss of forest types, because the ones most likely to be lost are aggregated into an "other" category. (4) We encourage EPA to use particularly sensitive ecosystems as a focal area upon which to report indicators. For example, rivers and oceans are treated as large ecosystem categories in the current report, but prominent bays and estuaries are critically important ecosystems for both biodiversity as well as extractive resources. These ecosystems share two additional attributes: they are very susceptible to degradation and perturbation because of human impacts, and there is a large and robust set of data describing the conditions of these ecosystems. Judicious use of critical ecosystems can be very useful for characterizing condition at a broader level.

*Questions in Chapter Three (Better Protected Land) of the draft ROE*

A deficiency of the draft ROE is that questions are framed differently in the land chapter in comparison to the air and water chapters. In some cases questions are framed to answer questions about extent of ecosystems, and in other cases they are framed to answer questions about ecosystem condition. Answering questions about condition requires a different suite of indicators than those currently used in the report. The SAB recommends revising the questions and indicators to make them more illuminating of actual ecosystem condition. In some cases the use of new indicators may be appropriate. In developing the next ROE the EPA should consider framing questions to reflect land condition. The SAB provides examples in Table 1.0 of the kinds of questions and indicators that might reflect forest condition. Similar kinds of questions and indicators can be developed for various types of grasslands, deserts, and aquatic systems. These examples are neither intended as an exhaustive list, nor a specific prescription for choice of indicator. The SAB recommends that the authors of the next ROE think hard about which of these indicators may be obtained and analyzed in the short time available for preparation of the report. The SAB also recommends that EPA begin thinking about the activities that may be initiated now in order to expand these indicators in the future, given the current constraints on monitoring.

It is likely that state-collected data on wildlife health status can be used as indicators of forest condition. Wildlife status indicators that could be developed include: tick loads of deer; morbidity (papiloma on deer), and peregrine eggshell thickness. EPA should also consider using breeding bird data on neotropical migrants. Multiple data sets for the same indicator should be compared in table form. Very few differences are likely to be observed in agricultural land, but it would be useful to know about transformations within agricultural land.

Table 1.0: Possible indicators of condition and response to stressors

| Question: What is the extent of forest habitat diversity and contiguity? |
|---|
| Rationale for selecting question: We know that plant community diversity determines food chain structure. Disruption of community diversity degrades ecological integrity. |
| Indicators:<br>Forest Community Diversity. Despite the observation that overall forest quantity has, if anything, slightly increased during the past 20 years, there are likely numerous ways by which changing land use continues to threaten biological diversity of forests. One indicator of habitat loss as a stressor would be changes in the quantity of forest types that are rare and threatened. Indicator opportunities: (a) spatial and temporal changes in rarity ranks of threatened forest types (based on NatureServe classification scheme); (b) Changes in spatial extent of key community types.<br><br>Habitat Patch Size. Ecological data indicate that the size of forest fragments has an important effect on species richness (e.g., birds, mammals, amphibians) and on trophic structure (i.e., the presence or absence of top predators). A critical indicator of forest patch size can be captured through an index of changing road density as well as geostatistical approaches to remote sensing data (i.e., FRAGSTATS on land cover data). Indicator opportunities: (a) DOT Road density data; (b) Random selection of representative forest patches distributed across the U.S. using LANDSAT data; (c) Millenium ecosystem assessment (This report should be completed soon, and it provides global data analysis, so that patch attributes in the United States could be compared to other parts of the world). |
| Question. Are invasive species degrading forest productivity? |
| Rationale for selecting question: Invasive species are competitive dominants that displace native species, disrupt biogeochemical cycles; and engineer abiotic environments. Invasive species represent the second leading cause (behind habitat loss) of species endangerment on the United States. (Wilcove, Rothstein, & Dubow, 1998). |
| Indicators:<br>Acreage spread of key invasive species. Indicator opportunities: USFS and BLM track acreage spread of key invasive species. Numerous state and local agencies map regionally important invasive species (e.g., hay-scented fern in New England, garlic mustard in the upper Midwest, kudzu in the southeast, scotch broom in the west). Regional trends and case studies can be used to illustrate a problem of national scope and concern. |
| Question: What is the ecological condition of forests? (forest age) |
| Rationale for selecting question: Forest age is an indicator of standing productivity and a surrogate for the likelihood of disturbance (e.g., fire susceptibility); disease or pest invasion; and a measure of degree to which U.S. forests are represented by old growth stands. |
| Indicators:<br>Indicator opportunities: Forest Age data from USFS FIA plot data; classified into USFS community types; perhaps by biome. A sequence of spatially explicit maps can be used to show time trends using isoclines of net growth across the country. |
| Question. What are trends in the disease state of forests? (Insect pests and microbial pathogens) |
| Rationale for selecting question: An indicator of forest tree health is pests and pathogen outbreaks. |
| Indicators:<br>Indicator opportunities: Exhibit 5-10 of the draft ROE provides a temporal trend in acres of forest impacted by insect outbreaks and disease. This trend is problematic in that it is difficult to discern a single outbreak, event in the 1980's, from which we are experiencing a recovery, or a real trend toward fewer outbreaks. A spatial analysis combined with this temporal analysis would allow these data to reveal whether there were chronically higher insect outbreak levels in the 1980's or if this peak results from a single large event and subsequent recovery. Additional opportunities include the spatial spread of prominent insect pests such as gypsy moth, woolly adelgid, Japanese ash-borer for insects; dogwood anthracnose, white pine blister rust and others among tree diseases. USFS collects data on these infestations. |

The SAB notes that Chapter Three of the draft ROE also provides information on indicators of waste and toxic contaminants released to land. The SAB did not comment on this section of the draft report because the SAB ROE Panel did not have the expertise to assess the information provided. However, the SAB notes that the ROE should contain a discussion of the problem of intense land contamination by discarded chemicals, leading to such problems as leaching into ground water and potentially toxic human and wildlife exposures. Such contaminated sites are sufficiently widespread to constitute a national problem even though each site may be relatively isolated.

*Indicators in Chapter Four (Human Health)*

This Chapter lacks an overall framework that would relate the health indicators to the environmental stressors presented in the other chapters. The SAB recommends that some additional indicators be added to Chapter Four of the draft ROE. Endocrine disruptors in the environment should be addressed and consideration should be given to adding indicators of: time of puberty, testicular cancer, prostate cancer, sperm counts and function, gender ratio at birth, and thyroid disease. In addition, neurobehavioral function (including cognitive function, visual memory, etc.) could be listed as an environmental health indicator. The discussion of relative rates of infant mortality in Chapter Four should indicate that the high proportion of teenage mothers is one reason why infant mortality in the United States is high. Chapter Four currently does not provide any reason for the relatively high infant mortality rate in the United States, and readers may conclude (inappropriately) that it is completely a result of exposure to environmental chemicals and not related to socioeconomic conditions. The discussion of lead in Chapter Four (case study) should reference articles in the April 17, 2003 issue of the *New England Journal of Medicine* providing evidence that even the current "acceptable" blood lead level of 10 micrograms/dl may not be protective of health. These articles reported that: 1) serum lead levels of three versus one micrograms/dl delayed puberty by several months in blacks and Hispanics (but not whites), and 2) IQ was adversely affected by serum lead levels even up to only ten micrograms/dl, with most of the loss between the levels of one and five micrograms/dl.

The SAB recommends several other additions to Chapter Four. Brain barrier differences in children are discussed as a reason for the susceptibility of children to environmental contaminants. It should be also be noted that end organ susceptibility may be equally or more important. Breast milk monitoring should be considered as a method for determining the body burdens of many of the most worrisome chemicals. The SAB also notes that old data on the incidence and rising incidence of autism are used in Chapter Four. A recent investigation in Brick Township, New Jersey by the Centers for Disease Control found a prevalence rate of 6.7 per 1,000 children for autistic spectrum disorders (Bertrand et al., 2001). The prevalence of autism in Brick Township seems to be higher than that in other studies, particularly studies conducted in the United States (Burd, Fisher & Kerbeshian, 1987; Kirby, Brewster, Canino & Pavin, 1995; Rito, Freeman & Pingree, 1989) but within the range of a few recent studies in smaller populations that used more thorough case-finding methods (Arvidsson, Danielsson, Fosberg, Gillberg & Johansson, 1997; Baird, Charman, & Baron-Cohen, 2000; Kadesjo, Gillberg, & Hagberg, 1999). New technologies should also be discussed in greater detail in Chapter Four. These include the use of genotypes and more sensitive and specific neurobehaviorial testing (e.g., visual memory testing and functional MRIs). Chapter Four is focused on disease causation. It should be noted, however, that environmental chemicals may not cause certain diseases, but may exacerbate disease processes such as asthma and cystic

fibrosis. Neurobehavioral function in typical and dysfunctional children may also be affected by environmental chemicals. EPA should also link longstanding state databases on health such as cancer registries and birth defects to environmental data sets. Data from the CDC's Environmental Public Health Tracking Project may be available to provide this type of information for the next ROE. In Chapter Four EPA should also consider addressing emerging persistent chemical contaminants such as brominated flame retardants and perflurooctane sulfonate.

The SAB also notes that there is extensive peer-reviewed literature documenting associations between PM and ozone pollution and human health effects such as respiratory morbidity and cardio-respiratory mortality. The arbitrary insistence on "national scale" data seems to have obscured these important findings in EPA's draft ROE 2003.

*Indicators in Chapter Five (Ecological Condition)*

The SAB finds that the status and trends of ecological conditions at the regional and national scale were not communicated well in Chapter Five of the draft ROE, and it was difficult to understand why EPA had judged many of the indicators as important to include. For many indicators, both the value of the indicators and supporting information is diminished by the way the indicators were presented, developed, and assembled in the report. Some examples of these deficiencies and recommendations for improvement may help EPA make the Report on the Environment more clear, concise, and persuasive.

Several indicators collapsed data and measurements into pooled or average values that are too generalized to convey clear information on environmental status and trends. For example, the pooled surface area of lakes and reservoirs (exhibit 5-25) show little change in a five-decade data series spanning the era of dam building in the United States from the 1960s through the 1980s. Also, the desirability of increases or decreases in lake and reservoir area is not evident or explained. The statement that "changes in this indicator reflect the effects of climate on water level…" is greatly oversimplified and misleading. Report sections on indicators often provide numerous qualifications on indicator use, and at times go so far as to state that indicator value changes cannot distinguish natural from human pressures (e.g., marine mortalities). The problems and reservations on indicator clarity, precision, and interpretation can be greatly reduced by limiting indicators to those that have a direct relationship to specific environmental changes, and indicators known to be sensitive to targeted trends. The ideal ecological indicator would be: (1) based on familiar and easily understood measures; (2) based on data known to be strongly correlated with the environmental attribute of interest, (3) and relatively insensitive to confounding and non-environmental factors.

The SAB finds that in Chapter Five of the draft ROE there is frequent redundancy among indicators and with regard to their intended interpretation. Chapter Five appears to collect indicators from the basic chapters on air, land, and water. The repeated use of related indicators can be helpful for reinforcing a status or trend conclusion, but the SAB perceives this practice as an impediment to developing a clear and concise message on the ecological condition of the environment. For example, there are three indicators based on animal, fish, and marine organism deaths and deformities even though strong reservations are stated for interpreting each one. In another example, model results are used from a single government database to project indicator values for two closely interrelated indicators: soil compaction and soil erosion. Rather than amassing related indicators with suitable data, the SAB feels that the overall impact of the ROE

will be greater if the most informative and well-supported indicators are used to answer specific questions and show specific trends.

The SAB feels strongly that there are too many indicators included in Chapter Five of the draft ROE, and too many for a number of the ecosystems assessed. While we support the numerous indicators in the chapters on air, land and water, we believe that the overarching chapter on ecological conditions should concentrate on a limited number of select indicators. Large numbers of indicators can impede communication when an overall sense of status and trend is being sought. This chapter of the draft ROE includes 74 indicators, with the number per ecosystem type ranging from 4 to 16. Using this many indicators can complicate gaining an understanding of environmental status and trends and EPA may wish to consider reducing the number of indicators in this chapter. The SAB recognizes that cutting the number of indicators to a few or several per assessment level poses a very difficult challenge. Selecting a few well-supported, sensitive, and precise indicators is a substantial technical challenge. It also runs counter to the natural interests of agency programs, report participants, and interest groups who often want to see their work and resources highlighted. Nevertheless, the SAB feels that relying on the strongest and most informative indicators will considerably strengthen the impact of the total message and increase the influence of the report. If EPA decides that the best approach to assessing the ecological condition of each ecosystem is to synthesize multiple indicators, then perhaps the multiple indicators could be included in appendices, with the synthesis for each ecosystem presented in the report, along with the synthesis for all the ecosystems in each region, or the Nation.

The section of Chapter Five that discusses essential ecological attributes captures only a limited set of human drivers of ecological change. The drivers considered in the draft ROE are mainly those associated with physical alterations of the habitat and the impacts of that alteration on ecological health. There are other human drivers that have marked impacts on species populations and ecological health. For example fisheries can have direct impacts on the biological condition, growth characteristics, life histories, and genetic composition of the targeted species. However the impacts of fishing can extend beyond the target species to other aspects of the ecological community. For instance, changing predator abundance and size distribution can alter forage species characteristics and composition, and consequently impact the species that serve as the food source for foragers.

There are other less obvious ecological impacts that can result from human drivers. While it is widely recognized that water quality influences biological communities, the integrity of ecological community structure can influence the sensitivity of the community to water quality. The depletion of filter feeders and grazers can adversely affect water quality through reductions in filtration of plankton and suspended sediment or through a reduction in grazing of plankton or other algae. The resulting increases in turbidity or decreases in plankton can have substantial impacts on water quality and remaining biological communities. For example, the loss of oysters (filter feeders) and the depletion of menhaden stocks (plankton grazers) in Chesapeake Bay have led to increased turbidity and planktonic primary productivity. In many coral reefs, a persistent shift from coral to macroalgal dominance has been attributed to a reduction in herbivorous fish and invertebrates, causing increasing ambient levels of nutrients to be channeled into less preferred autotrophic forms, resulting in less material being transferred directly to higher trophic levels. Alternatively, increases in bottom-feeding fish in ponds and small lakes can lead to increases in the suspension of sediments, increases in planktonic production, and a decrease in bottom vegetation due to reductions in light penetration. We therefore recommend that

indicators of fish stocks and diversity for coastal, estuarine and Great Lakes fisheries be developed and discussions of how the condition of fisheries can impact water quality be added to the discussion of ecological conditions. In this regard, the SAB notes that one of the most destructive stressors on freshwater fisheries communities is invasive aquatic species. Invasive species affect food web structure and productivity at every trophic level and should therefore be included as part of this discussion.

### 5.3 Response to Charge Question 3

Charge Question 3: Conventional Agency practice has been to measure and reduce emissions and subsequent exposure to pollutants. Can you suggest how measurements for human health and ecological condition impacts resulting from environmental perturbation could be more effectively addressed?

#### 5.3.1 Key Recommendations in Response to Charge Question 3

The SAB provides the following key recommendations to enhance synthesis in the human health chapter of the draft ROE.

1. Presentation of the state of the environment in a health context greatly enhances the value and meaning of the ROE while at the same time complicating it. The linkages described in the draft ROE are extremely important in representing the state of the environment as it relates to human health. However, the SAB notes that health impacts resulting from environmental pollution should be addressed in the ROE through a more rigorous and systematic consideration of their linkages.

2. The criteria for identification of environmentally related health effects should be included within future human health chapters. There are many technical challenges associated with identifying health effects associated with low-level chronic exposure to environmental contaminants (e.g., endocrine disrupters). In the draft ROE, EPA has identified health effects associated with acute exposures. Section 4.3.5 of the document also identifies other emerging health effects. The SAB notes that EPA should justify why acute effects are the preferred measures for rapid identification of change that can lead to action.

3. The selection criteria for identification of health effects should take into account the precautionary principle (i.e., the threat of harm to human health should be considered when determining the requirements for cause-and-effect relationships).

4. For those diseases that are included in future human health chapters, a clear description of the role and strength of evidence that relate a disease to pollutants in air, water, land, or diet should be provided. When discussing the effects of environmental change on health outcomes, EPA should also discuss other risk factors and confounding variables related to those health outcomes. Bradford-Hill criteria[1] (Bradford-Hill, 1965) should be considered in characterizing the nature of the evidence and strength of association in epidemiological studies. In the broader context of both epidemiology and clinical toxicology, the National Research Council Committee on Research Priorities for

[1] Bradford-Hill criteria to establish causation include: consistency, strength of association, temporal sequence, dose-response, specificity, coherence, biological plausibility, analogy, and experimental evidence.

Particulate Matter has considered the kind of evidence that would be informative for assessment of hazardous particulate matter. The Committee concluded that integrated epidemiological and toxicological approaches will be needed to test and cross-validate hypotheses based on human observational and animal experimental data (National Research Council, 2004).

5. For many environmental pollution-related health effects, exposure and effects susceptibility are key considerations and should be discussed in the context of linkages. Where appropriate, susceptibility factors such as age, gender, polymorphisms, and socioeconomic status should be acknowledged. The differential impact of the environment by socioeconomic status is particularly important as an issue of environmental justice. This differential impact may be a result of environmental hot spots or susceptibility (e.g., inadequate health, poor diet).

6. The current document does not adequately treat the health threats posed by environmental contaminants in diet. Diet represents an important route of exposure for a wide range of contaminants (e.g., pesticides, metals, PAHs, heterocyclic amines, PCBs) representing an integrative medium across air, water, and land. The U.S. Department of Agriculture and or Food and Drug Administration have databases that are likely to satisfy the criteria for category 1 or category 2 indicators.

7. The section on emerging health effects (Section 4.3.5 on page 4-38 of the draft ROE), particularly that part of the section on arthropod-borne diseases (page 4-40), should be linked to the ecological condition section of the draft ROE (Chapter Five, or those parts that are moved into Chapter Three). This section is important because of the growing awareness that many "new" infectious diseases emerge in large part from changes in the environment. These diseases, in turn, can result in changes to the environment as well. Lyme disease is mentioned in this section, but should be elevated as a case study to emphasize this concept. Ecological phenomena such as habitat fragmentation (increased "patchiness"), reforestation in the eastern United States that led to the explosion of the deer population, and oak tree masting events that increased deer mouse populations all allow for increased transmission efficiency to humans of the tick-borne bacteria that cause Lyme disease. Emergence of ehrlichiosis, babesiosis, Powassan virus fever, and other tick-borne infectious diseases could be prevented or minimized by a better understanding of interactions between infectious agents, their hosts, and the environment. Pathogen and host genetic factors may also exert selective pressures that affect infectious disease emergence. Linkages also exist between water pollution and human exposure to aquatic pathogens such as *Pfisteria, Cryptosporidium, and Microcystis* toxins.

8. Linkages exist between land use, standing water, and the emergence of West Nile virus (WNV) fever. Genetic factors may help explain why the North American strain of WNV has become more virulent and now (for the first time ever) is manifested by poliomyelitic presentations. Long-term exposure to low levels of xenobiotics may make individuals more susceptible to infections by pathogens. Conversely, prior infection with pathogenic microbes may predispose individuals to more severe outcomes from chronic exposure to industrial pollutants.

The SAB provides the following key recommendations regarding enhanced synthesis in the ecological condition chapter of the draft ROE.

1. It is recommended that future ROE chapters addressing ecosystem condition be reorganized and refocused on ecological condition. The single variable approach currently used in the chapter should be de-emphasized, and a conceptual model of linkages and feedbacks should be created to explore how certain drivers of environmental change lead to altered ecological condition. This chapter presents an opportunity to synthesize the most critical indicators from prior chapters to obtain an assessment of ecological condition. This will require a dramatic change in the organizational structure of the chapter. Various parts of the draft ROE should be integrated in a conceptual model, and Chapter Five should be populated with synthesized analyses driven by major questions about ecological condition. The conceptual model should include two essential elements: symmetry of questions and indicators focused on conditions and trends, and symmetry between Chapters Four and Five. The use of such a model will improve the discussion of linkage between ecological attributes and health.

2. The use and presentation of each indicator should be reevaluated to focus the ROE on the most meaningful indicators.

3. The gaps and limitations section should also be reorganized to place some material in an appendix.

4. The appropriate level of ecosystems and associated indicators should be included in the ROE using some examples of sensitive ecosystems, and some examples that are explicit in their linkages to ecological attributes of human concern (e.g. the Chesapeake Bay and the Great Lakes where contaminated sediments, fish advisories associated with high levels of mercury and PCBs, and beach closings caused by pathogens in recreational waters link environmental perturbation to human health risks).

### 5.3.2 Specific Comments in Response to Charge Question 3

*Linking environmental exposure and human health effects*

The linkage between environmental exposure and human health is addressed in Chapter Four of the draft ROE. The SAB believes that the following approaches and suggestions will help to make this critical linkage. The SAB recommends that the overall document should be reorganized and a conceptual summary should be included at the beginning to help set the stage for a discussion of links between exposure and human health effects. The SAB also believes that it will be important to look for and include additional measurements that are intermediate between ambient concentration and human/ecological effect. These can include measures of personal exposure, biological markers of exposure, measures of body burden (the direct result of exposure and uptake), and measures of sub-clinical change. Ambient concentration does not directly describe exposure and uptake of toxic materials from the environment. Within the context of the conceptual model outlined at the beginning of the document, measures of personal exposure to compounds with known health/ecological implications are one step closer to an index of health impact than ambient concentration. In addition to the examples currently included in the draft ROE, which are restricted primarily to blood levels of heavy metals, additional possibilities to explore include: Pb and other bone seeking elements and radio-nuclides in bone (a more stable measure of integrated exposure than concentration in blood, which has a relatively short half-life); heavy metals in nail and/or hair; bio-accumulating organic and inorganic pollutants in human breast milk; carboxyhemoglobin (COHb) levels as a marker of

exposure to emissions from combustion sources; exhaled breath concentration of volatile organics; and heavy metals or metabolic byproducts of organics in urine. The SAB recognizes that data to support the development of indicators for many of these markers of exposure may not be available from national representative surveys. However, movement in this direction is important to establish linkages between the condition of the ambient environment and human/ecological impact.

Evaluating sub-clinical changes resulting from environmental exposures is another strategy for linking exposure and effects. For example, there are well-developed relationships between exposure to ozone and pulmonary function. These effects have been demonstrated in a wide range of individuals including asthmatics and healthy exercising adults. Recent studies have also demonstrated the use of protein adducts and DNA adducts as measures of exposure. Within this general context, it is important to consider mixtures and multiple routes of exposures. In the toxics area, effects are likely to be at least additive or possibly multiplicative, and exposure can be from air, water and food. The results of the National Health and Nutrition Examination Surveys (NHANES) conducted by the Centers for Disease Control's National Center for Health Statistics may be particularly useful for linking exposure with potential effects. It also may be necessary to consider health and ecological outcomes when the causal relation between exposure and outcome is not completely confirmed. This relationship is especially important in light of the potentially severe adverse consequences of not acting to mitigate ecological change.

The SAB believes that it also will be necessary to develop indicators of the impact of air quality change on ecosystem health. This linkage has the potential to lead to the direct synthesis of ecological and human health impacts. Emission of climate forcing gases and aerosols is an obvious and important area for development. The goal is to track major ecosystem changes that result from environmental perturbation from the emission of pollutants. For example, ecological impacts with known health implications include habitat fragmentation and loss of biodiversity.

The SAB also recommends that emissions should be analyzed in a GIS context, incorporating climate, population, and other factors to describe how people come in contact with pollutants and vice versa. This analysis should include pollutants that may be derived from sources or processes not regulated by current EPA programs, acknowledging the fact that some impacts are derived from sources outside the United States. For example, a systematic summary of global transport (from satellite observations) could track the movement of Asian/African dust, which has implications for coral reefs as well as human asthma. An additional example is an analysis of the link between global deforestation and desertification with resulting dust events that can lead to ecological and health impacts. The SAB notes that addressing these recommendations will increase the scope of the ROE but recommends that EPA consider including this important information in future recurrent assessment reports.

*Synthesis to provide an integrated picture of ecosystem condition*

The draft ROE provides many indicators describing the condition of air, water, and land. There is, however, a need recognized by both EPA and the SAB to combine information from the air, water, and land chapters and synthesize them in ways that provide an integrated and meaningful picture of the condition or integrity of individual ecosystem types. In addition, insights about condition of individual ecosystem types should be synthesized to assess condition of entire ecoregions or the whole country as data present themselves for future reports on the environment. The SAB notes that the current draft of the ROE attempts to do that, but the SAB

finds that the draft ROE takes a decidedly single variable approach (e.g., extent of a land use type across time). The limitation of such an approach is that it does not adequately reveal the linkages and feedbacks among various biotic and abiotic components that make up an ecosystem, nor does it adequately assess indirect effects or unintended consequences. The SAB acknowledges that combining and synthesizing information in the ROE to develop an integrated and meaningful picture of ecosystem condition is a challenging task. There are very few existing hierarchical or integrated indices that combine indicators in a meaningful manner. This is a subject of current research. While the SAB does not suggest that future ROEs should contain a model of ecosystems that reflect real world complexity, the SAB does recommend that these ROEs should contain some conceptualization of important linkages among ecosystem components (e.g., extent of land cover type and biodiversity) and then explore how certain drivers of environmental change lead to altered environmental condition (e.g., extent of invasion by alien species which impacts the number of species and index of biodiversity within an ecosystem; changes in air and water quality that can impact species and/or habitat quality). Doing this effectively requires changing the organizational structure of Chapter Five of the draft ROE in two ways. First, EPA should develop a working conceptualization of how different parts of the ROE can be integrated. Second, the synthesized analysis of condition should be driven by major questions about environmental problems.

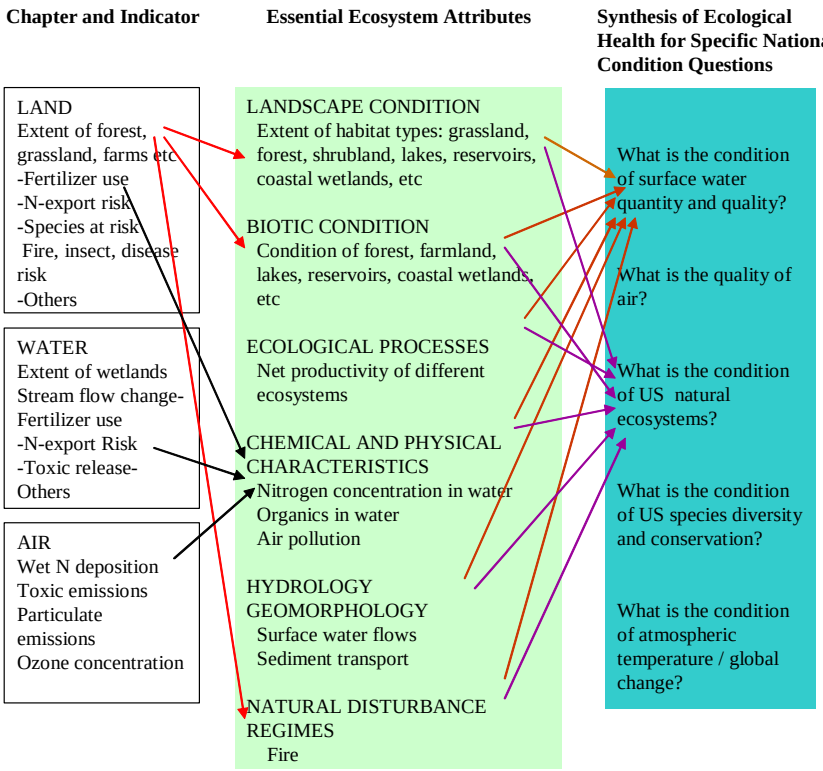
*Example of information integration.*

The synthesis of information should begin with a clear articulation of the specific goal of analysis. What question is being asked for each synthesis? It is presumed that the goal of analysis for the ROE is to describe the condition or health of different ecosystem types. This goal begs the question, "health or condition in relation to what?" The answer to this question requires defining the environmental problems of critical concern, for example, consequences of global warming, consequences of biological depletion (biodiversity loss, habitat loss), consequences of altered nitrogen cycling, etc.

Descriptions of ecosystem condition should then be expressed in terms of essential ecosystem attributes (EEA's), which are influenced by a host of variables that determine the air, water and land components of an ecosystem. The schematic in Figure 1.0 below describes a sample approach one might take to combine information from Chapters One, Two, and Three of the draft ROE in order to provide an integrated picture of the health of different ecosystem types and of the United States. The schematic provides an illustrative framework for understanding the linkages among ecosystem attributes, function, and condition and builds systematically on many of the elements already included in the draft ROE. Such a schematic, by explicitly recognizing the end goals (or questions), can also be used to identify gaps and deficiencies in current monitoring data, thereby providing a planning tool for gathering future monitoring data.

**Figure 1.0: Illustrative Example for Integrating Indicators from Ecosystem Types into an Assessment of National Ecological Condition**

Each column contains only examples, not all issues and questions are included. Arrows are shown just for a few examples. Notice that indicators related to a single location (e.g., land) can be used to assess a number of Essential Ecosystem Attributes (EEAs), and indicators from several locations (e.g., land, air, and water) can be used to assess a single EEA. Similarly, assessment of conditions related to specific aspects of ecological health involve integrating information from across several EEA's.




## 5.4 Response to Charge Question 4

Charge Question 4: The ROE focuses on indicators at the national scale. Regional indicators are highlighted in a few case studies. How useful are national indicators in presenting information on the quality of the environment? How much consistency is necessary in indicator measurements and data quality across the country? Should more detailed regional data and indicators be accommodated in a national overview of the environment, and how could these regional data be accommodated?

### 5.4.1 Key Recommendations in Response to Charge Question 4

It is the opinion of the SAB that national indicators are useful when available because they can provide a broad overview of environmental conditions. However, the SAB strongly encourages EPA to expand the use of local or regional indicators and data in the ROE when these data can provide information about national condition[1]. It would also be helpful to include

[1] The national condition is really a composite of local and regional conditions. Too much averaging tends to lose information.

more detail in the ROE on local trends and examples, as spatial averaging of air and water pollutant concentrations often produces meaningless metrics. The SAB provides the following key recommendations regarding the use of national and regional indicators in the ROE.

1. The SAB recommends that indicators in the ROE should not be limited to those for which data are available at the national level. The report appears to be more of a national inventory than a description of national environmental health examination. Much can be inferred from data available at local and regional scales. A nationally focused epidemiological approach masks important regional and local changes and impacts. By taking an exclusively national focus, potential issues may not be noticed until they become severe.

2. Additional categories of indicators and data should be further developed in the next iterations of the ROE. Indicators that are relevant on a local or regional scale, such as groundwater withdrawal in key aquifers and contaminated sediment levels in the Great Lakes, should be used to evaluate goals and assess progress toward the improvement of environmental conditions and public health at the relevant scale.

3. Approaches that could be used to evaluate local and regional data include: determining whether criteria are exceeded, evaluating data to determine whether regional goals have been met, and integrating regional goals to evaluate national progress.

4. EPA must be judicious in choosing regions from which data are to be analyzed and presented. The use of EPA Regions as frames of reference is probably arbitrary. The SAB notes that EPA has regional data available (e.g., Regional Vulnerability Assessment, ReVA), and these data should be reflected in the indicator exhibits of the ROE when they help to answer appropriate questions.

5. Spatial distribution information in the form of maps describing indicator data should be included in the ROE when possible because these are very informative. Greater use of maps in the ROE would provide important information on spatial distributions that is largely lacking in the current draft. Exhibit 1-8 of the draft ROE, which provides spatial distributions of $PM_{2.5}$, is a good example of how maps can be used to identify regional differences.

6. It is very important to use appropriate spatial or temporal averaging methods when describing indicator data. The SAB recommends that data distributions should not be averaged across individual EPA Regions. EPA should instead consider using areas like ozone urban core sites for grouping and scaling data. It is also important to use an appropriate time basis for reporting data. For example, annual averaging of $SO_2$ emissions is appropriate, but annual averaging of ozone data is not the best approach because of large seasonal variability and because averages are a poor measure of exceedence episodes.

### 5.4.2 Specific Comments in Response to Charge Question 4

*Use of regional data*

Regional (and even local) data are useful if the regions are defined appropriately. However,

grouping data according to EPA administrative region is arbitrary and should be avoided (e.g. the ozone distribution in Exhibit 1-11). The appropriate grouping or scale will differ depending upon the particular indicator. Ozone provides a good illustration. Rather than grouping ozone data by EPA Region, it would be useful to group the data by transport sites and urban core sites. Another possible approach is to present national data, and then present trends for particular hot spots (e.g., Los Angeles and Houston) and pristine areas in related vignettes to assess impacts.

Charge question 4 asks whether consistency in data quality is required. While the SAB recognizes EPA's desire to use Category 1 or 2 indicators when possible, the use of other indicators is strongly encouraged if data are available and have been reported in peer-reviewed form. This is particularly important in cases for which high quality indicator data are available at a local or appropriate regional level. The SAB encourages the EPA to use such data in the ROE, particularly where regional data could be used to draw conclusions about the national condition. The SAB is concerned that EPA has included the statement, "no category 1 or 2 indicators exist" in tables such as Exhibit 1-2 in the draft ROE *Technical Document*. This statement implies that associations between, for example, human health and stratospheric ozone depletion are not known or do not exist. It would be better for the table entry to include a statement such as "only regional (local) data available; see section ***." This could provide a reference to another part of the draft ROE.

*Data averaging*

The SAB is concerned that the extensive use of annual averaging in the draft ROE causes a great deal of information to be lost. For some indicators, such as $SO_2$, annual averaging of emissions levels is certainly appropriate. For others, such as ozone, annual averaging (exhibit 1-11) is not the best approach, since annual averages are a poor measure of exceedence episodes. It is also unclear in some cases whether reported annual averages in the draft ROE are for the entire year or for the summer ozone season only. Annual averaged ozone levels will be lower than the averages restricted to the summer months. The mean may also not be the most appropriate statistic to use if data are not distributed normally. If the data are normally distributed, one could consider inclusion of standard deviation. If the data are not normally distributed, one might report median and range with some measure of uncertainty.

*Data gaps*

The identification of data gaps and limitations is an important part of the ROE. In the draft ROE, EPA effectively identifies explicit gaps associated with the individual indicators (e.g., "ozone monitoring is conducted mostly in urban areas…"). However, as noted previously in this report, discussion of some gaps appears to be unnecessarily negative (e.g., "the indicator does not present actual emissions data; thus, it has the inherent limitations of estimates…"). This data gap could be stated simply by describing the approach used to estimate the data and referring to Appendix B. The SAB also notes that the discussion of gaps focuses on the specific indicators that are listed. It would be helpful if missing indicators also were identified. For example, in the indoor air section, the listed gaps are gaps in the reported data. Some indication of useful indicators for which data are not available (e.g. indoor concentrations of formaldehyde, $PM_{2.5}$) would be helpful.

### 5.5 Response to Charge Question 5

Charge Question 5: The Public Report is intended to summarize the Technical Document for a broad, non-technical public audience. Does the Public Report accurately and adequately reflect the technical content, including the gaps and limitations, of the Technical Document?

#### 5.5.1 Key Recommendations in Response to Charge Question 5

It is the opinion of the SAB that the draft ROE *Public Report* should be restructured. While it reflects the technical content of the draft ROE *Technical Document*, it does not convey information in a fashion that is easily digestible by the public and possibly policy makers as well. In particular, the public document reads as a distillation of the *Technical Document*. This makes the *Public Report* less useful than it could be. Rather than only containing selected examples from the *Technical Document*, the *Public Report* should also provide restructured and recomposed information in a readily understandable format. The *Public Report* could be a valuable tool to educate the public on issues identified in the report and on the relationship between human activity and the environment. The SAB provides the following recommendations for improvement of the draft ROE *Public Report*:

1. EPA should conduct an evaluation of the *Public Report* to determine:
    - What people want to know and why they want to know it;
    - What people need to know for decision-making;
    - How people want to obtain information and how they want to access to levels of detail ; and
    - When people want to obtain information.

    This evaluation will inform revision of the *Public Report.* The evaluation may reveal that improvements such as those included in Appendix C of this report would make the *Public Report* a more useful document.

2. The executive summary needs revision; there is no information in the executive summary on human health and ecological conditions in the United States – this needs to be redressed.

3. In places, the scientific terminology used in the *Public Report* reaches beyond the average grasp of the general public. The SAB recommends that EPA thoroughly review the *Public Report* to remove or define these terms.

#### 5.5.2 Specific Comments in Response to Charge Question 5

The public document of the draft ROE reads as a distillation of the *Technical Document*. The Public Document can be enhanced by providing restructured and recomposed information in a more easily digestible format. In particular, the graphics in the Public Document should be simpler and cleaner, with the data sources and caveats hyperlinked to the *Technical Document*. The SAB suggests that a graphic approach patterned after the State of the Great Lakes document might be used. This approach would involve a color coding scheme, with all indicators presented as having deteriorating (red), mixed/deteriorating (orange), mixed (yellow), mixed/improving (green), and good (blue) values. For static indicators, such as area, categories could reflect increasing and decreasing size instead of value.

The *Public Report* should do more than simplify the *Technical Report* (although even that task was not well-accomplished in the *Public Report*). It should generally summarize the state of human and environmental health today. It should also point to upcoming problems and discuss the tools used to understand the health of the planet, from molecular to ecological levels.

In developing future versions of the ROE *Public Report*, the SAB recommends that EPA identify and consider target audiences. The document must educate journalists, members of Congress, government officials, and other diverse audiences. Although the *Technical Document* can be made available on the Internet, the *Public Report* should be made available in printed form. EPA should consider including a CD with the *Public Report* containing hyperlinks to Internet websites where more information is available.

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## Appendix A: Technical Corrections and Comments on the Draft ROE

Page number

1-3: Exhibit 1-1. The method for averaging emissions is unclear (how are PM2.5 data and ozone data combined?) Were the emissions of secondary pollutants such as ozone included, or were the ozone precursor compounds used? There are many questions associated with the aggregate curve; it should be replaced with curves for individual criteria pollutants. Averaging is inappropriate here.

1-8: Exhibit 1-4. AQI is a poor measure when used in this fashion, particularly when essentially no changes were observed since 1989. Minor point – the method of plotting percentage implies error bars. Is the number of monitoring stations consistent throughout period? This figure is confusing and better omitted.

1-11: Exhibit 1-6. It would be better to show all years than two arbitrary groupings. If showing two groupings, 1982-1992 and 1992-2001 is preferred over the two overlapping periods shown.

1-14: Exhibit 1-11. EPA regions are a poor choice for spatial averaging. The method of averaging is not clear.

1-17: Exhibit 1-14. Benzene does not have a NAAQS.

1-26: Exhibit 1-22 and 1-23. It is difficult to discern differences. It is better to plot differences directly, color coded, so that regions of increase/decrease, and magnitude of change, can be readily seen.

1-34: Exhibit 1-26. The right hand side referred to as 1984 data in figure; 1994 in caption. Edit to correct value.

2-9: List URLs for the existing programs on conditions of water resources.

2-10: The examples in the side-bar of statistically-based examples really don't explain the statistical design of the programs. Rather than focus on the results, the focus should be on the actual design.

2-11: The altered fresh water ecosystem indicator combines physical alterations (streams and wetlands) with land use alterations (riparian, lakes). Does this combination of apples and oranges present a conceptual problem? Is there a consistent approach that can be taken?

How about other possible indicators? For example:

- Streams/rivers: ratio of current base flow to prior base flow
- Riparian zones: % continuous; % total area
- Lakes: % hardened shoreline
- Wetlands: % native plant species (current metric could have a wetland that was not physically altered but now totally covered by a monospecific stand of an invasive, and

not be considered as “altered”)

2-12: Lake trophic state index usually has a very specific meaning (Carlson, 1977), which includes TP, chlorophyll a, and transparency. Given the focus on TP here, the use of trophic state index may be confusing. Might also note the possible limitations of using TP, how often and where samples are taken, and pros and cons of other parameters.

2-14: Coastal wetlands should also include Great Lakes coastal wetlands; the ca. 1500 Great Lakes coastal wetlands totaling ca. 17,017 $km^2$ were ignored in the document. It seems as though the document was written in the year 2000 and then quickly updated with a few citations in 2001 making it very much outdated for its content. Huge leaps regarding these topics have been made in the past 4 or 5 years. For example, the U.S. EPA established a national bioassessment of wetlands working group (BAWWG), much of which deals with establishing standardized protocols for inland wetlands. They also established the Great Lakes Wetlands Consortium dealing with establishing standardized protocols for measuring the status and trends of Great Lakes coastal wetlands:

http://www.epa.gov/owow/wetlands/bawwg/
http://www.glc.org/wetlands/
http://www.epa.gov/waterscience/biocriteria/States/wetlands/wetlands0.html

2-17: The figure is not very intuitive about how gains (especially) and losses are partitioned among the reasons.

2-18: Section 2.2.3 recognizes the role that chlorophyll plays in SAV growth and distribution. Unfortunately, as indicated in the Chesapeake Bay SAV synthesis, suspended solids play an equally important role in many systems. Omission of this fact from the discussion and is a serious shortcoming in the discussion. Furthermore, an indicator for suspended solids is necessary to describe the condition of the water clarity.

2-19: The figure needs more explanation for depth of measurement; possibly use SAV cover as an indicator (based on remote sensing or aerial photography data).

2-19: The water clarity indicator is taken from the EPA Coastal Condition report. There are serious problems associated this indicator and it should not be used in its current form. In fact, the use of the indicator is qualified by stating that “the indicator does not account for naturally turbid conditions” and “low light penetration conditions are not necessarily associated with impaired aquatic health”. After seeing this qualifier, one is left questioning the value of information in the report.

The problem is not with the indicator but rather the parameter used as the measure. It is not always possible to use the same level of parameter on a national scale. This is a situation where a regional or even a local value is necessary to develop the indicator and then the local indicator is aggregated up to a national scale.

2-20: The dissolved oxygen (DO) indicator is taken from the EPA Coastal Condition report.

Dissolved oxygen is a valuable indicator however the values employed to develop the indicator are inappropriate for use on a national scale. Bottom DO varies depending upon the degree of vertical stratification and time of year. It is widely recognized that in waters from the Chesapeake Bay north, summer bottom DO should not fall below a site-specific value of between 3.2 and 3.8 mg/l. This range of values protects aquatic life and is considered safe for resident biota. Bottom water in the Gulf of Mexico can actually be a little lower and still be safe for resident aquatic life. It is misleading to rate waters in these areas less than "good" when they are below 5.0 mg/l but above the appropriate value. As with clarity this indicator should be developed at the regional level and aggregated up to the National level. Once again, this indicator was qualified by stating that "The relationship between threshold values and effects on aquatic life is neither well established nor expected to be consistent." Statements such as this undermine the credibility of the ROE effort and such indicators should be modified or not presented at all.

2-20: Another data gap would be time of day for sampling, as DO exhibits a strong diel pattern.

2-21: Referencing the 15 ppb chlorophyll level as "equal to the restoration goal recommended for SAV restoration in the Chesapeake Bay" is inappropriate and not consistent with the goal recommended by the Chesapeake Bay program. The value of 15 ppb was taken out of context from table in Batuik, *et al.* (2000). The table states emphatically that the recommended criteria for SAV restoration is a specific percent light penetration at a site-specific restoration depth. Chlorophyll levels necessary for SAV growth are site-specific and depend upon a combination of suspended sediment and chlorophyll values that enable the necessary percent light penetration at the site-specific depth of application. Furthermore the site-specific light penetration value and associated parameters are growing season averages. The draft ROE and the National Coastal Condition Report from which this data came does not indicate whether growing season averages or raw data scores were used. Therefore it is not possible to determine if the data correctly match the appropriate duration period.

2-22: There is a disconnect between the figure and text; do the data deal with ocean or coastal systems? Chlorophyll is not indicative of species composition, so harmful algal blooms (HABs) may be missed.

2-23: Additional considerations - eutrophication. The desired indictor is certainly desired and necessary however the presentation of the indicator as shown in the draft ROE does little to further it's development. The use of static measures on a seemingly arbitrary scale needs to be revisited and the indicator further refined. The document does qualify the indicator, raising questions about its use here. As correctly noted, "High scores may not be a true measure of eutrophication". It is also pointed out that "there is no strong scientific data to indicate that the thresholds used are indeed indicative of eutrophic conditions on a region-by-region basis." It may be possible that trend data may be more appropriately used here to show an increasing or decreasing trend rather than some arbitrary static measure. It is strongly recommended that the Agency develop this indicator further before incorporation into the future ROE.

While this section discusses eutrophication, the reference to "these conditions" including sea grass decline needs the additional parameter of suspended sediment in order to fully capture the

causes of SAV decline.

2-24: It seems that the differences between urban and agricultural pressures are also due to the activities associated with each land use.

2-25: a) The name of indicator may not be representative—perhaps "urban/developed land cover" would be appropriate. b) Why restrict this indicator to riparian buffer strip? Increasing urbanization or developed land cover has impacts throughout watersheds in terms of storm runoff and nonpoint source pollution. c) Wouldn't percent change over time be a better metric, assuming there are consistent baseline dates available? d) The spatial arrangement of the buffer zone (either what is left intact or removed) should be considered—contiguous zones vs. patches can affect efficiency of riparian zones. It is not just simply how much, but how it is arranged.

2-26: Similar concerns to above. Why limit agricultural land cover to just riparian zone? Perhaps change detection over time would be a better indicator. Consider refining the agricultural land indicator to type of agricultural land use. Perhaps subdivide the indicator by relatively broad categories, such as row crops, Concentrated Animal Feeding Operations (CAFOs), etc.

2-29: Sedimentation index. How often were samples taken per stream? Were these one-time grab samples, integrated over time, do they include storm events? More information is needed to assess the indicator.

2-31: Atmospheric N deposition. It may be of use to note that although the absolute deposition rate is potentially useful, the percent of total N that is supplied by atmosphere is also important. A low rate in a very low N system may be of greater concern than a high rate in a very high N system.

2-32: Nitrate concentrations. It is unclear when surface water samples were taken, how often, and whether they include storm events or are base flow.

2-34: P also can be very important; the ROE should not focus exclusively on N in estuaries (see Smith, 1998 Pages 7-49 in: Successes, Limitations, and Frontiers in Ecosystem Science, Pace and Groffman (editors). How often were samples collected for this analysis? This section should be cross-referenced to page 2-37 indicator (TP in coastal waters).

2-34: The section on total nitrogen in coastal waters includes Mid-Atlantic estuaries as well as near shore coastal waters. The use of arbitrary percentiles of distributions without regard to site-specific issues is misleading. EPA recognizes that each estuary reacts differently to nitrogen concentrations. The same nitrogen concentration would have a greater impact on water quality in the Chesapeake Bay than it would in the Delaware River. A more technically defensible approach to this dilemma would be to use a regionally derived end-point indicator (such as DO) for evaluations of good or bad, and then use trend data for the nutrient concentrations as warning signs to indicate whether the situation is getting better or worse. This is the approach being employed in the Chesapeake Bay. It provides more meaningful information and avoids the subjective and site-specific issues of quality.

2-36: P in large rivers. It is good that sampling frequency was included, but the threshold for goal for impairment is too high.

2-38: Sediment toxicity in estuaries. The indicator of sediment toxicity should be associated with the cause of toxicity. The references used contain information that can identify the causes of toxicity, including artificial toxicity due to sample manipulation and handling. It is not clear from the draft ROE how artifactual toxicity data was accounted for. Subdividing the toxicity by cause would provide invaluable information to the public and decision makers and improve the utility of the ROE.

2-39: Hg. it is not clear how often data were collected, how many samples, variance, etc. in the data shown.

2-40: The chemical contaminant data shown reveal nothing about absolute concentrations; shouldn't there be an explanation about a threshold or criterion that must be exceeded? Are these based on predicted environmental concentrations (PECs) or dose compliance concentrations (DCCs)? Do they exceed drinking water standards? Also, could these data be shown as trends from '92 to '98?

2-41: Pesticides in streams and groundwater. Detection does not necessarily translate into hazard. Why not use human health standards for the limits? Why use 0.01 and 0.1 ppb standards?

2-43: This seems like an indicator that should be cross-referenced to the air emission chapter (for $NO_x$ and $SO_x$).

2-44: Toxic releases. This is a good example of how the metric may be quantifiable, but without more spatially explicit information, the data can be misleading. Even if overall release levels decline, unless those declines were proportional among all sites and regions, it is likely that certain areas may be getting worse even if overall trends are better. In addition, we may be reducing in areas that have gross release rates, but still not meeting ecosystem needs (similar to losing weight in obese people---first few pounds are easy to lose, but unless you lose a lot the overall health of a person may not be demonstrably improved).

2-46: Sediment contamination. There is nothing included on Areas of Concern in the Great Lakes. Lots of EPA information are available and should be included.

2-47: Sediment contamination of coastal waters. This report should recognize that for many older cities sediment contamination is largely the result of historical practices and activities. There are numerous studies in regions such as the San Francisco Bay and the Elizabeth River in Virginia that demonstrate vastly improving trends in sediment quality. This data should be mined and the appropriate indicators developed to capture these trends.

2-53: Recreation in and on the water. This section discusses a number of sources of pathogens in recreational water but leaves off waste from domestic (urban pets) animals and wildlife.

Studies from TMDLs are showing that animal waste is a major source of indicator organisms in all waters. That animal waste is originating from wild life (sea birds, deer, etc) as well as domestic pets.

2-54: Section 2.4.2. What are the sources of recreational water pollution? It would be informative to note in the text that the sources identified and listed in this section account for only 25% of the total reported cases.

2-56: Consumption of fish and shellfish. It would be useful to point out in this section that the mercury body burden of some marine species such as swordfish are natural and, according to studies cited on the University of California at Davis web site, have been stable for 100 years.

3-3: Paragraph four: Change "a function of human needs and population density" to "a function of human needs, wants, and population density."

3-3: Exhibit 3-1. In the figure caption, the line is labeled with the units "per acre mile," which cannot be an accurate measure.

3-4: U.S. population density map. This is a critical figure. Consider putting this figure in the introduction. This map should be the focal point for many analyses within this chapter. (Is there a map with changes in population density to see the drivers of change?) When phrasing the idea of "regional" analyses, the draft ROE mentions EPA Regions as the regional unit. Please use the resolution of the data to guide the definition of regions, and if the regional indicator can be displayed over the entire United States, use this map as the basis for the indicator because population density ultimately is the key driver for many environmental conditions (but not all).

3-4: Exhibit 3-2. There's nothing wrong with this map, but it should be accompanied by a comparable map that shows the rates of change in population density. Data clearly show that the fastest rates of change have consistently (since the early 1800's, in fact) been in the West, a point that gets lost if only the static measure of density is presented.

3-5: Exhibit 3-3, list of indicators. With the tabular listing of the indicators, please include a column that references the page upon which it appears. This helps guide the reader through a long document. As has been mentioned previously, considerable revision is needed in the questions asked and indicators selected. It matters where the different ecosystems types are located, what their quality and size is, and what the adjacent ecosystem types are.

3-7: Text indicates that indicators were not identified for protected lands. Future ROE versions should be able to find indicators for both the extent and quality of protected lands by integrating data available from many of the sources in the box on protected lands on page 3-8, as well as non-government organizations such as World Wildlife Fund, The Nature Conservancy, the Wilderness Society, the Land Trust Alliance and the National Parks and Conservation Association. Most state governments and NGOs also have reports on the status of public and private protected lands.

3-8: The box on protected lands should acknowledge that protected legal status does not always

mean protection in reality. Conservation easements often only protect private land from major development, but do not restrict uses that can significantly degrade water quality and biological resources. In addition, the lands put under conservation easement are often already significantly degraded from a biological and ecological perspective, so the easement only conserves scenic views.

3-9: Urban –suburban. There is no getting around the fact that land use categories ranging from urban to wilderness is a continuous gradient and that definitions are arbitrary. Definitions of suburban vary and recognition and discussion of the ones used, as on this page, is good. For land cover and fragmentation very low density (1 house/40 acres) is an increasingly used and important category. Although there might be little to do in the short term, the long term goal should be to classify land use along a continuous gradient of human use density (e.g., land in row crops is as dense as suburban in terms of habitat loss).

3-10: Dot map of metro area boundaries and central cities, NRI. This does not add much beyond the map on page 3-4. The map on page 3-11 (change) is the one that is useful.

3-12: Extent of urban / suburban lands. It seems that the $1km^2$ pixel area as the minimum mapping unit for suburbs used in the Heinz report will miss capturing low density housing on a major scale. The age of this data is problematic. Perhaps data from the U.S. Census Bureau that would indicate the density of housing could be mapped.

3-14: Extent of croplands. This graphic is a little odd in that the dots suggest something like point occurrences or towns, whereas this really indicates regions of nearly continuous agricultural land. Please consider alternate mapping form, although the map and the information are good to use.

3-15: Change of extent of cropland, pastureland, CRP. This graphic shows little change, yet there has been a massive shift away from pastureland in the eastern tall grass prairie region of the Midwest that has resulted in a strong decline in grassland associated birds of this region. This is the type of national indicator that misses critical changes. Mapping change in pastureland by county would be ideal. A spline fit of the change that was then mapped as isoclines would be nice.

3-16: Percent change in cropland. This is a great map. The report needs more like it.

3-17: Cropland extent. Surely the USDA has county level statistics on row crop acreage. This would be a variable indicator that changes because of changing cropping patterns and farmland economies, but it would still be a good indicator of an important variable in land use because row crops receive so many more chemicals than pastureland.

3-18: Extent of Grassland Shrubland. This says relatively little regarding extent or condition. The graph is overly complex; stacking the bars would suffice and allow you to assess this at different time periods to denote change. In capturing trends in the extent of the categories, this would be strengthened by a geographical presentation, as there are ecoregions where this is likely to be more important than others.

3-19: Forest extent. Regional information on amount of forest is fine, and would be even better if there were graphed data for more than one time. The text talks about the change in forest acreage since 1987. It would be nice to show what regions that has occurred in. It is not clear why public vs. private ownership matters. Inclusion here seems to imply that there is little the government can do to protect forests since so much is privately owned. Exhibit 3-10 in current form does not bring added value and should be deleted.

3-20: Exhibit 3-11. This figure also does not improve understanding of forest extent or quality and should be deleted. Data on the amount of timber that is certified as being sustainably harvested from public and private land would be of greater value in terms of indicating potential environmental impacts in forests.

3-20: Timber harvest. If timber harvest is disaggregated by forest types, even hardwood vs. softwood, interesting trends can be observed as U.S. timber harvest increases in softwoods and decreases in most hardwoods.

3-20: This section requires an indicator on the extent of change, or status of change of plant community types (habitats) at risk. The USDA has reported on this (Reed Noss, author). NatureServe (contact Denny Grossman) has plant community threat ranking information that would be useful here as well.

3-21: Section 3.1.5 - Human health effects associated with land use. This section is weak. For example, trends in work related health problems in the agricultural and forestry industries would be a good indicator. It may not work for this report, but it would be an indicator. So, EPA should think more about the question, in the broad sense, then write carefully about why what we might think of as indicators do not work for this report. There should be a section like this for each land use category.

3-21: Section 3.1.6 - Ecological affects associated with land use. There should be a section like this for each land use category. This has a very specific introduction that suggests that sediment runoff is a good indicator in general for this. It is a good indicator for agricultural land. Thus, this should be a subsection of agricultural land.

Other good indicators:
Agricultural Lands:
- Change in sediment run-off potential (as presented)
- Change in acreage of organic farms (USDA)
- Change in streamside buffer strips
- Change in fertilizer / pesticide sales (as a measure of application)

Grasslands
- Changes in leased acreage or total stocking of federal grazing lands (Bureau of Land Management [BLM] and U.S. Forest Service [USFS])
- Changes in invasive species spread, or acreages infested (BLM and USFS)
- Changes in grassland-associated bird populations (Breeding Bird Survey [BBS]; see papers by J. Herkert on this issue.)

Forests:

Changes in patch size (L. Iverson; USFS, Delaware, OH may have statistics, may have published them.
Changes in stocking rates of trees (FIA)
Changes in number of acres listed as fire hazards (USFS)
Population trends in forest associated birds and neotropical migrant birds (BBS).

3-26 and 3-27: Exhibits 3-15 and 3-16. Some consistency needs to be developed in how data are presented. There is no logic in presenting some data as histograms and others as line graphs. Exhibit 3-16 should be changed since it implies what the values would be for 1992, 1994, and 1996, which are not actually known.

3-27: Exhibit 3-16. Printing the cumulative % change is misleading. This is a % change from 1991, but could be interpreted, if not read carefully, to imply and increasing rate at which this is decreasing. If anything, this should report the time interval % change.

3-28: Agricultural pesticide use. This is a good indicator, but one has to be very careful here in that a change, up or down, could reflect changes in environmental management or impact, but could also mask effects if the response unit is pounds and the dose changes between chemicals (i.e., switching chemicals for a control may alter the pounds, or the impact per pound). That problem is difficult to solve.

3-31: Pesticide residues in food. This is an important indicator and would benefit from graphic presentation.

3-33: Potential pesticide runoff. Is there an indicator available that does include fruits, nuts and vegetables? There are parts of California, Florida, Michigan and elsewhere that would be wholly misrepresented because they focus on something other than the big grains (Napa valley and grapes, for example). It would be excellent if the text could include a few actual pesticide runoff values and compare them to the potential values to help the reader take the potential estimates seriously. The text should explain why a potential impact is being used here (and in exhibits 3-20 and 3-21), while most of the report is focused on actual values (e.g., because the issue is so critical and actual data not available at national scale).

3-37: Section 3.2.5 - Human health effects associated with toxic substances. Organizationally, EPA should put this under Agricultural land. Data from poison control centers appears to be an indicator. Why not treat it as such?

3-37: Persistent bioaccumulative toxic chemicals. EPA has missed a couple of very important data sets here. First, it is important to track eggshell data on birds that were susceptible to DDT (e.g., peregrine falcons). Joel Pagel (USFWS, Los Angeles) would know where these data are. There is also data on bioaccumulation in marine birds and mammals from Alaska. There is probably more elsewhere. Keith Miles, University of California at Davis knows about these data.

3-38: Nitrogen runoff from farmlands. This section seems to get disorganized. Creating a

similar construct to Chapters One and Two should help. Doesn't EPA track data on factory farms (concentrated animal facilities) and their pollution exports? This would be a good indicator here. Not capturing the rise of the concentrated animal facilities and discussing pollution concerns regarding them is an obvious omission from this report.

3-40 and 3-41: It was difficult to determine which type of waste includes automobiles.

3-45: Exhibit 3-28. Aren't there data on this metric from before 2000? A trend on this would be as interesting as a static measure.

3-47: What is the extent of contaminated lands? It would be helpful to see a geographic presentation of where contaminated lands are. The lack of a treatment of contaminated groundwater is an obvious omission. Something should be said about it.

3-49: The superfund information. This implies that we are getting a good grip on superfund sites. One would wonder if the problem is getting better or not because we could be generating new superfund sites at a rate that exceeds their rate of cleanup. While there has been good control on this, it would be useful to report on the year(s) of superfund creation to show that the development of new superfund sites is on the decline.

3-52: Exhibit 3-31. This interesting exhibit demonstrates the variation that can occur when data come from different sources; some of the estimates from different sources are very close while some are very different. It helps the reader understand the challenges in preparing this report. Similar comparisons for other ecosystems or issues could be included in the report.

3-52: This says that data on protected lands of different types and levels of government do not exist. The data likely exist, but have not yet been integrated in a format that is readily useful to EPA.

5-12: Extent of area by forest type. There are classifications by type, and assessments of area by type. Here EPA aggregates by type and lumps everything uncommon into "other". It may be better to capture "other" and try to detect which of the low abundance types are declining.

5-14: Forest Pattern and Fragmentation. The program FRAGSTATS is used specifically to look at attributes of fragmentation and has been applied by USFS researchers on US forests. Contact Louis Iverson (USFS, Delaware OH) for details.

5-15: At risk native forest species. "Too little is known about plants" is not really accurate. No one has aggregated the data, but habitat associations for all plants are, in fact, known. The Biota of North America Project (BONAP, John Kartesz) manages the floristic database for NatureServe rarity rankings. They may have this habitat information. Certainly, this can be done by region. Also, why not use the United States endangered species list is for part of this?

5-15: Exhibit 5-8. This does not tell us much. Try for a geographical presentation of the distribution of rare species.

5-16: Exhibit 5-9. This needs to be labeled "change in diameter class sizes for representative forest species". Also, it is quite unclear.

5-18: Exhibit 5-11. This is a good indicator. Can EPA go back and distinguish stress due to pollutants from climate, disease and others?

5-19: Exhibit 5-12. Ozone injury. Even bad ozone problems would not manifest much in some areas owing to lower industry. Mapping damage would be the ideal. For example, damage is probably highest downwind from major industrial cities. This is good, but would be better with a map of the response.

5-20: Carbon storage. This, of course, makes the most sense as an indicator with global change. It is essential to deal with climate change. This is also an area where an international comparison is possible.

5-21: Soil Compaction. It would be ideal to restrict this to forests that are actually harvested. Alternatively, compare harvested and unharvested stands. This is the sort of indicator that requires some comparison to background expected. This comparison probably would show forests to be in good condition, but it is hard to interpret without some context.

5-22: Soil Erosion indicator. The indicator seems like a good idea. However, given the data limitations, this isn't worth reporting because EPA claims it misrepresents forested lands. EPA should try to use some estimate of error, report that, and provide details about the error estimate in the appendix B. Alternatively, EPA should decide it isn't reliable and discard it. It seems that this should be presented under "Forest Condition", as should all measures using forest health monitoring (FHM) data.

5-23: Processes beyond the normal range of variation. Although the idea of this indicator is sound, this does not tell us anything. If related to climate change, then it might have some import. As it stands, it seems out of place.

5-24: Landscape condition. The text states that "…although the acreage of some of the types of forests have changed, none are currently at risk of being lost." This is strictly true of the data presented, but badly misleading. Certainly there are forest types that are at risk of being lost (See NatureServe data). Since EPA lumps all rare types, EPA only assesses exceedingly common ones. This is a bit like surveying fast food restaurants to see how often they go out of business; create McDonalds, Burger King, three others and lump every independent restaurant into an "other category". The answer would be that no one ever goes out of business, which would be erroneous.

5-24: Biotic condition. EPA reports that no reliable data set exists on forest stream biota. This seems very odd. Certainly there are many indicators of biotic integrity, from the endangered species list to the NatureServe rankings. "Precious Heritage" has published lists of the fraction of species at risk. These data clearly show that aquatic organisms, in general, are in rough shape. To report that there are no indicators available for forest streams seems to be an overly narrow slice of the pie. If EPA reorganizes to create biodiversity measures by region, by taxonomic

group, or nationally, EPA would not be boxed into these kinds of statements that, while strictly true, are uninformative and misleading.

5-25: Farmland Landscapes. EPA is assessing ecological condition of a landscape here. This is very different from other sections where EPA assesses condition of an ecosystem. This section will require indicators of pastureland change and forest fragment change and condition. One approach would be to create a set of polygons around regions that are dominated by agricultural lands and then assess landscape condition and biotic condition in these regions. That would require de novo analysis.

5-26: Right column, 2nd paragraph "Unfortunately, there is no single, definitive, accurate estimate of the extent of cropland." That seems to be a weak excuse. There are many. They vary for sensible reasons. EPA should choose one, justify the choice and use it.

5-26: Why not map the nitrogen leaching into groundwater? EPA has a map of groundwater leaching potential that can be used.

5-29: Exhibit 5-17. Despite the fact that soil quality index (SQI) scores from 1994 and 1995 were calculated using "different calculation procedures and sampling variability" sampling variability suggests that EPA can estimate a confidence interval and compare the two. Given that this is just one year, any trends are likely to be insignificant. Thus, this reads as if it is due to index calculation. The differences between these years are large and consistent. Pick one year and report it. Otherwise, this just lacks credibility. Frankly, many read as if they were written so as to best minimize credibility and that is disturbing.

5-31: Near bottom, right column. "… Agricultural lands …highly managed, ...no natural reference exists." The point is not a natural reference; it is trend in condition data. This is not a sufficient justification for a lack of indicators.

5-32: Grassland / Shrubland indicators. EPA identifies stressors (non-native species, desertification, groundwater depletion, overgrazing). There are indicators of all of these. They are likely to be either regional, or require assembly and analysis on a national level. Look beyond the Heinz report to USDA, USFS, BLM statistics.

5-33: The table on page 5-33 is somewhat misleading. It argues that we need more data, but it also fails to get at data that really do exist, just not previously published in a national report.

5-34: At risk grassland species. As in animals, there is better data. BBS can identify grassland birds and EPA could examine trends in those species. NatureServe could also identify grassland-associated species (perhaps even plants using Biota of North America Program [BONAP]) and do a better job.

5-35: Declining birds. EPA misses an important interpretation here. Although native and non-native birds aren't really doing anything different (except for the latest time period), grassland birds have been markedly declining since the 1980's. That is an important trend that probably reflects the concentration of animals and the loss of pastureland regions.

5-37: Ecological condition of urban / suburban areas. See R. Primack on plants in New York City and regions. See R. Blair on birds and butterflies in San Francisco. The Baltimore and Long Term Ecological Research Programs (LTER), the urban to rural gradient in New York City, and other individual studies provide a means to assess ecological condition within selected urban environments.

5-38: Summary on urban indicators from previous chapters. The three final bullet points on the right are reported in a funny way. What is the minimum acceptable nitrate concentration, 0.1? If so, then 97% of the 21 urban streams failed. If the phosphorus concentration is 0.1, 67% failed (why use "two-thirds" here and 40 and 25 percent above if not to underplay the large number?). For contaminants, 85% or 100% failed, depending on our standards, which aren't reported. This is a compelling case that urban surface waters fail our standards for water quality. Don't sugar coat it.

5-38 to 5-40: Index of Biotic Integrity (IBI) indicator. The report correctly identifies that expected biotic diversity in urban streams is lower than for other traditional free flowing streams. However the IBI scores for all systems were aggregated into one indicator. This aggregation results in a loss of valuable information that could be used to demonstrate the potential adverse relationship between urbanization of the landscape and the loss of biologic diversity instream. The aggregation can also be interpreted as indicating that those urban systems could be restored to the level of diversity that they had before development. It is recommended that an indicator be developed to measure the shift of streams from natural to urban (such as the % of stream miles as urban) and then segregate the IBI score indicator by stream types. This combination of indicators would provide data on the loss of streams to urban encroachment and the associated loss of diversity as well as provide a measure of the relative health of each type. For example, what percentage of urban streams had good or bad IBI?

5-39: Exhibit 5-23. Patches of habitat within urban lands. EPA's interpretation under "what the data show" contains a logical error. The "large" bar is taller in the Northeast than others, but these are percentages of "natural lands." Let's say that the Northeast has no natural lands, but those that exist are big (Meadowlands, Central Park, Jamaica Bay). The result would be that a relative high proportion of these would be large, even though other regions had more large areas, and more small areas (San Francisco, for example). So, it may be better to express as acreage and not a proportion of the regional total.

5-40: Top left: "…but their overall condition, nationally or even regionally, is virtually unknown." This is just wrong. We know more about urban areas than most. The data are just varied and scattered.

5-42: Right column - "Urban development accounted for an estimated 30% of all wetland losses….". The report would benefit from an indicator of trends in wetland losses in urban and other areas over the last few decades.

5-43: Top left - Dams, impoundments. There may not be readily available published figures, but there are estimates. The data on what proportion of lakes are oligotrophic lacks meaning

because we do not know what we should expect. Is this high or low? Why not use the EPA data on impairment?

5-45: Extent of ponds, lakes and reservoirs. This is out of place and belongs in the extent portion of chapter 2, but is also a bit of a nonstarter in that lakes and reservoirs are not to be equated, and that error rate relative to the other data EPA reports is 100% (indicator gaps and limitations).

5-46: At risk freshwater native species. Use the NatureServe data by taxonomic group. Lumping them together gives an unrealistically favorable impression of the condition of aquatic biota because of the large number of some groups of species with relatively low risk. A large number of these groups are very threatened, but contain fewer species, and this simply misses this obvious point.

5-49: At risk freshwater plant communities. Once again, NatureServe has better data. The USDA (Reed Noss, lead author) reported on this a few years back.

5-52: Landscape condition. The Heinz report may have declined to pick any one of the several acceptable methods for stream classification. Nonetheless, they exist and EPA should pick one and use it.

5-52: Left column. No fish caught in 16% of streams. Is this an indicator, or do we not expect to catch fish in these streams? EPA's next report should make this determination.

5-53: Oceans. Look to the Pew Oceans Commission for new indicators on the state of the Oceans. This is an area where EPA can compare U.S. ocean waters to International waters.

5-57: Coastal Living habits. Coral Reefs. There is an abundance of reef information. Check "Shifting Baselines." They have a website with resources (www.shiftingbaselines.org). There is good data on Pacific estuaries and invasion by S*partina* and *Caulerpa* and seagrass beds in Southern California, as well as invasion in transportation bays, such as San Francisco Bay through ballast water. There is an abundance of knowledge on habitat loss in nearshore environments along the Pacific. Knowledgeable people are concentrated at the Bodega Bay Marine Lab (Don Strong, Susan Williams, Ted Grosholz,…), although others exist. Their reports are peer reviewed and published. Similar studies have been done on the east coast. This comment applies throughout this section.

5-64: Ecosystem condition of the nation. Here is where EPA misses the opportunity to use many good indicators. EPA mentions neo-tropical migrants in the introduction, but then does not analyze the Breeding Bird Survey data on them. Why?

5-69: Exhibit 5-42. Please consult the authors of the original data on this figure. It does not make sense. The figures a-c, at a glance, are virtually identical (aside from the pacific ~1998). We expect growth to vary with climate, but we don't expect climate to be uniform across the continent. We expect normalized difference vegetation index (NDVI) to vary because of cloud cover or other instrumentation errors, but we hope to minimize those. So, what drives the very

similar patterns across regions? If they were a continuous trend, that would suggest a driver. This variability makes one suspicious of whether or not it is real.

5-72: It is good to see the report attempt to synthesize all the information presented for each of the six Essential Ecological Attributes into some assessment of the national condition for that attribute across all ecosystems (although no data is presented for two attributes). It would be great if Exhibit 5-44 on page 5-75 did not merely have indicator categories in each box, but instead had some assessment of condition in each box.

5-72: Biotic condition. This section is unfairly disparaging. There is a wealth of information available that was not used in this report. We know considerably more than this report suggests, and the biotic condition of most systems is considerably worse than this report suggests.

5-74: Vertebrate deformities. Isn't there data on eggshell thickness and birth failure in large birds (pelicans, eagles, peregrine)? These would all be non-target effects. There are likely lots of case studies of non-target effects of herbicides and pesticides.

5-76: There are figures on the estimate rates of harmful algal blooms through time. Why aren't these used?

## Appendix B: Specific Comments Referring to the Draft *Public Report*

A major deficiency in the public document is the lack of qualifying language for some of the indicators. The technical deficiencies in the National Coastal Condition Report that were outlined previously in Appendix A should be explained. The *Technical Document* did provide qualifying language concerning the limitations of those indicators. Unfortunately the qualifying language was not included in the *Public Report*. The *Public Report* therefore presents an inflated sense of the accuracy of these indicators. Lack of qualifying language for these indicators is a serious omission.

Page number

i: Executive Summary. The report does not meet one of its stated purposes, communicating how to better "manage for environmental results". SAB does not think that the report should focus on this issue.

ii: The cleaner air summary has too much focus on how quality has changed, and not enough description of what our current air quality is.

iii: The average reader will not understand the opening statement; that we know a great deal about the condition of water at the regional, state, tribal and local levels, but we don't know the national status. The average person would ask why?

iv: The opening box summary talks about EPA's role in protecting land, and not about the status of land (in contrast to the air and water opening boxes). The report should not talk about EPA's role here.

x-xi: The *Public Report* could use lots of graphics like exhibit I-2, that puts data in a geographic context. Unfortunately, with the exception of the Great Lakes pie chart, the data presented on these two pages have nothing to do with the maps on which they are placed.

1-2: The section opens with the question "how clean is the air we breathe?". The apparent answer "cleaner than 3 decades ago", does not answer that question.

1-6: Pollution is not only impairing visibility in national parks; it affects visibility in cities too.

2-6: Overall Condition of estuaries and Great Lakes. This presentation used the results of the National Coastal Condition Report that had numerous qualifiers concerning the accuracy of the indicators as true indicators. The absence of any of this language in the presentation of the report seriously undermines the credibility of the *Public Report*.

Pg: 2-7: Dissolved Oxygen and Clarity. The manner in which these indicators were developed undermines their utility as indicators of "good or poor" conditions. The Technical report actually provided information about this shortcoming, but the omission of the DO and clarity qualifier in the *Public Report* calls into question the objectivity and utility of this report.

Pg 2-11: What are the ecological effects associated with impaired waters? This section deleted the discussion in the technical report that recognizes that urban waterways have reduced diversity due to their very nature, and that it is unreasonable to expect urban waters to have fish and benthic diversity comparable to more pristine waterways. The *Public Report* missed a valuable opportunity to educate the public about the impact that urbanization has on aquatic systems. Prevention is the key to this problem and this discussion could have played a major role in that activity.

5-5: Seems like the draft ROE is "mixing apples and oranges". For most ecosystems, the focus is on area of overall system, but for coastal the draft ROE includes biotic elements (SAV); this could create confusion due to lack of consistency.

5-6: column one has switched from ecosystem type to land cover type; was this intentional? Why are wetlands broken out from fresh waters in this table, but aggregated with it in text?

5-7: Define what is meant by imperiled or critically imperiled. Does this have a quantitative component?

5-7: Biotic Condition . The EPA missed an invaluable opportunity by not providing a discussion of the status of fish stocks and the role that fish stocks have on water quality. The Essential Ecological Attributes currently focus on the role of human management activities have on water quality through the alteration of the physical and chemical aspects of the environment. However it is well established that human management of the biological systems (fisheries) has a role affecting water quality. Reductions of filter feeders and grazers though harvesting adversely affects water quality, and this role needs recognition in the ROE. The *Public Report* provides an excellent opportunity to educate the public as all aspects of the environment and our impact on it.

5-9: Consider using ppm instead of mg/L - it is easier to understand for lay audience.

5-10: Use a figure to explain role of solar energy instead of text.

5-11: Exhibits 5-7 and 5-8 should be better coordinated to use same scale of units, and with better explanation of what yield and load mean. Load, in particular, can confuse the general public, so care must be taken to differentiate that high loads may be due to discharge, concentration, or both. Is the high load in the Mississippi because of its discharge or disproportionate concentrations?

5-18: The parallel with GNP or a similar macroeconomic index is not yet appropriate. To have a macroecological index, one would need to aggregate at a higher level than is being done here—perhaps take the individual indices for each ecological condition and sum, or weight appropriately, to develop an entirely new index.

## Appendix C: Suggested Improvements in the draft *Public Report*

An evaluation of the *Public Report* may reveal that the following suggested changes would improve the document.

1. The *Public Report* could be shorter in length; where appropriate, the report could contain hyperlinks to the *Technical Document* or relevant URLs that provide supporting information. The supporting text may not have to be in the *Technical Document* itself.

2. The graphics in the *Public Report* may not have to be drawn only from the *Technical Document*. Graphics in the *Public Report* could be simple and user-friendly. They could involve color-coding (assigning colors to relative state of health), reduction of text in graphics, and making graphics map-based. Examples of useful approaches that could be considered by EPA include the State of the Great Lakes (Environment Canada and EPA, 2001, 2003) and Reefs at Risk (Bryant, Burke, McManus, & Spalding, 1999) reports.

3. Where possible, information in the *Public Report* could be presented in a spatially distributed fashion. The use of national maps, with blow-ups of information within specific regions, could be very useful. It may be useful to strike a balance between providing enough data to make graphics informative, but not overwhelming readers with too much data. If done well, the graphics in the *Public Report* can provide a quick overview of national status and also allow readers to see how their regions fit into the national condition.

4. In developing future versions of the ROE *Public Report*, EPA should identify and consider target audiences. Some of these target audiences may include: journalists, members of Congress, government officials, and other diverse audiences. Although the *Technical Document* can be made available on the Internet, the *Public Report* could be made available in printed form. EPA could consider including a CD with the *Public Report* containing hyperlinks to Internet websites where more information is available.