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

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**SCIENCE ADVISORY BOARD**

September 24, 2009

EPA-SAB-09-018

The Honorable Lisa P. Jackson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Subject: Science Advisory Board (SAB) Advisory on EPA's draft *Guidelines for Preparing Economic Analyses (2008)*

Dear Administrator Jackson:

EPA's National Center for Environmental Economics requested that the SAB review EPA's draft *Guidelines for Preparing Economic Analyses* (2008). The *Guidelines*, originally issued in 2000 and recently updated, represent Agency policy on the preparation of economic analysis required by legislative and administrative mandates and are intended to provide technical guidance to analysts on the economic analysis of environmental policy. The SAB Environmental Economics Advisory was impressed with many facets of the updated *Guidelines*. We applaud EPA for a number of carefully revised chapters and substantively improved coverage of many topics. In the enclosed report, we provide responses to EPA's charge questions and recommendations for additional improvements. In this letter, we provide highlights of our overarching comments.

The current draft of the *Guidelines* could be improved by clearly identifying EPA's role and discretion in setting environmental policy. Specifically, policy options are described in the *Guidelines* in a manner that could allow the reader to infer that EPA has the discretion to choose from a variety of policy instruments (e.g., regulations or taxes) to achieve environmental targets. In reality, of course, only the legislative branch has the power to tax, subsidize or assign liability, and both the Clean Water Act and the Clean Air Act very clearly specify what kinds of regulations EPA may promulgate. The *Guidelines* should make clear that while economic analysis can identify superior policy options, EPA's legal authority defines its menu of choices. This might be done quite effectively by using examples from legislation to make the limitations concrete.

In addition to clarifying EPA's role in policy, the *Guidelines* should be grounded in the realities of information and political constraints, as well as market distortions,

either market induced or created by government interventions --- so named "second best" conditions. For example, the theory section focuses on first-best policy choices but this framework is nearly irrelevant to contemporary water pollution problems. The section on subsidies does not acknowledge that many subsidies in agriculture, car manufacturing, oil and gas, etc. are not designed to correct externalities but may in fact worsen them. Examples, such as the perverse incentives created by federal subsidies for corn-derived ethanol, are needed to illustrate these issues.

The *Guidelines* provide scant coverage of the long-standing issue in benefit-cost analysis of valuing the benefits of protecting ecological systems and services. Monetizing ecosystem services remains an area of significant challenge. The *Guidelines* should discuss situations where "non-monetized" benefits are expected to be a significant portion of the regulatory outcome including advice for practitioners in this case and noting that adherence to formal dollar-based benefit-cost analysis can lead to incorrect efficiency signals. We note that the recent SAB report on *Valuing the Protection of Ecological Systems and Services* (2009) provides useful insights on this topic.

The literature cited in the *Guidelines* needs to be updated. In its coverage of economic valuation methods for benefits analysis, the *Guidelines* did not incorporate numerous new studies using revealed preference methods, stated preference, approaches combining the two, and experiments in the lab and field. Other areas in which the literature needs updating include mortality benefits valuation, empirical work on the limited effectiveness of voluntary approaches (without financial incentives) and water quality trading.

The *Guidelines* could also be strengthened with case studies. For example, the *Guidelines* identify the basic steps involved in "benefits transfer" (using values of environmental quality estimates for one location to value changes at another), but readers would benefit substantively from a concrete real world example. The *Guidelines* enumerate a step-by-step approach for economic impact analysis but again, readers would benefit from a specific example from EPA's own experience. The *Guidelines'* discussion of environmental equity impacts would be greatly enriched with a case study.

Finally, the *Guidelines* are focused on economic analysis needed for "traditional" environmental problems, e.g., chemical releases from point sources to air and water. Given the emergence of climate change as the preeminent environmental threat, EPA will need more complex, interdisciplinary analysis to address greenhouse gas mitigation including information from the bio-physical sciences, economics and atmospheric sciences. Computable general equilibrium (CGE) models, a subject covered well in the *Guidelines*, will be of critical importance but CGE models will likely be wedged in a portfolio of models tracking complex processes. EPA's greenhouse gas lifecycle analysis of various fuels (required by Congress in the Energy independence and Security Act of 2007) is an early example of the daunting analytic challenges associated with forecasting greenhouse gas emissions under various policies. The *Guidelines* should anticipate a changing role for economics amidst the extraordinary complexity posed by climate change and other global processes.

By providing thorough and consistent technical advice regarding the application of benefit cost analysis to environmental problems, the *Guidelines* significantly elevate the quality and transparency of the information upon which environmental decisions are made. We again applaud EPA for developing these *Guidelines* and the Agency's commitment to continually revise and improve them. Indeed, we believe these *Guidelines* could serve as a successful model for all state and federal agencies who undertake benefit-cost analysis in support of environmental decision making. We greatly appreciate the opportunity to provide advice on this draft of the *Guidelines* and look forward to the Agency's response.

Sincerely,

***/Signed/***

Dr. Deborah L. Swackhamer, Chair
EPA Science Advisory Board

***/Signed/***

Dr. Catherine Kling, Chair
SAB Environmental Economics Advisory Committee

Enclosure

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[*] In order to serve on the Council of Economic Advisors, Dr. Greenstone resigned from the Environmental Economics Advisory Committee in February of 2009 and hence was not involved in writing this Advisory thereafter.

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Enclosure

**Advisory on EPA's *Guidelines for Preparing Economic Analyses***
**by the**
**Science Advisory Board**
**Environmental Economics Advisory Committee**

**Executive Summary**

The goal of EPA's *Guidelines for Preparing Economic Analyses* is to establish a sound scientific framework for performing economic analyses of environmental regulations and policies. Originally issued in 2000, the *Guidelines* are intended to reflect Agency policy and guide Agency practice on the preparation of economic analyses. EPA's National Center for Environmental Economics recently updated the *Guidelines* (September 2008) and asked the Science Advisory Board for its input. The SAB Environmental Economics Committee (EEAC) met on October 23-24, 2008 to address the Agency's charge questions on the *Guidelines*. The Background section of this report discusses some crosscutting issues. Below we provide specific responses to each charge question.

1. *Do the published economic theory and empirical literature support the statements in the guidance document on the merits and limitations of the different regulatory and non-regulatory approaches discussed in Chapter 4: Regulatory and Non-Regulatory Approaches to Pollution Control?*

   Yes, the chapter is supported by economic literature; however it too closely mimics textbook expositions of environmental economics. In order to make it more useful for EPA analysts, we recommend that EPA clarify and discuss the specific role that EPA has in policy design and implementation and provide guidance for economic analysis done specifically within that context. We also recommend a better distinction between efficiency and cost-effectiveness, improvements to the discussion of "cap and trade," a better definition of design standards and technology based performance standards and the inclusion of recent literature on voluntary approaches and the observability of information.

2. *Do the published economic theory and empirical literature support the statements in the guidance document on the consideration of the baseline discussed in Chapter 5: Establishing a Baseline?*

   Yes, this chapter provides very comprehensive guiding principles for specifying the baseline scenario to identify the incremental benefits and costs associated with a policy. We recommend that EPA consider the key dimensions of the economic analysis and any phenomena in the baseline about which there is uncertainty and to construct two or three (rather than more) scenarios that can provide benchmarks for policy analysis.

3. *Do the published economic theory and empirical literature support the statements in the guidance document on the treatment of discounting benefits and costs discussed in Chapter 6: Discounting Future Benefits and Costs in the following circumstances:*

   a. *Are the descriptions of fundamental social discounting approaches, conceptual conclusions and recommendations consistent with the appropriate economic literature on social discounting? Are the correct*

*conclusions drawn from the respective literatures on discounting for public projects (government spending) and discounting for regulations (government-mandated spending)?*

Yes, the descriptions of fundamental discounting approaches, conceptual conclusions and recommendations are consistent with the appropriate economics literature. We do not believe there are significant differences in the approach to discounting for public projects (government spending) and discounting for regulations (government mandated spending). We suggest that the chapter should begin with acknowledgment of the many controversies and complications associated with discounting and orient readers to where in the chapter these are discussed.

b. *The Guidelines do not draw a firm conclusion on the extent to which shadow price of capital adjustments are likely to be necessary for most EPA policy analyses. The issue depends greatly on the elasticity of capital supply and EPA plans to pursue additional research on this issue, as noted in the draft Guidelines. Does EPA's conclusion reflect the sense of the literature or can a firmer conclusion be drawn? Does the Committee have suggestions regarding situations where these adjustments would be necessary or unnecessary?*

Yes, the EPA conclusion does reflect the sense of the literature. As noted in the chapter, the shadow-price of capital approach is theoretically correct, but the quantitative significance of adjusting for this shadow price is critically dependent on the extent to which EPA regulations displace other investment. In an economy that is open to foreign investment, there may be minimal displacement and so adjustment for the shadow price of investment is negligible. We are pleased to learn that EPA is investigating the elasticity of investment to environmental regulation.

c. *While EPA concludes that a rate of 3% is generally consistent with estimates from low-risk government securities, the Agency would like to more firmly establish a rigorous basis for a consumption-based rate. What data and methods would the committee suggest EPA pursue?*

We are unable to suggest better data or methods for estimating a consumption-based discount rate, and doubt that alternative credible estimates would differ dramatically from the 3% real rate specified by OMB in Circular A-4. Given the benefits of harmonization of parameter values among federal agencies, we do not encourage EPA to move away from this rate.

d. *Chapter 6 recommends adopting an approach to long term discounting based on the work of Newell & Pizer (2003). While EPA recognizes that data may not clearly support a particular statistical model over other alternatives (e.g., random walk vs. mean-reverting), the Chapter concludes that the recommended approach is an improvement over constant discounting. Does the committee believe this is a reasonable conclusion from the economics literature? More specifically, is the recommendation to use a random walk model as a default reasonable given the state of the literature?*

No, we believe that calculating present values using the Newell & Pizer approach can be used as one of several alternatives (complemented by appropriate caveats and discussion of the theoretical and empirical issues), but we do not believe it should be relied upon exclusively for reasons provided in the Advisory.

e. *EPA has struggled with the question of the length of time an analysis should capture and has arrived at some practical recommendations (see Section 6.1.6.3 and 6.4). Are these recommendations consistent with good economic practices? Does the committee have additional recommendations or insights on this subject?*

Yes, the recommendations are generally consistent with good practice. In considering the time horizon an analysis should cover, there is no general answer beyond the answer to the question of what consequences to include: those that may have a quantitatively significant effect on the conclusions of analysis.

4. *Do the published economic theory and empirical literature support the statements in Chapter 7: Analyzing Benefits on the merits and limitations of different valuation approaches for the measurement of social benefits from reductions in human health risks and improvements in ecological conditions attributable to environmental policies?*

This chapter provides good coverage of the main categories of benefits and the methods used for their estimation. However, it fails to capture a significant amount of recent literature on recreation demand models, combining revealed and stated preference, validity and reliability, valuing mortality and morbidity and ecosystem services. In particular, we urge the Agency to vastly expand its guidance on characterizing and valuing non-monetized ecosystem systems and services. We also recommend expanding the discussion of evaluating studies and data.

5. *Chapter 7 includes a brief discussion of the Agency's current approach to mortality risk valuation with more details provided in Appendix B. These sections will be updated when the Agency concludes its efforts to update its mortality risk valuation*

*approach. In the interim, are the discussions provided in Chapter 7 and Appendix B clear and balanced?*

We will refrain from detailed comments on EPA's approach to valuing mortality risk until the Agency's update is complete. In the interim, we recommend EPA consider expanding its literature review and discontinue use of old, discredited wage-risk studies.

6. *Does Chapter 8: Analyzing Costs contain an objective and reasonable presentation of the published economic theory, empirical literature, and analytic tools associated with estimating social costs?*

   Yes. As a suggestion for improvement, we recommend covering non-competitive markets where results can be significantly different. Our detailed comments offer suggestions for other revisions, such as examining three cases: single market analyses, multiple market analyses and general equilibrium analyses.

7. *Does Chapter 8 contain an objective, balanced and reasonable presentation of the published economic theory, empirical literature, and analytic tools associated with computable general equilibrium (CGE) models? Is the description of the relevance of these models for economic analyses performed by the EPA reasonable?*

   Yes. We recommend discussion of the parameterization of CGE models as well as a few minor revisions as discussed in our detailed comments.

8. *Does Chapter 9: Distributional Analyses: Economic Impact Analyses and Equity Assessment contain an objective and reasonable presentation of the measurement of economic impacts, including approaches suitable to estimate impacts of environmental regulations on the private sector, public sector and households? This discussion includes, for example, the measurement of changes in market prices, profits, facility closure and bankruptcy rates, employment, market structure, innovation and economic growth, regional economies, and foreign trade.*

   Yes, this chapter contains an objective presentation of many aspects of economic impact analyses. In our detailed comments, we offer suggestions for minor improvements.

9. *Does Chapter 9 contain a reasonable presentation and set of recommendations on the selection of economic variables and data sources used to measure the equity dimensions identified as potentially relevant to environmental policy analysis?*

   Yes, the main items in assessment equity issues are correctly identified. One limitation is that the main distributional issues discussed in the chapter relate to costs, not benefits. Although it may be more difficult to identify the distribution of benefits, it would seem appropriate to at least represent the ideal case as one in which the equity and impacts associated with both benefits and costs are

considered. We suggest that EPA consider creation of a website to catalog all the data sources.

10. *Appendix A: Economic Theory was prepared for those readers who wished to have a better understanding of the economic foundations underlying benefit cost analyses. Does Appendix A summarize the relevant literature in an objective and meaningful way? Are there topics that warrant (more) discussion in this appendix that were otherwise missed?*

    The Appendix provides a good discussion of core economic principles. As suggestions for improvements, we recommend distinguishing between stock and flow pollutants and inclusion of the concept of "user costs."

11. *Please identify and enumerate any inconsistencies you may find across chapters and other issues/topics on which we should provide further elaboration. Also, please identify any definitions provided in the new glossary that are inaccurate or that otherwise need revision.*

    In general, we would like to see broader discussion of a number of cross-cutting issues. For example, we'd like to see a discussion of the need for transparency in making assumptions and judgments and a discussion of the ways in which biases and errors will matter the most. The *Guidelines* should more frankly acknowledge the "second best" world of most environmental policy problems due to information constraints, political constraints, imperfect competition and market distortions created by taxes and other government policies. The *Guidelines* sorely need case studies and examples to illustrate and make concepts concrete. We underscore our recommendation to provide guidance to analysts for exploring a range of ecological indicators and conceptual models of ecosystems and services.

## Background

EPA's National Center for Environmental Economics (NCEE) oversees the Agency's economic analysis of environmental issues. NCEE guides research and development on economic methods, produces EPA's major economic reports and issues guidance for performing economic analysis at the Agency. In this later role, NCEE issued *Guidelines for Performing Economic Analysis* in 2000. These *Guidelines* are meant to provide guidance on economic analysis for those performing or using such analysis, including policy makers, analysts and contractors providing economic reports to the EPA. In 2008, NCEE updated the *Guidelines* to incorporate the most recent advances in environmental economics and asked that the SAB EEAC review the revised document. The SAB EEAC met on October 23 – 24, 2008 to review draft *Guidelines* (September 2008) and respond to NCEE's specific charge questions. This face-to-face meeting was followed by a public teleconference on March 4, 2009 to discuss and amend a preliminary draft Advisory. On August 6, 2009, the SAB provided a quality review in a public teleconference.

In addition to offering specific responses to charge questions, this Advisory also presents some general advice and cross-cutting recommendations. We first identify and discuss these cross-cutting issues below and then proceed to the specific charge questions.

## Crosscutting Issues

In general, EEAC would like to see more upfront discussion of the "whys" associated with the material in the *Guidelines*, perhaps in the form of a conceptual overview chapter. It would be useful to explain why a benefit-cost analysis is a valuable undertaking (other than to satisfy a regulation) and why economic impact and equity analyses can be important supplements to benefit-cost analysis, etc. Readers need to see a definition of economic efficiency (allocative and technical, which will help in explaining the relationship between cost effectiveness and benefit-cost analysis) and an explanation of the relationship between economic efficiency, benefit-cost analysis, and cost-effectiveness. We also suggest defining social costs and benefits (as distinct from private costs/benefits), with examples.

In addition to introducing these basic concepts, EEAC would like to see discussion of a number of cross-cutting issues. Environmental policy analysis is inherently an integrated assessment process in which results from different sciences are combined to predict environmental outcomes and their economic consequences. Realistically, a great deal of judgment will have to be exercised by analysts. Given this, the *Guidelines* should discuss the need for transparency in making assumptions and judgments and the ways in which biases and errors will matter the most. For example, if all benefits and costs are understated by about the same amount, the "answer" of whether the benefits exceed the costs will not likely change, however if the costs are biased up and the benefits biased down, the wrong efficiency message could be sent. Care should also be taken to avoid multiple counting of benefits and costs when there are overlapping

regulatory initiatives. Clarity and transparency in the specification of the baseline, including the regulatory initiatives already in place, will enable more accurate identification of the incremental effects of a regulatory initiative.

The *Guidelines* should not underemphasize the value of economic analysis for deregulatory and/or non regulatory purposes. The statement in the *Guidelines* that "formal economic analysis is not required for the selection and implementation of a non-regulatory approach," is true and probably an important point to make. However, the statement could also suggest that economic analysis is less valuable or informative in this case. It is not. Non-regulatory approaches can bring both sizeable costs and benefits and the same can be said for deregulatory decisions. The *Guidelines* should indicate that decisions to deregulate or adopt a non-regulatory approach can be as much informed by economic analysis as those that are purely regulatory in nature.

We recommend that the *Guidelines* incorporate the concept of ecosystem services and its various components, as outlined in the *Millennium Ecosystem Assessment (MA) Synthesis Report* (2005) and highlight the issue of properly valuing and characterizing ecological systems and services in a benefit-cost analysis. Although OMB Circular A-4 does not require that all economic benefits of a policy be monetized, it does require some scientific characterization of those contributions. Users of the *Guidelines* should be warned that an inappropriate focus only on impacts that can be monetized can provide misleading policy guidance (as with other cases of unbalanced information). In addition, a strong recommendation should be made to provide quantitative measures of ecological impacts and a qualitative characterization of ecological effects. We urge EPA to consider the SAB's recent recommendation to begin with a conceptual model of the relevant ecosystem and ecosystem services and map those effects to services or attributes that the public values (*Valuing the Protection of Ecological Systems and Services*, 2009). The SAB report covers a wide range of alternative methods for characterizing, valuing and gauging ecological impacts. We urge EPA to evaluate and determine the appropriate use of these alternative methods and provide much more guidance on characterizing non-monetized effects.

We understand that EPA is developing a separate chapter dedicated entirely to uncertainty (which we applaud), but the topic is important enough to merit some discussion in the conceptual overview or as a cross cutting issue throughout. It would be useful to point out that uncertainty extends not only to economic information, but to environmental data and modeling. Uncertainty in environmental modeling can be as much or more a source of errors than imperfections in economic assumptions and data. In addition, analysts will be confronted with heterogeneity of data for various reasons (geographic, economic, cultural etc). Recognizing the sources of heterogeneity and deciding how to address them are major analytic decisions. Given that analysts usually face asymmetric information (e.g. on costs vis-à-vis benefits), advice is needed on how to address these information deficiencies. The *Guidelines* might discuss the possibility of ensemble modeling (e.g. hydrology and ecology) and the use of a "weight of evidence" approach, especially for the case of non-monetized ecological effects.

The literature on environmental policy increasingly emphasizes that realizable outcomes will be "second best" due to information constraints, political constraints, imperfect competition, and market distortions created by tax and other government interventions. This emphasis is not adequately reflected in the *Guidelines*. For example, the theory section focuses on first-best optimal regulation, a framework that provides a baseline but is of limited relevance to regulation of contemporary environmental problems. For example, agricultural nonpoint pollution is now the leading cause of the nation's water quality problems, yet it is less observable than emissions from points sources and far more stochastic. Consequently, the emissions based policies emphasized in the *Guidelines* are irrelevant inasmuch as they are targeted to conventional point sources. Agriculture is subject to multiple non-environmental policy distortions that must be considered in the measurement of the social benefits and costs of regulating agriculture. Further, agriculture is a source of multiple externalities, some that are positive, some that are negative, that are regulated to varying degree (including not at all) by multiple authorities. The *Guidelines* should be more adapted to the complexities of contemporary environmental problems.

Given that economics needs to apply to economic analysis, we believe some discussion should be devoted to the allocation of EPA resources in undertaking economic analyses. Where possible, the Agency should consider tailoring the resources spent on the analysis with the size of the proposed regulation's impact. Analysis of the costs of a small project may emphasize simple partial equilibrium analysis, while a larger one may employ both partial equilibrium and CGE models. Similarly, the selection of the number and identity, of say, products or markets to be included in an analysis should consider the benefits and costs from the adding each individual market or product. The evaluation of a large project may justify conducting a new study on willingness to pay (WTP) for the amenities it provides if such information has the potential to change the regulatory decision while a study on the impacts of a smaller project may rely on a benefit transfer analysis if the regulatory impacts are expected to be small. For large regulations with significant impacts, the costs of analysis may be trivial in comparison to potential increases in net benefits if the information results in a change to the final regulation or policy decision.

The *Guidelines* should discuss the analytic challenges posed by emerging environmental problems, particularly climate change. The *Guidelines* are implicitly focused on conventional point source pollutants. Attention to emerging challenges from nonpoint pollutants, changes in carbon and other biogeochemical processes, invasive species, etc. would give the *Guidelines* a more contemporary and forward looking view. The *Guidelines* should point out (and perhaps demonstrate) that the analysis needed for policy decisions to address greenhouse gas emissions will necessarily draw from a complex interdisciplinary suite of studies, data and models. A case in point is the Congressional requirement in the Energy Independence and Security Act of 2007 for EPA to issue a Renewable Fuel Standard based on its calculation of lifecycle greenhouse gas emissions for various fuels. This lifecycle analysis covers the full fuel lifecycle from production to consumption and hence requires an extraordinary synthesis of tools and information from the bio-physical sciences, economics and atmospheric modeling. The

*Guidelines* could reference this specific example as well as discuss generally the interdisciplinary challenges posed by climate change and other global issues. Given the specter of climate change and other global processes, we expect that future revisions of the *Guidelines* will need to be broader, describing a kind of regulatory analysis that draws from all the sciences. We note that revisions will be made easier with NCEE's adoption of a loose leaf format to update chapters as appropriate.

**Question 1: Policy Options**

*Do the published economic theory and empirical literature support the statements in the guidance document on the merits and limitations of the different regulatory and non-regulatory approaches discussed in Chapter 4: Regulatory and Non-Regulatory Approaches to Pollution Control?*

With a few exceptions, the presentation in Chapter 4 is supported by economic theory and empirical evidence in the published literature. We commend the Agency on a good chapter and offer the suggestions below for improvement.

This chapter provides a good description of policy instruments, much in the same way that a good environmental economics text might. In this regard, we suggest that EPA clarify and discuss the specific role that EPA has in policy design and implementation. For example, the *Guidelines* point out the efficiencies that can accrue with performance-based standards, but do not tell the reader that EPA often does not have the discretion to choose this option, e.g. when "best available technology" standards are required by law. Similarly, after demonstrating that social welfare is maximized by choosing the level of pollution that equates marginal costs with marginal benefits, the *Guidelines* do not inform the reader that EPA is often explicitly prevented from setting standards by this criterion.

We suggest that EPA clarify and discuss the Agency's specific role in policy design and implementation. This would involve stating where EPA has discretion to make decisions in the context of the larger policy arena and then discussing the rationale for the different approaches actually used. That is, EPA primarily issues regulations and those regulations are typically highly prescribed by Congressional mandates as well as the courts' interpretation of environmental laws. On the other hand, EPA analysis can inform the design of future environmental programs by Congress so it is important to retain the discussion of the full suite of policy options described here, but clarifying EPA's discretion in setting policy (even if it varies from statute to statute) would be beneficial. To this end, we recommend that the chapter be organized in two parts: (1) standard treatment of policy options similar to what is currently covered in the Guidelines and (2) discussion of EPA's actual discretion highlighting how economic analysis is used in this narrower context. This would take the chapter beyond the usual treatment of an environmental economics text and make it directly relevant to the agency. One way to explain EPA's role is to show some examples of specific actions (e.g. how design or performance standards are set and/or EPA's role in voluntary programs).

Another topic that would be well suited for discussion in this chapter is the issue of asymmetric information between the regulator (EPA) and the regulated (consumers and industry). This issue has ramifications for the design and efficiency of many kinds of environmental regulations and its importance should be mentioned.

Along these same lines, the chapter discusses maximizing welfare without noting

that in most cases EPA is charged with implementing laws that specify criteria EPA must use. EPA's regulations are not typically based on a calculation of an "optimal" E*, but are more tied to legally-defined criteria. Again, the chapter would be improved by clarifying how EPA's actual authority fits into this paradigm.

This latter point could be nicely integrated into Section 4-1 which could be improved by distinguishing efficiency from cost effectiveness. By dividing the section into two parts: (i) Efficient Level of Pollution (MD = $MAC_{aggregate}$ )* and (ii) Cost-Effective Allocation of Pollution – equalize marginal cost across sources ($MAC_1$= $MAC_2$= … = $MAC_n$), the distinction between optimality of pollution levels and least cost approaches for implementation can be distinguished. Each section will need a supporting graph and should be integrated by showing how aggregate MAC is derived from individual MACs. See Field and Field (2008) and Baumol and Oates (1988) for dividing the discussion this way. Also, in the discussion of the efficient level of pollution, it is important to define social welfare using the underpinnings of Pareto Optimality.

The suggestion in the previous paragraph will allow the use a cost-effectiveness graph to tell the cap and trade story demonstrating its property as a least-cost instrument. Likewise, instead of telling the cap and trade story assuming an optimal level of aggregate pollution for permit allocations, tell the story from the standpoint that a cap and trade can achieve <u>any aggregate level of emissions</u> at least cost. Then, point out that the efficient solution is a special case where the permit allocation is efficient (MD=MAC). Use the same approach for the tax in Section 4.3.2. Again, these points can be illustrated with the point that EPA typically does not set the optimal level of emissions, but can help design and implement instruments to achieve least cost solutions. This discussion can be linked to the asymmetric information issues mentioned earlier by noting that the least cost solution can be achieved, even if the regulator knows nothing about the individual firm costs.

The discussion in Section 4-2 should be clear about the difference between design standards (technology forcing) and technology based performance standards. This could be accomplished by dividing Section 4-2 by (i) design standards and (ii) performance standards and discussing uniform and technology-based performance standards using the cost-effectiveness graph introduced in the previous section. Uniform standards are generally not cost effective but have a low information burden (since one need not know MACs). Technology-based performance standards can be cost effective in principle but have a high information burden (need to know MACs). Regardless of the form of standard, it is always important to recognize that different options may yield different levels of environmental improvement which need to be adequately accounted for in analysis that compares design with performance standards.

We recommend the section on taxes include some discussion of what is taxed: the pollutant, an input, a process, or something elsewhere? In principle it should be placed on damages (a true Pigouvian tax), but administrative and monitoring costs may suggest targeting the tax elsewhere. Taxing gas may be much easier and probably as effective as

* MD = marginal damages. MAC = marginal abatement cost

taxing damages from auto emissions. Similar principles apply to permit trading, so although EPA lacks the legal authority to levy a tax, a discussion of targeting would have broad application.

On this point more generally, note that policy design is dependent on observable and available information. For example if policy makers can not observe actual pollution levels, but inputs and practices that cause pollution can be observed and there are reasonable estimates on the relationship between the input, technology use and the pollution level, then taxes or regulations may be based on the imputed pollution levels. Policies should be designed to best take advantage of the available knowledge. In particular identifying sources of heterogeneity among users and knowing how they affect pollution levels can be central to policy design. The proliferation of geographic information systems and remote systems to obtain data provide new opportunities for policy design. Studies suggest that there is a significant efficiency gains from policies that adjust to observed heterogeneity relative to uniform policies (Xabadia et. al., 2008). Availability of new sources of or means to obtain information may lead to redesign of policies – for example, availability of a technology that allows cheap monitoring of pollution may lead to regulation on taxation based on annual pollution rather than imputed pollution. Policy makers should reassess policy design and implementation as technology progresses. (See Xabadia et. al., 2008) as one example. There are many other papers that demonstrate the efficiency gains from increased targeting.

As noted in the cross cutting issues discussion earlier, we suggest adding discussion of second best solutions covering imperfect markets, pre-existing policies, asymmetric information, and so forth. In this chapter, EPA could incorporate the implications of imperfect markets and other second best solutions in the relevant sections and refer readers to the material in the cross cutting issues discussion. Examples include monopoly, price supports in agriculture, pre-existing environmental policy, recent biofuels legislation, etc.

When the section on market based regulations is introduced, it would be helpful to explain that these controls tend to be least costly, have a low information burden on regulators, provide incentives for technological advancement, and so forth. Monitoring and enforcement costs and other administrative costs, of course, can favor direct regulation.

It would be helpful to mention that information disclosure strategies can allow the market to create incentives for pollution control (following Coase) with the victims directly signaling their preferences to firms. But these are most likely to work when there are contractual obligations between polluting firms and affected parties (e.g. consumers/workers) and more difficult to work when they affect third parties (see Tietenberg, 1998). Also it should be mentioned that credibility of information is important. Information disclosure can lead to inefficient outcomes when information is not credible (see Brouhle, K. and M. Khanna, 2007).

The section on subsidies should mention that many subsidies in existence, such as

those in agriculture, car manufacturing, oil and gas, forestry, and so forth, are not corrective subsidies designed to correct externalities and may in fact worsen externalities. This could also be discussed in the second best discussion.

An area of omission is the relatively new literature regarding the effectiveness (or lack there of) of voluntary approaches ( Morgenstern and Pizer, 2007 and National Research Council, 2002, as well as a number of journal articles). These should be noted and made a part of the section on voluntary controls. Assessment of the effectiveness of a voluntary program in the literature has been based on estimates of participation rates and the reduction in pollution achieved by the program relative to that in the absence of the program. A comparison of the costs of pollution control under a voluntary program relative to that under alternative policy options to achieve the same level of pollution control would be valuable for assessing the cost-effectiveness of voluntary approaches.

**Question 2: Baselines**

*Do the published economic theory and empirical literature support statements in the guidance document on the consideration of the baseline discussed in Chapter 5: Establishing a Baseline?*

Yes, the approach described in the *Guidelines* to establish a baseline is supported by economic theory and empirical literature in this area. This chapter provides very comprehensive guiding principles for specifying the baseline scenario to identify the incremental benefits and costs associated with a policy. It describes the methods for defining a scenario that does not include the policy (baseline scenario) and one that does include the policy; that is, a 'with' and 'without' policy comparison. It suggests that in some cases it may be appropriate to specify multiple baseline scenarios to describe the state of the world in the absence of a regulation. While we agree with the need to consider more than one baseline when it is difficult to define a unique state of the world in the absence of the policy with a high degree of certainty, the number of baselines constructed should be limited to as few as possible that cover the reasonable baseline alternatives. In some cases it may also be appropriate to use probabilistic analysis with a continuum of baselines to provide the benchmark for policy analysis.

Additionally, in defining the baseline scenario, analysts need to consider which sectors should be included. Although the direct effects of the policy may be focused on a few sectors, indirect impacts can be significant and should be measured. It is therefore important to establish which other sectors of the economy may be affected, directly or indirectly, by a policy and should be included in the baseline. Some policies can have pecuniary effects that will affect the opportunity costs of implementing that policy. This is particularly relevant when the pecuniary costs occur in inefficient markets; in such cases the opportunity costs of a policy can differ from the monetary costs of the policy (see Boardman et al., 2006).

The assumption of full compliance with the existing and newly enacted regulations does not appear realistic. Instead, compliance rates in the baseline should be based on available factual evidence. Assumptions about compliance rates in the policy scenario should also be based on a realistic assessment. These rates are likely to depend on how stringently the policy is implemented and enforced.

We also suggest including a text box distinguishing the induced innovation effects of regulation from the Porter Hypothesis. It would be useful to clarify what the Porter hypothesis is (i.e., define it) and to distinguish between its strong form and weak form. The strong form of the Porter Hypothesis states that regulations can induce innovations that can lead to cost savings that are larger than the costs of the innovation and compliance. The weak form of the Porter Hypothesis simply states that environmental regulations lead to innovation. We agree with the statement that there is only limited evidence of the strong version of the Porter Hypothesis; some references to the literature providing situations in which it might hold (such as in the presence of imperfect information, high search costs, etc.) could be added. There is much more evidence to

support the weak form of the Porter Hypothesis (which is similar to the induced innovation hypothesis) and this should be made clear.

**Question 3: Discounting**

*Do the published economic theory and empirical literature support the statements in the guidance document on the treatment of discounting benefits and costs discussed in Chapter 6: Discounting Future Benefits and Costs? (sub parts for this charge are copied below)*

Overall, the chapter provides a clear and comprehensive discussion of discounting. This chapter has been updated to reflect much of the current thinking on discounting in the context of environmental decision making and we applaud EPA for doing so. We begin with some general comments then respond to each of the subparts of the charge question below.

Discounting is an important, complicated, and controversial topic. The results of an economic evaluation can be extremely sensitive to the discounting approach that is used, especially for projects where significant benefits and costs are incurred at widely disparate times (e.g., climate change mitigation; nuclear-and hazardous-waste storage). We suggest that the chapter begin with an acknowledgement of these issues and orient readers to the parts of the chapter in which they are discussed. (At present, readers must wade through the necessary but less interesting section on mechanics of discounting before grappling with these topics). Some of the issues that could be highlighted include: (a) differences between relatively short run ("intra-generational") and long run ("inter-generational") discounting that arise in part because inter-generational contexts necessarily involve a greater distributional aspect and future generations are not represented in markets; (b) sensitivity of results to choice of discounting approach and discount rate; (c) distinction (and frequent confounding) of efficiency and distributional issues; (d) distinction between utility vs. consumption discount rates; (e) "ethical" or prescriptive vs. descriptive approaches to selecting a discounting approach; (f) uncertainty about future economic growth and other conditions; (g) constant vs. non-constant (e.g., hyperbolic) discounting approaches; and (perhaps) (g) future changes in relative prices that imply different consumption discount rates for different goods.

Although it is implicit in the text, the distinction between discounting to reflect differences in timing of consequences and discounting to adjust for inflation should be emphasized. It is conventional (and recommended) to measure effects in real dollars and use a real rather than nominal discount rate to account for differences in timing. (Note that if inflation rates differ across goods, the real discount rate depends on the inflation adjuster that is used.)

There is much confusion in the literature (and in policy discussion) about the determinants of the discount rate, e.g., whether it is a result of preferences for consumption sooner rather than later or of the productivity of capital investment. At least for "intra-generational" discounting, the (consumption) discount rate (or rates) is best understood as being determined by a price (or prices) – the interest rate(s) at which consumption can be shifted through time (e.g., consumers may shift consumption to the future by consuming less and investing more, and may shift consumption toward the

present by saving less or borrowing). The interest rate is determined, like other prices, as a market equilibrium between agents who wish to shift resources through time. Consumers adjust current and future consumption so that their indifference curves for current and future consumption are tangent to the market opportunities for shifting consumption through time (determined by the interest rate). As noted in the chapter, a variety of interest rates exist (associated with riskiness of investment and time horizon) and there are wedges between private returns associated with taxation of investment returns and other factors. For longer-term "inter-generational" issues, the interpretation of the discount rate as a price is less natural, because market interest rates for periods longer than about 30 years rarely exist and future generations' do not directly participate in current markets, so their preferences may not be adequately represented.

In the discounting chapter or elsewhere, it may be useful to highlight the distinction between positive (i.e., descriptive) and normative perspectives (i.e., prescriptive) justifications for economic evaluation and the tension between these. Economic evaluation is normative in that it is conducted in order to compare alternative policies, yet it is positive in that it attempts to identify the policy that maximizes the perceived welfare of the affected population. Behavior that differs from Economic evaluation is sometimes justified as identifying policies to maximize (or at least increase) social welfare, which is normative because it is based on an assumed social welfare function. In contrast, economic evaluation is also sometimes justified as identifying policies that produce potential Pareto improvements, i.e., policies such that all members of the affected population would prefer to the alternative policy (if combined with appropriate compensation payments). Policies that increase social welfare are not necessarily potential Pareto improvements, that those that are potential Pareto improvements need not increase social welfare. Moreover, individual behavior that is inconsistent with maximization of individual utility (e.g., behavior that is dynamically inconsistent, perhaps because it accords with hyperbolic discounting) creates a tension between these perspectives and raises questions about how to conduct the analysis. See Hammitt (2009, 2002) and Portney (1992).

*a. Are the descriptions of fundamental social discounting approaches, conceptual conclusions and recommendations consistent with the appropriate economic literature on social discounting? Are the correct conclusions drawn from the respective literatures on discounting for public projects (government spending) and discounting for regulations (government-mandated spending)?*

The descriptions of fundamental social discounting approaches, conceptual conclusions and recommendations are consistent with the appropriate economics literature. We do not believe there are significant differences in the approach to discounting for public projects (government spending) and discounting for regulations (government-mandated spending) – in both cases, there can be a need to account for differences in timing of benefits and costs and the relevant conceptual basis is social valuation of consequences at different points in time.

*b. The Guidelines do not draw a firm conclusion on the extent to which shadow price of capital adjustments are likely to be necessary for most EPA policy analyses. The issue depends greatly on the elasticity of capital supply and EPA plans to pursue additional research on this issue, as noted in the draft Guidelines. Does EPA's conclusion reflect the sense of the literature or can a firmer conclusion be drawn? Does the Committee have suggestions regarding situations where these adjustments would be necessary or unnecessary?*

As noted in the chapter, the shadow-price of capital approach is viewed as theoretically correct, but the quantitative significance of adjusting for this shadow price is critically dependent on the extent to which EPA regulations displace other investment. In an economy that is open to foreign investment, there may be minimal displacement and so adjustment for the shadow price of investment is negligible. We are pleased to learn that EPA is investigating the elasticity of investment to environmental regulation.

*c. While EPA concludes that a rate of 3% is generally consistent with estimates from low-risk government securities, the Agency would like to more firmly establish a rigorous basis for a consumption-based rate. What data and methods would the committee suggest EPA pursue?*

We are unable to suggest better data or methods for estimating a consumption-based discount rate, and doubt that alternative credible estimates would differ dramatically from the 3% rate specified by OMB in Circular A-4. Given the benefits of harmonization of parameter values among federal agencies, we do not encourage EPA to move away from this rate.

*d. Chapter 6 recommends adopting an approach to long term discounting based on the work of Newell & Pizer (2003). While EPA recognizes that data may not clearly support a particular statistical model over other alternatives (e.g., random walk vs. mean-reverting), the Chapter concludes that the recommended approach is an improvement over constant discounting. Does the committee believe this is a reasonable conclusion from the economics literature? More specifically, is the recommendation to use a random walk model as a default reasonable given the state of the literature?*

We do not recommend using the Newell and Pizer approach as a default but as one of the alternatives for inter-generational discounting. Since the declining discount rates under this approach are sensitive to modeling assumptions, transparency in the assumptions underlying the determination of the discount rates used will be important as will comparisons with other alternatives.

The conceptual idea, identified by Weitzman (1998, 2001), should be clearly stated in the chapter: uncertainty about the appropriate discount rate to use has a nonlinear effect on the discount factor that varies with the time horizon. Specifically, because the discount factor for time t, $[1/(1 + r)]^t$, is a nonlinear function of the discount rate r, the expected discount factor is not equal to the discount factor obtained by substituting the expected value of r in this formula. For small t, the difference between

the two discount factors may be small, but as t becomes arbitrarily large the expected discount factor approaches the discount factor corresponding to the minimum possible value of r weighted by the probability assigned to that minimum value. Weitzman developed a distribution for r by polling economists and derived a corresponding schedule of certainty-equivalent discount rates (the discount rate associated with the expected discount factor); Newell and Pizer built on his work by conducting an empirical analysis of historical interest rates. Their results are naturally sensitive to modeling choices about the intertemporal correlation of rates.

Our concern about this approach is the following. In a world with no uncertainty about the discount rate, one can compare streams of consequences in terms of their present values or their future values at any future date. The choice between these perspectives has no effect on the ranking: because the present value of a policy is simply the present value of the policy's future value (i.e., the future value discounted to the present), whichever policy has the larger present value will also have the larger future value.

In contrast, when the discount rate is uncertain, the rank ordering of policies by present values and future value may differ. As shown by Weitzman, for large t the present value is dominated by the small discount rates. But the future value is dominated by the large discount rates (i.e., the expected value of the factor used to convert present consequences to their future value, $(1 + r)^t$, is dominated by the largest possible values of r). This dependence of the evaluation on what appears to be an arbitrary choice of perspective suggests a problem with the analysis that urges caution in its application and invites further investigation (Gollier, 2004; Hepburn and Groom, 2007). Given this concern, we urge caution in interpretation of results calculated using the Newell and Pizer approach and encourage further investigation.

*e. EPA has struggled with the question of the length of time an analysis should capture and has arrived at some practical recommendations (see Section 6.1.6.3 and 6.4). Are these recommendations consistent with good economic practices? Does the committee have additional recommendations or insights on this subject?*

In considering the time horizon an analysis should cover, there is no general answer beyond the answer to the question of what consequences to include: those that may have a quantitatively significant effect on the conclusions of analysis (as noted in Section 6.1.6.3). With positive discounting, the influence of consequences decreases with their temporal distance; unless the probability-weighted magnitudes of consequences grow sufficiently rapidly with time, their effect on the analysis will become negligible. In general, there is no method for knowing whether a consequence may be sufficiently important to merit inclusion except by including it and testing for its effect. For this purpose, a rough estimate or upper bound is often sufficient. As noted in the text, many exogenous factors are likely to influence the date at which the effects of the policy become negligible (e.g., technological innovation or policy change).

**Question 4: Benefits**

*Do the published economic theory and empirical literature support the statements in Chapter 7: Analyzing Benefits on the merits and limitations of different valuation approaches for the measurement of social benefits from reductions in human health risks and improvements in ecological conditions attributable to environmental policies?*

This chapter provides good coverage of the main categories of benefits of environmental policies and regulations, and of the methods used to estimate them. The chapter might flow better if the discussion of the main categories of benefits was more concise, and more details about the valuation of these impacts were offered in the overview at the end of the chapter.

Chapter 7 falls significantly short of capturing a considerable amount of recent literature on benefits. In the following pages, we identify a number of areas where the literature of the past decade or so is not adequately reflected in the chapter. We have not made an effort to be exhaustive in recommending additions, but rather to identify areas as obvious omissions. In general, the Handbook of Environmental Economics published by North Holland in 2005 would be an excellent starting place. More specifically, the literature in the following areas needs to be updated:

1. Recreation Demand Models. A great deal of work published in the last decade on random utility maximization (RUM) and Kuhn-Tucker models have taken these approaches beyond the descriptions provided in the Guidelines. Updated approaches to valuing the opportunity cost of time, identification of choice sets, and other aspects of recreation demand should also be included. Potentially useful sources for journal research that should be reflected in the Guidelines can be found in the collection of articles in Herriges and Kling, (2008), among other works. In addition to covering methods for valuing natural resources that have recreational use, this volume is also a good source for articles related to hedonics and locational equilibrium models. For more theoretical treatment cite Bockstael and McConnell, *(*2008). For more practical discussion cite Champ et. al. *(*2003).

2. Combining Revealed Preference (RP) and Stated Preference (SP). A revised draft of this chapter should discuss work over the past decade that has sought to combine revealed and stated preference methods. This has been an area of significant interest as researchers have attempted to understand how the strengths of each approach might be combined to improve the performance of welfare estimators. On the theoretical front, Herriges and Kling, (1999) raise the question of whether revealed preferences can ever accurately estimate welfare for quality changes when weak complementarity cannot be assured.

3. Stated Preferences: Validity and Reliability. A significant amount of recent work related to stated preference approaches is not reflected in the Guidelines. Understanding whether people over- or under-state their actual preferences for a non-marketed good when asked a hypothetical question and whether approaches to

mitigate these effects are successful remain important researchable questions. Considerable work on this question has been undertaken beginning with studies such as Bohm's (1972) experimental lab study which compared bids in hypothetical and real experimental markets that elicited subjects' stated value to sneak preview a Swedish television show. His results suggest that people moderately overstate their real values when asked a hypothetical question. Other early work includes the studies by Bishop and Heberlein, (1979), Duffield and Patterson, (1992), and others who compared stated preference estimates to those obtained from actual transactions.

Subsequent research has included both field and laboratory experiments. For instance, List and Gallet (2001) report the results of a meta-analysis to determine whether important experimental parameters systematically affect the relationship between hypothetical and real responses, concluding that certain elicitation methods that yield less hypothetical bias than others. Others (e.g., Cummings and Taylor, (1999), List, (2001), Lusk and Prevant, (2008), etc.) have studied hypothetical bias and incentive compatibility focusing specifically on the dichotomous choice elicitation format in contingent valuation. These and other references addressing this literature should be discussed in the *Guidelines*. Remaining research questions and needs should also be identified.

A final area in which SP validity and reliability research has appeared is in the arena of choice experiments. Although many choice experiment-based studies are not conducted in ways that would preserve incentive compatibility, some limited evidence exists suggesting little or no hypothetical bias when estimating marginal attribute values (see List et al., 2006, and Lusk and Norwood, 2005)

4. Valuing Mortality. There are a number of studies that need to be updated in this area, please see charge question #5 for specifics.

5. Valuing Morbidity. The *Guidelines* should provide a sense as to whether the research community is satisfied with existing estimates of morbidity benefits. Is the usual approach—symptom days—still judged acceptable? Likewise, this section points out that frequently used approaches, such as the cost-of-illness or averting expenditures, do not capture the full WTP to avoid an episode of illness. It would be useful to note that some studies (e.g., Rowe and Chestnut, 1985, and Alberini and Krupnick, 2000) have estimated that total WTP can be two to four times as large as the cost of illness, even for minor acute respiratory illnesses (as in Alberini and Krupnick's case).

6. Ecosystem Services and Benefits Assessment. The literature review is outdated, and there are no examples of recent studies that attempted to place a value on ecosystems and ecosystem services. It would be useful to know which measures of ecological system function was used in those studies, whether market or non-market valuation approaches were used, and what the strengths or shortcomings of these studies were.

Ecosystem services encompass a broad array of goods and services, ranging from standard market goods like agricultural products to far more complex and less well identified services such as nutrient cycling. Valuing the more complex ecosystem services is very challenging because it requires sequential linkages from the policy of interest to the direct effects on organisms to the associated indirect effects through changes in the functioning of ecosystems to the resulting changes in services and finally to the associated social values. Our understanding of each of these elements is rudimentary in some cases. Yet, we need to develop analyses to support policy decisions in spite of the many uncertainties.

This document should provide more extensive guidance on how to carry out valuation of ecosystem services within the context of policy decisions that EPA needs to make. A variety of techniques are available that can provide useful input to policy within the context of less than complete knowledge. In addition to standard cost-benefit methods, these approaches include cost effectiveness analyses, choice-based methods (e.g., Opaluch et al, 1993; Unsworth and Bishop, 1994; Adamowicz et al, 1998), etc. The report should also draw from recent reviews, including EPA SAB (2009) and the National Research Council (2004).

The report should address important challenges facing the practitioner, including: What does valuation of effects on ecological systems share with valuation of other benefits? In what way is it different? What are unique difficulties when valuing ecosystems or ecosystem services? What approaches are available in face of the many uncertainties?

As mentioned in the discussion of cross-cutting issues, we urge the Agency to vastly expand its guidance on characterizing non-monetized benefits. We recommend that the *Guidelines* incorporate the concept of ecosystem services and its various components, as outlined in the *Millennium Ecosystem Assessment (MA) Synthesis Report* (2005) and highlight treatment of ecological systems and services in benefit-cost analysis. Users of the *Guidelines* should be warned that an inappropriate focus only on impacts that can be monetized can provide misleading policy guidance (as with other cases of unbalanced information). In addition, a strong recommendation should be made to provide quantitative measures of ecological impacts and a qualitative characterization of ecological effects. These quantitative measures and qualitative descriptions are needed whether or not benefits can be monetized. We note that EPA's Office of Research and Development has an extensive Ecosystem Services Research Program that may be an excellent resource for economists who need information ecosystem impacts for economic analysis.

We urge EPA to consider the SAB's recent recommendation to begin with a conceptual model of the relevant ecosystem and ecosystem services and map those effects to services or attributes that the public values (*Valuing the Protection of Ecological Systems and Services*, SAB, 2009). The SAB report

covers a wide range of alternative methods for characterizing, valuing and gauging ecological impacts. We urge EPA to evaluate and determine the appropriate use of these alternative methods and provide much more guidance characterizing non-monetized effects. Another recommendation from the SAB report that could be appropriated for the *Guidelines* is to label aggregate monetized benefits as "total monetized economic benefits," not "total benefits." We believe the SAB report provides other useful examples relevant to the *Guidelines*.

In addition to updating the literature in the area just enumerated, we recommend expended treatment of the discussion about assessing studies and data. We applaud EPA's discussion of validity concepts (page 7-41) as the basis for choosing among studies for inclusion in a benefit-cost analysis, but the treatment of the validity and reliability of estimation methods is uneven. Much of the discussion about validity centers on stated preference methods. However, we feel that due to (usually untested) assumptions that they make about individuals' perceptions of environmental quality and identification of effects, revealed preference methods should be scrutinized for quality and validity, as should CGE models.

The material in Sections 7.4.2.3 "Considerations in Evaluating Stated Preference Results" and 7.4.3 "Benefits Transfer," could be used as a starting point. For example, the validity tests (content, criterion and convergent) discussed on 7-41 – 7-42 apply to all types of studies, not just stated preference, as do various biases associated with survey non-response (7-42 – 7-43). Other validity concepts that should be discussed include:

- Internal Validity: is there plausibly exogenous variation in the variable of interest (the one capturing health risks or environmental quality)?
- External Validity: Can the study's results be generalized to the overall population of interest? Can the study's results be generalized to the time period of interest? Is the study's treatment relevant for the program that is under consideration?
- Theoretical Validity: Can the study's results be interpreted as a measure of willingness-to-pay (WTP) (or a bound on WTP)?

A discussion of the trade-offs between revealed and stated preference approaches could be very helpful to readers. EPA should note that flaws of both stated preference (SP) and revealed preference (RP) should be considered when evaluating studies and performing regulatory analysis. For example, most hedonic properties, compensating wage differentials and other revealed preference studies assume, without testing, that people know the correct risks or level of environmental quality. These studies will often estimate the willingness to pay or accept for changes that do not match well the policy change under consideration. In contrast, validity questions related to stated preference studies are a limitation that should be not disguised or diminished. It would be useful to emphasize that judgment is essential to good analysis and that the results from stated (and revealed) preference studies should be carefully assessed with economics and common-sense basics. For example, is WTP for a change in environmental quality a reasonable

fraction of one's income? Does it increase in predictable ways as income increases, and are the estimates of income elasticity of WTP reasonable and consistent with other evidence?

Chapter 7 states that the Agency should use benefit transfer only as a last resort, when time and budget constraints do not allow original benefit estimation. We agree, but the reality appears to be that benefits transfer is the most common approach to completing a benefit-cost analysis. If correct, this should be acknowledged. Further, the exposition of the possible benefit transfer techniques reads somewhat mechanically and does not clearly discuss the underlying assumptions. For example, unit value transfer presumes that the original good, the characteristics and the tastes of its population of beneficiaries are the same as the policy good/locale. When a value function transfer is done, it is implicitly assumed that the population of beneficiaries to which we are applying the transfer has potentially different characteristics, but similar tastes, as the original one.

EPA should distinguish the criterion used to evaluate an original study from those that can be used to evaluate a study for use in benefits transfer. Given the importance of the process of "benefits transfer" in benefit-cost analysis performed for EPA, separate guidelines for analysts on to how to evaluate studies to use in a benefits transfer is warranted. In doing so, we note that there is an extensive literature that provides guidance on benefits transfer that the Agency can draw upon such as the special issues in *Ecological Economics*. Some issues that are likely to belong in such a set of considerations include: similarity of environmental good valued in original study to environmental good being valued in benefits transfer; similarity of original study sample to population of interest in the policy/regulatory setting; and overall quality of the original study benefits (i.e., the set of considerations in the above list "benefits – original studies").

The document discusses meta-analysis as one way of conducting benefit transfer. Almost two years ago, two meta-analysis experts briefed the EEAC about meta-analysis. They reminded us that a meta-analysis seeks, at best, to establish whether certain aspects of study design and execution influenced final values, and its results should be interpreted with caution. They offered a number of recommendations, warning against the "ecological fallacy" and against pooling values from studies conducted with extremely different methods. The chapter would benefit from reviewing the main lessons from that presentation.

**Question 5: Mortality Risk Valuation**

*Chapter 7 includes a brief discussion of the Agency's current approach to mortality risk valuation with more details provided in Appendix B. These sections will be updated when the Agency concludes its efforts to update its mortality risk valuation approach. In the interim, are the discussions provided in Chapter 7 and Appendix B clear and balanced?*

We will refrain from extensive comments on mortality risk valuation until the Agency's update is complete. In the meantime, we recommend the Agency consider expanding discussion in the following manner to improve the balance in the current version of this section.

The literature review about methods used for valuing mortality risks should be updated. Generally, the Chapter does a good job recognizing the advantages and limitations of using the two main metrics in mortality benefits valuation (the VSL and the VSLY) and of the different methods used for estimating them (revealed preference, usually in the context of occupational risk, and stated preference). It also does a good job discussing factors—such as age and pre-existing conditions—that matter with environmental exposures and may affect the VSL. The chapter does, however, overlook Viscusi and Aldy (2007), who look at age and the VSL in a wage-risk context. It could also include discussion of alternative methods for estimating VSL such as the "chained" approach linking WTP to reduce non-fatal injury with risk tradeoffs between fatal and non-fatal injury (Carthy et al., 1999).

Despite its careful discussion of the limitations implicit in using the VSL estimated from compensating wage studies when valuing mortality risks associated with environmental exposures, Appendix B and much of EPA's current practice continue to rely on old wage-risk studies. All of these wage-risk studies use old data, i.e., risk levels that are no longer likely to exist and obsolete preferences for risk and income; they are based on cross sections of data, do not control for self-selection into risky jobs and for heterogeneity in preferences for risk and income, and contain a massive measurement error in the risk variable. Better studies to discuss that control for unobserved heterogeneity as well as use better risk measures are Kneisner, et al. (2006), Viscusi (2004), Kochi (2008), among others.

The *Guidelines* should discuss the research concerning the VSL for specific causes of death that are associated with environmental exposures—cancer and cardio- and cerebro-vascular illnesses (e.g., Gayer et al., 2000, 2002; Davis, 2004; Johannesson and Jonsson, 1991; Alberini and Chiabai, 2007). The Guidelines should also discuss research needs in this area. A number of studies using revealed preference methods infer values for risks related to the agency's policies (e.g., Davis, 2004, Gayer et al. 2002, Greenstone and Gallagher (2008), Ashenfelter and Greenstone (2004), Gayer et al. (2000)) and others. Likewise, there are newer stated preference studies that infer values

for risks related to agency's policies that should be referenced (see Krupnick (2007) for examples).

In several places, the Agency refers to the importance of "the impacts of risk and population characteristics" on valuation estimates (e.g., p. 7-6, line 36; p. 7-8, line 31-43; p. B-4, lines 29-32), yet the discussion is generally focused on population characteristics. The agency should consider adding more discussion about the impact of risk characteristics on valuation, the newer literature valuing the events of relevance to environmental policy, and relate these issues to its recommended default value.

**Question 6: Social Costs**

*Does Chapter 8: Analyzing Costs contain an objective and reasonable presentation of the published economic theory, empirical literature, and analytic tools associated with estimating social costs?*

In general, the Chapter does contain an objective and reasonable presentation of economic theory, literature and analytical tools. While generally quite well done, we found several areas where improvements could be made.

At the end of Section 8.3.1.3 Discounting, the *Guidelines* state "In calculating firms' private costs, e.g. the internal cost of capital used for pollution abatement, analysts should use a discount rate that reflects the industry's cost of capital." While this quote is correct, we fear that it could be misinterpreted to suggest that costs and benefits might be legitimately discounted at different rates within a single analysis. Doing so could lead practitioners to make significant errors. For example, an analysis with different discount rates applied to public and private costs could justify a project whose private costs greatly exceed its public cost savings when both occur at the same time period in the distant future. Yet, as the time approaches, this decision would be reversed, implying a form of time inconsistency. The Guidance should be written to make clear that such a practice would not be appropriate.

The beginning of the chapter indicates that costs are usually viewed as straightforward to estimate, but in fact estimating costs presents many challenges. For example, estimating costs of new regulations requires forecasts many years into the future. As pollution control technologies are implemented over time, firms can learn from experience and the development of new technologies may reduce the cost of achieving the standards. At the same time, *ex ante* cost estimates may be based on the assumption that everything works as anticipated, but in practice deviations from expected outcomes often mean higher than anticipated costs. These challenges can be exacerbated since industry often has more information about costs than regulators and are likely to have the incentive to overstate their costs. All these arguments reinforce the report's indication that measuring costs are not at all straightforward, nor are cost estimates "hard" numbers.

The report differentiates between partial equilibrium analyses which model a single market or a small number of markets, versus general equilibrium analyses that model the entire economy. The Chapter might be better organized by examining three cases: single market analyses, multiple market analyses and general equilibrium analyses. Significantly different challenges are faced when carrying out multi-market partial equilibrium models than single market models, and it might make the explanation more clear.

Also, some additional guidance would be helpful on carrying out multimarket partial equilibrium models (e.g., Section 8.1.2, page 8-5). For example, the report could indicate the conditions under which multimarket models are likely to be necessary, and

how multimarket analyses should be carried out. The Just, Hueth and Schmitz textbook provides a thorough treatment of these issues, and could be both the source of information for the document summary and an excellent reference for further information.

It is important to note that it is not simply the number of markets that are affected directly by a regulation, but also their size and influence on the economy that determine whether partial equilibrium analysis is adequate. Indeed, the first example under CGE (Sec 8.1.2) is of a single but large market (electric utilities). Similarly, a partial equilibrium analysis of a significant change in "the labor market" is unlikely to be adequate, given its influence on nearly all markets in the economy. It might also be worth noting that definition of "a market" is not always clear cut. Is "the labor market" one or a large collection of segregated markets with somewhat permeable boundaries, by age, education, experience, geography, etc.?

On page 8-4, immediately below the figure, the text states "While in reality at least part of the compliance cost will likely be spent on abatement-related purchases from other industries – and is thus not necessarily a loss to society – in this market, the deadweight loss resulting from the regulation is lost completely." It should be made clear that expenditures in other markets are losses to society except for the portion that is a quasi-rent. We are concerned this passage could be interpreted as expenditure per se in other markets are not losses to society. Again, the Just, Hueth, and Schmitz (2005) textbook is an excellent source for appropriate accounting of multimarket effects.

In general, the treatment in the report focuses too much on perfectly competitive markets, and provides too little discussion of non-competitive market environments. In our introductory comments and in response to Charge Question 1, we discuss the need to incorporate real world "second best" conditions in the Guidelines. With respect to costs, results will differ significantly in a non-competitive market, or in a market where there are other distortions. In general, a complex game theoretic formulation is needed to assess effects in markets that are not perfectly competitive.

**Question 7: CGE Models**

*Does Chapter 8 contain an objective, balanced and reasonable presentation of the published economic theory, empirical literature, and analytic tools associated with computable general equilibrium (CGE) models? Is the description of the relevance of these models for economic analyses performed by the EPA reasonable?*

Overall, the discussion of the structure and use of computable general equilibrium models in Chapter 8 is concise and very good. It clearly summarizes the design and structure of CGE models, their strengths and weaknesses, and the role of such models in economic analysis at EPA.

The only major topic the section does not discuss is the parameterization of CGE models. Some use behavioral parameters estimated econometrically from extensive time-series data, while other models use parameters calibrated to a single input-output table or taken from the literature. Estimation is clearly preferable where adequate data exist. One of the principal benefits of general equilibrium modeling over input-output analysis is its ability to capture substitution in production and consumption, so it is important that the relevant elasticities be tied as closely as possible to the historical record. A paragraph on parameterization should be added to the section. A brief discussion of parameterization should be added to Section 8.4.4 on Input-Output analysis as well.

Secondly, the *Guidelines*' discussions of CGE modeling in general and the concept of general equilibrium welfare analysis in particular should be expanded to address the role of models that introduce pollution (or equivalently environmental services) in non-separable specifications for consumer preferences. Such specifications introduce the prospect for feedback effects where policies to reduce externalities lead to changes in the demand for market goods and then in turn the amount of pollution giving rise to the externalities. These responses "feedback" and affect the demands for market goods. The process can be expected to continue with the models describing systems where the market and non-market interactions affect the ultimate market equilibrium. It is important to draw distinctions between sorting models with multiple markets and what might be described as extended partial equilibrium analyses and CGE models. Recent advances in both types of models allow EPA to consider using these structures to assess when the changes associated with their policies would be large enough that conventional practices that assume away general equilibrium effects need to be modified or at least qualified. There is sufficient research that the *Guidelines* can begin to introduce candidate procedures for addressing these issues.

The section would benefit from a few minor revisions as well. First, the discussion at the beginning of Section 8.1.2 should emphasize that the need for general equilibrium analysis depends on the scope of the policy's effects rather than just the number of markets. A policy might have significant effects in a single market, but if the market is large enough (the labor market, for example), general equilibrium analysis would still be warranted. Similarly, a policy affecting a large number of very small markets might be adequately addressed by partial equilibrium analysis.

A second minor revision is that the discussion of the benefits of dynamic models should be expanded slightly. Not only are such models useful for capturing saving and investment effects, they can also be used to examine policies that themselves change over time—becoming more stringent, for example. In addition, models based on intertemporal optimization by the underlying agents can also capture anticipation effects: changes in behavior occurring when policies are announced that don't take effect until some point in the future.

A third minor point is that the discussion of the ability of CGE models to capture transition costs should be expanded slightly and the conclusion that they cannot capture such costs should be refined. It is true that many models are inappropriate for short run analysis because they assume that capital and labor are completely mobile between sectors, and because they typically use substitution elasticities that reflect medium to long run behavior. However, those are characteristics of existing models rather than the methodology itself. Models that use sector-specific capital stocks and costs of adjustment in investment are able to capture important short-run costs due to misallocation of capital. In principle, models with adjustment costs in labor demand could capture additional short-run costs due to labor misallocation as well. It would be most accurate to say that many existing CGE models are not designed for analyzing short-run transitional costs, rather than it being a problem inherent in the methodology. Finally, because CGE models differ considerably from one another in design and parameterization, it is valuable to use multiple models when possible, especially for policies expected to have very large effects on the economy. When EPA uses CGE analysis, it often does use multiple models and it would be very useful to note that in the text.

Finally, the issues of validity and reliability mentioned in other areas of the Advisory are equally relevant to CGE models. We suggest EPA make this point in this chapter and refer readers to the broader discussion of these issues elsewhere.

**Question 8: Distributional Analyses**

*Does Chapter 9: Distributional Analyses: Economic Impact Analyses and Equity Assessment contain an objective and reasonable presentation of the measurement of economic impacts, including approaches suitable to estimate impacts of environmental regulations on the private sector, public sector and households? This discussion includes, for example, the measurement of changes in market prices, profits, facility closure and bankruptcy rates, employment, market structure, innovation and economic growth, regional economies, and foreign trade.*

Chapter 9 contains an objective presentation of many of the aspects of economic impact analyses (EIA). It tackles market prices, profits, facility closures, unemployment, market structure, innovation, and growth. Although Chapter 9 contains information on estimating the economic impact of policies, discussing three approaches briefly: Direct Compliance Costs, Partial Equilibrium and Computable General Equilibrium (CGE), it points to Chapter 8 for more details. To make Chapter 9 stand alone, developing brief examples from chapter 8 for both partial and CGE may further the reader's understanding of why these are more effective than the direct compliance costs. Also, augmenting the warning of the complexity of CGE modeling may be worthwhile.

While there is attention to the implementation of CGE models, the discussion of partial equilibrium models basically directs the reader to find supply and demand curves or elasticities, but there are multiple ways of implementing partial equilibrium models. One which would tie this chapter to the benefits chapter is the "production function" approach. More discussion concerning implementation would be valuable.

The *Guidelines* acknowledge that input-output (I-O) models have important conceptual shortcomings as measures of economic benefits and costs. In addition, it might be pointed out that I-O models ignore opportunity cost of resources, implicitly assuming that inputs used in some new activity would otherwise go be idle and have no opportunity cost. For example, I-O analyses frequently use multipliers to calculate jobs "created" due to the direct, indirect and induced effects of an activity. A proper measure of benefits would account for the opportunity costs by subtracting the value of labor in its next best use.

Some other miscellaneous points to consider:

- Linear programming (LP) is more of an optimization method than an economic concept or model.
- There should be some discussion of the marginal cost of public funds as a cost of policies. This may belong in Chapter 8 rather than Chapter 9.

There should be a discussion of the implications of distortions other than taxes for costs, such as imperfect competition and rent seeking public interventions.

**Question 9: Measuring Equity Effects**

*Does this chapter contain a reasonable presentation and set of recommendations on the selection of economic variables and data sources used to measure the equity dimensions identified as potentially relevant to environmental policy analysis?*

Data sources for both items are reasonably well addressed in Chapter 9. For information on the former, the U.S Census (household and economic) provides a majority of the data while industry rating agencies provide a deeper understanding on which industries are susceptible as described in the document (9.5.2 - 9.5.4). However, there is some uncertainty in how to obtain information on government entities as only accessing data through "community or state finance agencies" is mentioned (9.5.2.2). Information on assessing how the populations of interest are being affected can be found via various environmental sources pointed out in Section 9.8.4. Overall, the chapter contains all the relevant economic variables necessary in an equity analysis. To support analysts, EPA might consider creation of a website to catalog all of the data sources.

The chapter also provides a reasonable discussion of what the analyst should consider in measuring the distributional aspects of regulations. The main items in assessing equity issues are correctly identifying the populations of concern and accounting for how the populations of interest are being affected. In doing so, it is important to balance data acquisition costs against the value of accuracy.

One limitation we note is that the main distributional issues that are discussed in this chapter relate to the cost side: i) direct compliance expenditures (p. 9-17), ii) indirect costs (taking into account multipliers, GE effects, etc.), and iii) enforcement costs. The bulk of the chapter relates to direct compliance expenditures, and discusses how regulation influences prices, through changes in the composition of industry for example. This focus on the cost side misses many important issues related to environmental justice. EPA should note that there may be just as much interest in considering the distributional effects of benefits of an environmental change. The costs of identifying the distribution of benefits may be much more data intensive and costly than identifying the distribution of costs. Nonetheless, it would seem appropriate for this document to represent the ideal case as one in which the equity and impacts associated with both benefits and costs are considered.

In the context of describing the benefits, costs, or net benefits distribution across populations, it would be useful to describe how the concepts of Lorenz curves and/or Gini coefficients could be used.

**Question 10: Economic Literature**

*Appendix A: Economic Theory was prepared for those readers who wished to have a better understanding of the economic foundations underlying benefit cost analyses. Does Appendix A summarize the relevant literature in an objective and meaningful way? Are there topics that warrant (more) discussion in this appendix that were otherwise missed?*

The Appendix provides a thorough and clean discussion of the core economic foundations relevant to benefit-cost analysis with two exceptions. First, a discussion explaining the distinction between stock and flow pollutants should be added. A stock pollutant is an unwanted byproduct of production or consumption that accumulates through time whereas a flow pollutant does not accumulate. Much of the *Guidelines* deals only with a special case where the damage from pollution comes exclusively from the one-period flow of the pollutant and does not consider the general case where the damage comes the accumulated stock of the pollutant. This distinction can be important when undertaking benefit-cost analysis for pollution reduction as the form of the damage function differs. Since greenhouse gases are a prominent and potentially catastrophic stock pollutant, this is an especially important topic for the *Guidelines* to address.

Second, the concept of "user cost" should be defined and explained. User cost relates to forgone future benefits of a resource. That is, exhaustible resources used today will not be available for future use. Benefit-cost analysis related to resource stocks will often need to consider and estimate user costs so its inclusion is important.

**Question 11: Omissions**

*Please identify and enumerate any inconsistencies you may find across chapters and other issues/topics on which we should provide further elaboration. Also, please identify any definitions provided in the new glossary that are inaccurate or that otherwise need revision.*

Most of our advice on cross-cutting issues is provided in the Introduction to this Advisory. Below are a few additional ideas that merit consideration.

First and foremost, the Guidelines sorely need case studies and examples to illustrate and make concepts concrete and meaningful.

International trade in market and nonmarket goods is not adequately covered in the *Guidelines*. The discussion of costs, for example, generally assumes a closed economy without international competition. The discussion of policy instruments focuses exclusively on the management of "internal" externalities.

Dynamics are another issue receiving inadequate attention in the *Guidelines*, although dynamic models are discussed in the CGE chapter. Dynamics become relevant to policy analysis, and to estimation of benefits and costs in several contexts. One context is stock pollution problems, climate change being the leading example. Another is when the costs of pollution control or the benefits of pollution reductions have dynamic elements. The costs of pollution control have dynamic elements when there are capital adjustment costs and when there is induced technological change – both features of the "real world." Benefits of pollution reductions have dynamic elements when pollutants are stock pollutants, and when those damaged by pollution have capital adjustment costs in adapting to environmental conditions, and when environmental conditions induce innovations among those who are damaged. Dynamics in these contexts are important in benefit and cost estimation.

**Appendix: Compilation of Line by Line Comments from Individual Members**

The following comments are suggested edits from individual panelists. As these comments were minor and not considered for full panel deliberation, they are listed separately here for the Agency's consideration.

Page 4-3, Line 13: Drop statement "... does not attempt to detail the relative merits of putting them into practice …" . Report discusses merits of various approaches.

Section 4.1: Divide this section into two parts: (i) Efficient Level of Pollution (MD = MACaggregate) and (ii) Cost-Effective Level of Pollution – minimize cost across sources (MAC1= MAC2= … = MACn). Each will need a supporting graph and should be integrated by showing aggregate MAC is derived from individual MACs. See Field and Field textbook for dividing the discussion in this way. Also, in discussion of efficient level of pollution be sure to define social welfare using underpinnings of Pareto Optimality. In the discussion of efficient level of pollution note that in the presence of uncertainly, one may prefer to think of the efficient level of pollution as a distribution about E*.

Section 4.2: Divide this section by (i) design standards and (ii) performance standards for clarity. They seem to bump up against each other in the discussion. Be clear about the difference between design standards (technology forcing) and technology based performance standards. Show uniform and technology-based performance standards using cost-effectiveness graph introduced in previous section. Uniform standards are not cost effective but have a low information burden (do not need to know MACs) and technology-based performance standards are cost effective in principle but have a high information burden (need to know MACs).

Page 4-6, Lines 2-4: Definition of Command and Control (CAC) is not quite right. CAC sets requirements on specific firms. Please clarify. Also, consider dropping the terminology CAC. Simply refer to these directly as design and performance standards.

Page 4-6, Lines 28-29: Drop "…firms are not responsive to price signals ..." and "… random events and emergencies …". Emergency argument for standards is ok but it can be applied in the context of any regulatory approach including market-based approaches.

Page 4-6, Lines 31-32: This sentence is incorrect. Polluters may have face different design or performance standards under CAC regulations.

Section 4.3: When the section on market based regulations is introduced, state why economists tend to prefer these controls: they tend to be least costly, have a low information burden on regulators, and provide incentives for technological advancement. Monitoring and enforcement costs and other administrative costs, of course, can favor direct regulation.

Page 4-8, Coase Box: Even when the conditions mentioned in the opening sentence of the third paragraph of the Coase Box are met, the Coasian solution may not be reached due to asymmetric information and bargaining strategies (ala principle-agent theory) followed by the parties to the transaction. Please qualify the statement accordingly. Also, full information is not a necessary condition for a bargain, even a socially efficient bargain, to take place.

Page 4-9, Line 31: Not sure what is meant by "...when only one permit price exists." When would more exist? Please clarify or drop.

Section 4.3.1.1: Use cost-effectiveness graph to tell the cap & trade story demonstrating its property as a least costly instrument. Also, instead of telling the cap and trade story assuming an efficient level for permit allocations from the start, tell the story that for any aggregate level of emission there exists a cap and trade will be least costly. Then point out that the efficient solution is a special case where the permit allocation is efficient (MD=MAC).

Page 4-11, Lines 23-24: Mention an ambient-based trading scheme directly for dealing with non-uniform mixing (hot spots) and then explain why, due to administrative costs, something intermediate (zones) between emissions based scheme and ambient base scheme maybe efficient.

Section 4.3.2: Expand the discussion of the revenue raising property of the tax and how it can be used to displace other distortionary taxes.

Section 4.3.2: Again, separate cost effectiveness for any given level of emission from efficient (Pigouvian) for special case.

Section 4.3.2: Include some discussion of targeting the tax. Do you target the tax on the pollutant, input, process, or elsewhere? In principle you should place it on damages, but administrative and monitoring costs may suggest targeting elsewhere. Taxing gas is much easier and probably as effective as taxing damages from auto emissions.

Somewhat related to the previous point, please note that policy design is dependent on observable and available information. For example if the policy makers can not observe actual pollution levels but inputs and practices that cause pollution can be observed and there are reasonable estimates on relationship between the input and technology use and the pollution level, then taxes or regulations or fees are based on the imputed pollution levels. Policy makers should be aware of the available information and design policies to best take advantage of the available knowledge. In particular identifying sources of heterogeneity among users and knowing how they affect pollution levels is crucial to policy design. The proliferation of geographic information systems and remote systems to obtain data provide new opportunities for policy design. Studies suggest that there is a significant efficiency gain from policies that adjust to observed heterogeneity relative to uniform policies (Xabadia et-al 2008). Availability of new sources of or means to obtain information may lead to redesign of policies – for example, availability of a technology

of cheap monitoring of pollution may lead to regulation on taxation based on annual pollution rather than imputed pollution. Policy makers should reassess policy design and implementation as technology progresses. See Xabadia, Angels, Goetz, Renan-Ulrich and Zilberman, David, "The Gains from Differentiated Policies to Control Stock Pollution When Producers are Heterogeneous". American Journal of Agricultural Economics, Vol. 90, No. 4, pp. 1059-1063.

Section 4.3.3: Divide section by (i) subsidy per unit emission and (ii) other subsidies. It more or less falls out that way now, but a clear separation would help.

Page 4-14, Lines 2-4: Drop "However, there may be cases in which a subsidy is more feasible than an emissions tax especially when it is difficult to identify polluters, or when research and development activities relevant to emission abatement would otherwise be under-funded." First part of sentence is handled elsewhere and what does "Under-funded" mean? Is there a market failure here?

Page 4-18, Lines 20-24: Drop this passage. A more meaningful distinction between liability rules and other regulations is that they are ex post regulations usually used in cases of accidents or episodic environmental events, not typical flow pollutant cases.

Section 4.4.2: Mention that information disclosure strategies can allow the market create incentives for pollution control (following Coase) with the victims directly signaling their preferences to firms. But these are most likely to work when there are contractual obligations between polluting firms and affected parties (e.g. consumers/workers) and more difficult to work when they affect third parties (see Tietenberg, "Disclosure Strategies for Pollution Control," Environmental and Resource Economics, April-June 1998, v. 11, iss. 3-4, pp. 587-602. Also it should be mentioned that credibility of information is important. Information disclosure can lead to inefficient outcomes when information is not credible (see Brouhle, K. and M. Khanna, "Information and the Provision of Quality-Differentiated Goods," Economic Inquiry: 45(2): 377-395, April, 2007).

Section 4.4.3: Move this section into the market incentive sections and expand the discussion to include issues of limited assets, activity level incentives, courts costs and so forth. See Segerson (1995) for a nice summary.

Page 4-18, Footnote 54: Another study that shows the types of firms that had incentives to improve environmental performance following negative stock market returns is Khanna, M., W. Quimio, and D. Bojilova, "Toxic Release Information: A Policy Tool for Environmental Protection," *Journal of Environmental Economics and Management*, 36 (3): 243-266, November 1998.

Page 4-19, Line 19: "…information on investment options .." This speaks more to the public goods property of information provision than it does information disclosure. It has not really been mentioned until now and is different than information disclosure. Consider bringing information provision into chapter. There may be a under provision of

information on technology following a public goods argument. See Goulder and Parry (2008).

Section 4.5.3: Weitzman argument. When MAC's are uncertain, and if MD is believed to be constant or flat, then favor a price instrument. If MD is believed to have thresholds or be vertical then favor a quantity instrument. This avoids making costly mistakes. This message does not come across clearly in this section. Also, the "degree of uncertainty" is given as a factor in choosing among policies. This is not technically correct. For example, large uncertainty about emissions is of no policy consequence if the marginal damage cost is constant.

Page 4-22, Line 31: It is incorrect to say that voluntary programs *require* firms to set goals (also see line 38) or to say that they definitely achieve environmental improvements. Also, it is not accurate to say that most voluntary programs set goals (line 37). They also do not make it simpler to monitor and measure if participants are meeting the goal – most voluntary programs do not require firms to provide emissions data to the EPA (for a review of these issues and comparison of programs see Khanna, M. and D.T. Ramirez, "Effectiveness of Voluntary Approaches: Implications for Climate Change Mitigation," in *Voluntary Agreements in Climate Policy*, edited by A. Baranzini and P. Thalmann, Edward Elgar Publishers, pp. 31-66, 2004.)

Page 4-23, Footnote 63: The references on voluntary programs are a little outdated. A more recent and updated citation on motivations to participate in different types of voluntary programs, challenges in evaluating their effectiveness and evidence about their effectiveness is Khanna, M. and K. Brouhle, "Effectiveness of Voluntary Environmental Initiatives," Chapter 6 in *Governing the Environment: Interdisciplinary Perspectives*, ed. By M. Delmas and O. Young, Cambridge University Press, Cambridge, U.K. (forthcoming). Khanna, M., "The 33/50 program: Program Design and Effectiveness," in *Reality Check: The Nature and Performance of Voluntary Environmental Programs in the United States, Europe and Japan* edited by R. D. Morgenstern and W. Pizer, RFF Press, Washington DC, 15-42, 2007.

Page 4-24: The box on water quality trading directs people to certain EPA guidance on the design of trading programs. While we think there is merit to these documents, I have reservations about fully endorsing them because there is economically flawed advice about some design elements. This box also misses an opportunity to discuss the importance of economic science to the design of markets. Contemporary water quality markets fail to achieve the promise of trading because of participation and coordination failures that occur in part because of flaws in market design and development. On balance, I recommend dropping the box.

Page 5-2, Line 29: Recommending that the analyst provide " A clear written statement about the *current state of the economy*.." is too broad and may be unnecessary. Instead it is important to clearly specify the current and future state of economic variables that are relevant for the analysis.

Page 5-8, Lines 1-4. The *Guidelines* mention that regulations can lead to innovation (which may not occur in the baseline) which can lead to cost savings. They also mention that there is no statistical evidence supporting this claim of cost savings. Hence they suggest that analysts should avoid assuming differing rates of technological innovation based on regulatory stringency. That last statement (line 4) is incorrect and should be deleted. Instead there should be a brief discussion about the potential for induced innovation due to environmental regulations. Regulations can create incentives for technological innovation that lower the cost of compliance. It should also be recognized that regulations may also discourage innovation in some cases or crowd out other innovations.

Page 6-2, Line 21: NEARLY "any policy"

Page 6-2, Line 37: Can do half-cycle correction, i.e., assume effects occur at mid-year.

Page 6-2, Footnote 73: refers to exponential fn that was apparently deleted from draft

Page 6-4, Line 25 : Note NPV = NFV /(1+r)T.

Page 6-7, Lines 18-20: Text is duplicative

Page 6-10, Footnote 80: Qualify that result requires rate of return > consumption interest rate.

Page 6-15, Section 6.3. Although this section on "intergenerational discounting" is concerned with long time horizon problems, much of the text refers to climate change (e.g., paragraph beginning Page 6-16, Line 6). This is understandable (as that is the most prominent long-horizon problem) but the text could be revised to avoid the impression that it is only about climate change.

Page 7-9, Lines 33-34: The text here mentions possible approaches for valuing morbidity—ex ante and ex post. Please note that studies have also varied in whether they controlled for the opportunity to mitigate the illness (e.g., before or after taking medication).

Page 7-9, Lines 9-10: Recommend not listing fetal loss as a non-fatal health effect – some people would disagree.

Page 7-11, Line 20: Better to say that social costs include private costs (reflected in individual WTP) and external/public costs (e.g., medical care expenses paid by insurance or public sources). The existence of externally paid costs does not mean the individual "understates" own WTP.

Page 7-17, Lines 2-4: I guess this statement is true, but a tighter bound would be one shouldn't include effect for which cost of gathering information exceeds expected improvement in net benefits from choosing a better policy given this information. But I

don't want to make too much of the analytic cost point – seems to me that analytic costs are very small compared with B and C of the major regulations we're mostly considering (e.g., >100 M/yr for many years).

Page 7-19, Lines 15-16: It would help to clarify discussion of when multiple methods are substitutes or complements. In some cases different components will be captured by different methods (e.g., private WTP to reduce health risk, public cost of illness of treating illness), in which case it is appropriate to use both methods and add results (making sure they do not double-count subcomponents). In other cases where different methods provide alternative estimates of the same component, multiple estimates may be useful to triangulate on most accurate value, but should not be added.

Page 7-26, Line 22: Re opportunity cost of time, what if driving to the recreational site is itself enjoyable? After all, in some cases much of the benefit of travel is the journey, not the destination. I'm sure this is discussed in travel cost literature, but I don't follow it.

Page 7-28, Lines 9-11: Strike this sentence. We have no compelling evidence that instantaneous workplace deaths reflect the same tradeoffs that individuals are willing to make over environmental risks.

Page 7-28, line 17: replace "believe" with "assume."

Page 7-28, line 21: the work by Black and Kniesner (2003) uses only risk measures known be fraught with measurement errors (even the "best" data was based on inconsistent reporting of deaths (see Drudi, 1997) and aggregated in a manner that creates serious endogeneity problems (see Leigh, 1995 (JEEM) and Mrozek and Taylor, 2002 (JPAM)). The discussion here could place Black and Kniesner in this context and then look forward to the newer literature.

Page 7-28: The discussion of wage-risk studies needs to be updated with recent results by Kniesner et al. (2007) and Viscusi and Aldy (2007).

Page 7-28: Text on hedonics. What's the point of placing the discussion of the source of workplace risk data where they are now? It's a non-sequitur, and the text does not elaborate on the implications of these sources and of the level of resolution of the workplace risk data.

Page 7-28: Disagree with "Further, while estimates from the hedonic literature have been relatively consistent over the years, questions persist about…" Au contraire, Costa and Kahn (2004) find that in the US the compensating wage differentials required by workers to accept riskier jobs have grown, while workplace risks have declined, resulting in VSLs that have grown over time. Liu and Hammitt (1997) have likewise found that the compensating wage differentials have grown in Taiwan over 16 years, resulting in progressively larger VSLs.

Page 7-29, line 18 – 19: The Ashenfelter and Greenstone (2004) study is not a hedonics type of study! It's a revealed preference study of agency choices from which a VSL is inferred.

Page 7-30, lines 1-10: Would this section be more appropriate in the valuation of mortality/morbidity section?

Page 7-30: Sources of Risk, first paragraph. It would be useful to cite Eeckhoudt and Hammitt (2001) and also Evans and Smith (2006) who expanded on the notion of competing v. specific risks.

Page 7-31, Lines 36-38: Please explain the following sentence: "For example, if perceived risks are found to be lower than expert risk estimates, then WTP can be estimated with the lower, perceived risk (Blomquist, 2004)."

Page 7-35, Line 44: strike "with minimal additional assumptions".

Page 7-39, Line 29: change "experience, especially…" to read "experience in posted-price markets, especially…"

Page 7-39, Line 12: John Quiggin prefers to spell his last name "Quiggin" and not "Quiggen."

Page 7-39, Lines 2-5: Better to say statistical precision than efficiency. As I understand it, efficiency refers to making most use of information available in the data; it is not for comparing different datasets.

Page 7-39, Lines 38-42: Can you please provide some more recent applications of stated-preference studies using "multi-attribute choice questions?"

Page 7-40, Lines 37-41: Suggesting that choice questions allow someone to "express support for a program" is counter to the goal of using this method to estimate an actual WTP (not some general notion of "support").

Pages 7-40 to 7-43: Much of the material feels old and outdated… Assertions about the properties of SP data and the influence of survey design on SP responses are introduced throughout the stated preference section without proper citations to supporting evidence (e.g., page 7-39, lines 27-36, lines 31-33, and lines 34-36).

Page 7-42, Lines 2-10: The section on Criterion validity over-simplifies the issues. First, for public goods, what is meant by market data? (voluntary contributions markets? political markets?) One should note that theoretically demand revealing mechanisms for public goods are difficult to implement (e.g., Groves-Ledyard), which makes testing the validity of SP surveys for public goods that much more difficult. There have been some studies which compare hypothetical voting on a public good to later actual referenda on

such goods (e.g. Johnston, 2006,) – but this type of criterion test will not generally be available for the policy outcomes being considered by the EPA.

Page 7-42, lines 12-28: For studies that focus on policy-relevant outcomes for the EPA, convergent validity tests will generally not be available (since the goods being considered are not actually "deliverable" by the researcher). Even if similar goods could be delivered, if they are public goods it will be difficult to assure the RP (actual transaction) data are free from biases associated with public good provision. (This comment essentially reiterates the comment above for lines 2-10 on the same page.)

Page 7-43: Survey non-response bias is "created by those who refuse to take the survey" only if their WTP is systematically different from that of those persons who did take the survey. Please make this point clear.

Page 7-44, Line 14, etc.: I don't like the emphasis on doing a new study for each endpoint, since I think that RP & SP studies have so many validity/reliability concerns. On the contrary, I think we are on much stronger grounds having several studies that are relevant from which we can transfer estimates. This may depend on endpoint – for VSL, I want to know what multiple studies say; for some unique ecosystem, I would not care so much about estimated values for effects on other ecosystems.

Page 8-5, Line 44: "In reality, deadweight losses already exist in many if not most markets as a result of taxes, regulations, and other distortions" But presumably, in many cases the regulation will have the goal of correcting existing distortions, such as external costs of pollution. The term "deadweight loss" here is not really a loss if you are considering policies designed to correct externalities. Although the report recognizes that benefits of pollution reduction need to be considered, the term "loss" is not really appropriate here. This is more an issue of terminology, rather than substance.

Section 8.1.1: One of the down sides of partial equilibrium approaches is the possibility of "double counting" impacts. To this end, a clear warning or explanation of doubling counting should be included in the discussion in chapter 9 or chapter 8. Double counting occurs if the outputs from firms operating upstream and downstream are both impacted by the new policy and the impacts are considered separately. The impact on the downstream firm is typically passed on to the upstream firm. For a simple example, consider a fuel policy affecting both a delivery business and a local production business. If one of the local business inputs comes from the delivery business and the policies impact on the local business through this input is including in the partial equilibrium adjustment for the local business, any partial equilibrium analysis for the delivery business should account for this. This warning is especially of interest because the apparent interest in CGE analysis may lead an analyst to estimate multiple partial equilibrium models in place of a CGE due to their relative difficulty.

Section 8.1.3: I wouldn't use the term "economic impacts" since that term generally refers to Economic Impact Analysis, so the term might be incorrectly interpreted. Why not "economic effects".

Section 8.2.1: Alternative Concepts of Cost. The discussion in this section is confusing. If I understand it correctly, these are not alternative concepts of costs, but rather are categories of cost. If properly defined, these categories are simply decompositions of social cost, not "alternative concepts". Does this Section intend to indicate that, for efficiency purposes, only total social costs matter, but decompositions of social cost could provide information on the incidence of costs or the distributional consequences? EPA either needs to explain how these categories are useful, or if they are not useful the discussion could simply be dropped.

Section 8.3.2.1: The report should be more consistent in differentiating between benefits and costs. For example, this section refers to things like "irreversible environmental impacts" as a cost. While it is true that there is no true distinction between costs and negative benefits (e.g., irreversible environmental impacts), the report has separate sections on costs and benefits, and the discussion should be kept consistent by including environmental values in the benefits section.

Section 8.4.4: Input-Output analysis doesn't really belong in this section, since it does not provide a well defined measure of economic costs. We recommend that the discussion be moved to Chapter 9 given its close connection to Economic Impact Analysis and distribution across sectors. Note that Input-Output Analysis does not provide a measure of economic costs and benefits, but output from an I-O analysis could provide some information on how economic effects are distributed across sectors of the economy.

Section 8.2.3. Shouldn't this Section refer to "Distribution of Costs" rather than "Distributional Costs"

Page. 9-1. Footnote 179—avoiding double-counting likely needs more discussion and an example to illuminate the issue.

Page 9-7 and Table 2: Data sources for profiles I would like to add The Thomas Registry is another data source. The Thomas Register, which dates back to 1906, is used primarily by purchasing agents. Lavin [1992] states that the Thomas Register is the best example of a directory which provides information on manufacturers by focusing on products. According to Lavin, "The Thomas Register is a comprehensive, detailed guide to the full range of products manufactured in the United States. Covering only manufacturing companies, it strives for a complete representation within that scope." The EPA should also see the many other types of sources of business information discussed in Lavin, M. R., 1992, Business Information: How to Find It, How to Use It, 2nd ed. (Oryx Press, Phoenix).

Page 9-9, Line 15. They basically punt on pass-through. Perhaps more direction on what to do when basic elasticities are not available.

Page 9-9, Lines 41-42. Is this a cost or benefit? I see it as a net benefit that should be estimated somehow.

Page 9-9, Footnote 192: This then leads to the producers of equipment to dig out the coal being hurt. Be clear about how far down the chain we go.

Page 9-12, Lines 20-22: Regional analysis. Lacks a thorough discussion of regional economies and trade. In this way the document can update FN 204 by including work of Copeland and Taylor and Greenstone.

Page 9-16, Lines 10-12: Another indicator that could be considered at the community level is the foreclosure rate.

Page 9-18, Lines 1-8: This gets us back to the proper counterfactual. In this example they merely discuss the direct cost of the regulation without recognizing that these expenditures have other benefits and costs. For example, they confer tax breaks (complying with regulations is a deductible expense) and that the new capital is more productive than old capital. But a key consideration is whether, and to what extent, the displacement of investment leads this new capital to be less productive than innovation that it displaced.

Page 9-18 - 9-20: Some mention should concern temporal aspects of benefits and costs. For example, the entirety of Ch. 9 contains sections on equity issues for an analysis to consider. In addition to this, a discussion of household movement (Tiebout sorting) may be of interest to account for the long-term equitable distribution. That is, although there may be short run benefits for socially or economically disadvantaged populations, they may not hold in the long run. If these households are not home owners, they may be left out of the gain in benefits if market forces result in disadvantage populations moving because the gains remain attached to home or land and therefore the owner.

Page 9-23: Textbox “2” should be “9.2”.

Page 9-26: Extra period in box 9.3.

Page 9-29: What is the definition of poor? What about gender? This seems to be a relatively ad hoc list of equity factors, are there other identifying characteristics that might be relevant? What about intergenerational equity? .

Page B-4, Footnote 293: Sunstein (1997) and Hammitt and Liu (2004) are more recent citations.

Page B-7, Footnote 309: Adjustments in the VSL for population characteristics “does imply” (not “may imply”) support for variation in protection across the population.

Page A-2, line 4: change “y” to “P” and “x” to “Qd” to be consistent with Figure A.1.

Page A-2, line 19: insert language so sentence reads “The total WTP is equal to the SUM OF THE marginal WTP for each unit up to Q4”

Figure A.3: “P” on the vertical axis needs a “m” subscript to be consistent with the text.

Page A-8, line 7: Change sentence to read: “Benefit-cost analysis can also be SEEN as a type of…”

Page A-8, line 8: We suggest striking “that economists strive to avoid” from the sentence.

Figure A.6: The demand curve could be labeled in the figure directly (especially given there is no title for the figure).

Page A-12, line 32: Change “correct monetary measures of utility change” to read “exact monetary measures of utility change” to be consistent with standard language found in the literature.

Page A-15, line 12: Strike “However,” -- it is out of place given the preceding sentence.

Figure A.10: Consider changing the title on the horizontal axis from “Regulation” to “Pollution Abatement” or something similar.

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