Minutes of the Open Meeting on July 20-22, 2010

U.S. Environmental Protection Agency
Science Advisory Board
Mountaintop Mining Panel

Summary Minutes of the Advisory on EPA's draft Aquatic Ecosystem Effects Report and draft Conductivity Benchmark Report related to Mountaintop Mining and Valley-Fills

Date and Time: Tuesday, July 20, 2010, 8:30 A.M. – 4:30 P.M.; Wednesday, July 21, 2010, 8:05 A.M. – 5:35 P.M.; and Thursday, July 22, 2010, 8:00 A.M. – 12:15 P.M.

Location: Washington Plaza Hotel, 10 Thomas Circle, N.W., Washington, DC 20005

Purpose: The purpose of the meeting was to review and provide advice on the scientific adequacy, suitability and appropriateness of the following reports drafted by EPA's Office of Research and Development (ORD):

- "The Effects of Mountaintop Mines and Valley Fills on Aquatic Ecosystems of the Central Appalachian Coalfields" (Aquatic Ecosystem Effects Report), and
- "Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams" (Benchmark Conductivity Report).

Participants:

SAB Panel: Mountaintop Mining Panel of the U.S. Environmental Protection Agency's (EPA) Science Advisory Board (SAB) (See Roster, Attachment 1)

Dr. Duncan Patten, Chair
Dr. Elizabeth Boyer
Dr. William Clements
Dr. James Dinger
Dr. Gwendolyn Geidel
Dr. Kyle Hartman
Dr. Robert Hilderbrand
Dr. Alexander Huryn
Dr. Lucinda Johnson
Dr. Thomas W. La Point
Dr. Samuel N. Luoma
Dr. Douglas McLaughlin
Dr. Michael C. Newman
Dr. Todd Petty
Mr. Edward Rankin
Dr. David Soucek

	Dr. Bernard Sweeney Dr. Philip Townsend Dr. Richard Warner
EPA SAB Staff:	Ed Hanlon, Designated Federal Officer Stephanie Sanzone, Designated Federal Officer Dr. Anthony Maciorowski, Deputy Director, EPA Science Advisory Board Staff Office Dr. Vanessa Vu, Director, EPA Science Advisory Board Staff Office
EPA Presenters:	Ms. Denise Keehner, Director, Office of Wetlands, Oceans, and Watersheds, EPA Office of Water Dr. Susan Norton, EPA Office of Research and Development (ORD) Dr. Michael Slimak, EPA ORD Dr. Susan Cormier, EPA ORD
Other Participants:	Dr. Glenn Suter, EPA ORD
Attendees:	See Attachment 2, Public Attendance.

Materials Available: The agenda, roster, and meeting materials were circulated to the Panel in advance of the meeting. These materials were made available to the public via the SAB website (www.epa.gov/sab) and hard copies were also provided and made available to the public for review at the meeting. The meeting materials are available on the following SAB meeting website:
http://yosemite.epa.gov/sab/sabproduct.nsf/a84bfee16cc358ad85256ccd006b0b4b/4bb87d5b9c6dea458525770400481586!OpenDocument&Date=2010-07-20.

Meeting Summary

The meeting was announced in the Federal Register[1] and proceeded according to the meeting agenda[2]. A summary of the meeting follows.

July 20, 2010

Opening Statements and Welcome

Mr. Ed Hanlon, Designated Federal Officer (DFO), opened the meeting, and made a brief opening statement noting that the Mountaintop Mining Panel is a Federal Advisory Committee under the Federal Advisory Committee Act (FACA). He noted the meeting was open to the public and that five members of the public listed in the list of public speakers[3] requested to present oral statements (two individuals would present oral comments at the July 20 meeting, and three individuals would present oral comments at

the July 21 meeting). He also noted minutes of the meeting were being taken to summarize discussions and action items in accordance with requirements under FACA. Drs. Anthony Maciorowski and Vanessa Vu, Deputy Director and Director of the SAB Staff Office, respectively, also welcomed everyone for their attendance.

The meeting was turned over to the Chair, Dr. Duncan Patten. Dr. Patten noted this is an Advisory effort where a report seeking consensus would be prepared. Dr. Patten noted there are two separate Designated Federal Officers (DFO's) for the two advisory subjects: Ed Hanlon would serve as the lead DFO role on the Aquatic Ecosystem Effects Report; and Stephanie Sanzone would serve as the lead DFO role on the Benchmark Conductivity Report.

Dr. Patten stated that preliminary Panel member comments, public comments submitted directly to Ed Hanlon, and a table of public comments submitted to EPA's electronic Docket on the Aquatic Ecosystem Effects Report and draft Conductivity Benchmark Report were provided in Panel member folders, on the meeting materials tables, and on the meeting website. He noted that the website's table of public comments submitted to EPA's electronic Docket includes 'hot links' that go to the Docket Comment.

Dr. Patten reviewed the agenda and provided a summary of activities anticipated to occur after the meeting in order to develop two final SAB reports that would be prepared on the two EPA ORD reports submitted to SAB for review. He requested that Panel members introduce themselves.

Ms. Denise Keehner, Director, Office of Wetlands, Oceans, and Watersheds, EPA Office of Water (OW), made a brief opening statement and followed her slides on the Regulatory and Programmatic Context for SAB Review of EPA Conductivity Benchmark and Aquatic Effects Report[4]. Discussion then proceeded on the Draft Aquatic Ecosystem Effects Report.

I. Draft Aquatic Ecosystem Effects Report:

Dr. Norton, EPA ORD, presented her slides on the effects of mountaintop mines and valley fills on aquatic ecosystems of the Central Appalachian coalfields[5]. She outlined EPA's activities in developing the draft Aquatic Ecosystem Effects Report, and noted how EPA decided on which literature to review, the geographic bounds for the study, and environmental results of the analysis. A brief discussion occurred regarding toxic effects of selenium to the ecosystem, the link between selenium and conductivity, the reasoning for why data after 2002 was not inventoried as part of the report, prediction of conductivity concentrations in permits, and selection of specific conductance rather than specific ions as a benchmark to assess aquatic effects.

Dr. Slimak, EPA ORD, then presented slides[6] and outlined the six charge questions associated with the draft Aquatic Ecosystem Effects report. A brief discussion occurred regarding the selection of specific conductance as a benchmark to assess aquatic effects,

and regarding the regional scale and geographic watershed areas associated with the impacts assessed in the draft Aquatic Ecosystem Effects Report.

Public Comment:

A list of members of the public who provided oral statements and their affiliations is provided in Attachment 3.

Mr. David Ledford of the Appalachian Wildlife Foundation provided an oral statement[7] and noted that the focus for the draft Aquatic Ecosystem Effects Report is to restore wildlife habitat. He stated that the draft Aquatic Ecosystem Effects Report does not accurately characterize current restoration efforts associated with upland habitats, and that fish and wildlife habitat and grassland/shrub species are important for restoration objectives. He also noted that it is important to consider landscape context and human/landowner interests when assessing restoration. He stated that the SAB panel lacks expertise on upland habitat ecology, and noted that there is a current University of Tennessee project that was compiling information on upland wildlife response to mining reclamation. A copy of Mr. Ledford's oral statement is provided on the SAB Meeting website.

Mr. Rusty Ashcraft of Alliance Coal noted that a mining association formed a biology working group to review these draft EPA documents. He stated that that the toxicity effects discussed in EPA's draft Aquatic Ecosystem Effects Report were not consistent with the findings of the individual papers relied upon in the references of EPA's draft report, and that EPA's report had inconclusive results. He noted that it appeared that other factors were more important than conductivity and that there were many confounding variables that affected the results of EPA's analyses. He also noted that the conductivity benchmark emphasis on the mining industry ignored the larger impacts from other land-use change forces (e.g., development and road salting). He also stated that the draft Aquatic Ecosystem Effects Report's restoration techniques that were assessed did not consider newer restoration approaches. He further noted that mixing of genus-specific and species-specific responses ignored differences in sensitivity among taxa within a genus.

Dr. Patten asked the Panel if they had any questions for the public commenters. Hearing no questions, Dr. Patten noted that discussion would begin on the Panel's responses to charge questions for the draft Aquatic Ecosystem Effects Report.

Discussion on Charge Questions - Aquatic Ecosystem Effects Report:

Charge Question 1: Conceptual Diagram

Several Panel members noted that the conceptual diagram that EPA included in the draft Aquatic Ecosystem Effects Report was relatively comprehensive regarding direct consequences of mountaintop mining and valley fill operations (MTM-VF). They noted that the conceptual diagram did not appear to address indirect consequences of MTM-VF,

and EPA should consider amending the report and diagram to address specific indirect consequences of MTM-VF. Several Panel members provided comments on the diagram and suggested that additional components should be added to the diagram, including:

- impacts resulting from loss or alteration of upland and riparian systems were not well-represented on the left side of the diagram;
- activities and outcomes of the reclamation process were not addressed in the diagram at all;
- index of biotic quality is the only endpoint represented in the diagram, and other metrics could potentially be used that better represent functional endpoints (e.g., altered food web and energy flow);
- hyporheic zone modification and impacts were not well represented;
- the importance of antecedent geologic conditions is not adequately recognized;
- additional modifying factors such as geology, landscape context (e.g., such as rain shadow), and potential biological productivity in streams could be helpful if included in the diagram; and
- risks to the food web from Selenium (Se) also need to be more clearly differentiated, perhaps in the diagram.

A member suggested that EPA should place the conceptual model near the beginning of the draft EPA report and use it as an organizing tool for the remainder of the document. Another member recommended that EPA discuss additional endpoints in the report, including long-term impacts, disruptions in flow regime, nutrient loadings from increased overland flow, forest clearing impacts, and nutrient exchange between upland areas and streams.

A member recommended that EPA consider a simpler version of the diagram and consider future clickable formats for web communication. One member noted that the conceptual model is critical since it can point out the more and less important potential ecological effects from mountaintop mining.

Charge Question 2: Literature Review

The Panel noted that in general, while the draft EPA report included a reasonably complete reference list of peer reviewed published literature, several literature gaps existed in the draft report, including literature associated with: impacts of sediment treatment ponds (e.g., effect of dams downstream; non-mining literature); forest reclamation within the hydrological response discussion; short vs. long-term ecological effects associated with MTM-VF, and active mining vs. reclaimed lands related to MTM-VF. The Panel also suggested that while most of the data was from a 2002 database, more recent databases on VF were available.

A Panel member noted that literature on forested systems and on salamanders should be included, and that the report should cite more available data on freshwater mussels and water quality. The Panel discussed and noted that a significant amount of literature is available regarding the impacts to streams from MTM-VF operations, and that it would provide EPA with available references on this topic as well as on regional "reference

sites." The Panel also noted that it would be appropriate if EPA included some local grey literature to help scope some of the issues that are under-represented.

Charge Question 3: Loss of Headwater Streams

The Panel noted that in general, the draft EPA report characterized most of the potential ecological effects that may occur associated with the loss of headwater streams due to valley fill operations. The Panel acknowledged the limited available data on this topic, and recognized that this topic was a difficult issue to address in the report. The Panel noted that EPA's assessment could be strengthened by improving the discussion on the following issues associated with loss of headwater and forest resources:

- lack of estimate of ultimate areas to be affected by MTM-VF over different timeframes,
- lack of an explicit inventory of the diversity of freshwater habitats affected,
- lack of depth to the assessment of the loss of biodiversity, and
- need for improved precision and accuracy in assessment of effects of MTM-VF on ecosystem function.

A member stated it was disappointing that the draft report did not cover a number of related topics such as the physical, biodiversity, and habitat losses from mountaintop removal. One member noted that the draft Report had some good information on salamanders and brook trout, but recommended that more information be provided on invertebrate taxa that have restricted habitats and would be most affected by habitat fragmentation. Another member requested more information on the geology and history of the area, especially regarding native species that inhabit the ecosystem (e.g., mussels, crayfish). One member requested more information on the ephemeral stream biological and ecological functions.

After this discussion, Dr. Slimak stated that EPA's Office of Water desired a succinct report so that EPA Regions and other colleagues could find it readable. Dr. Patten recommended that ORD should balance readability with completeness and defensibility when finalizing the report. A Panel member noted that the draft report should separately discuss loss and rearrangement of headwater catchments, and identify relevant areas where literature is not available. Another member noted that the functional value of the catchments after being filled in should be discussed, and that cumulative effects should be assessed, including effects from urban stream losses, effects on headwater streams, and incremental increases in urbanization with resulting losses of biodiversity and loss of species richness.

The Panel discussed and commented that upland aquatic systems support a high diversity and biomass of amphibians, and noted that salamanders are key predators in these systems that serve to translocate nutrients. The Panel also commented that the draft Report's effects assessment was limited to headwater streams, and the losses of stream systems should potentially consider losses of other water resources such as wetlands and springs. Dr. Slimak responded that it was difficult to factor in losses of upstream streams within the Clean Water Act's (CWA) Section 402 permitting decisions, but that CWA

Section 404 permitting decisions could factor in such losses. Dr. Norton asked the Panel to identify literature that identified thresholds for habitat loss that can be sustained before losing species.

Charge Question 4: Downstream Water Quality and Stream Biota

The Panel discussed and generally agreed with EPA's overall conclusions that there is strong evidence for a causal relationship between MTM-VF and downstream water quality. The Panel provided several suggestions for improving the report's discussion on causal linkages between MTM-VF downstream water quality and effects on riparian and stream biota and functions. The Panel noted that field surveys consistently find degradation of macroinvertebrate and fish communities below MTM-VF areas. A member noted that freshwater mussels are unique in that area and very sensitive, and that impacts on fish populations could significantly affect mollusks.

The Panel commented that it was encouraging that EPA used field data rather than just laboratory data to develop the report. It recommended that EPA review and consider using two State reports from West Virginia on Selenium, and use such "grey" literature for scoping the problem given the absence of peer-reviewed literature. The Panel also noted that both laboratory and field data are important, and that laboratory data should support the draft conductivity report.

The Panel noted the draft EPA report should acknowledge that measures such as total dissolved solids (TDS) or conductivity are relatively coarse indicators of water quality because the relative toxicity of cations and anions varies greatly. The Panel recommended that the report recognize several complexities with use of conductivity as a measure of aquatic life effects of MTM-VF:

- ionic composition of TDS can influence the response;
- geology influences aquatic life effects;
- other stressors may have "confounding" effects and may interact with the results;
- it is difficult to indicate causal linkages with conductivity because there is no cause-effect related to ability to conduct electrical charge;
- "conductivity" is not a pollutant. Since some Ephemeroptera have a high range of sensitivities, it would be appropriate to consider sensitivity of specific taxa; and
- some constituents comprising conductivity have varying toxicities (e.g., bisulfate, bicarbonate), and recommended that EPA try to find data sets on relative composition of the ions comprising TDS.

Drs. Norton and Cormier noted there was a significant amount of water quality data on bicarbonate and sulfate concentrations, but limited water quality data on potassium and sodium concentrations. Dr. Norton noted EPA would consider water quality data on potassium and sodium.

Charge Question 5: Cumulative Ecological Impacts

The Panel discussed and generally agreed that the published literature is sparse with regard to the cumulative ecological impacts on terrestrial and aquatic ecosystems of filling headwater streams with mining overburden. The Panel noted that EPA should conduct an expanded effort to find or generate relevant information that addresses the cumulative effects aspect of the topics covered within the draft report. The Panel further suggested that EPA assess four aspects of cumulative aquatic system impacts in its report:

- temporal perspective, including whether impacts intensify with time (bioaccumulation of Se may offer some insights);
- synergistic perspective, including how these impacts interact with other stressors (e.g., other land use changes in the watershed);
- river continuum effects, including downstream impacts; and
- cumulative impact of multiple VFs within a watershed, including whether such impacts would be additive.

A Panel member noted that data is lacking on these four noted aspects of cumulative impacts, and recommended that EPA review literature to find evidence of threshold hydrologic impacts. The Panel discussed how to define cumulative impacts, and recommended that EPA:

- assess whether the response is a water quality or environmental response, and whether the response is continuous, declining, exponential or threshold;
- determine how that response interacts with other stressors (additive, compensating, synergistic);
- distinguish regional impacts from multiple localized impacts (regional impacts that are larger than the sum of the individual local impacts); and
- incorporate functional measures of ecosystem responses (indicators of changing trophic structure) into the cumulative impact assessment.

Charge Question 6: Effectiveness of Restoration Methods

The Panel discussed restoration methods and agreed that there is little published evidence that current restoration approaches are effective in recovering aquatic ecosystem functions that have been lost as a result of MTM-VF. However, the Panel recommended that this section of the draft Report be reorganized, cite certain available literature on the topic of restoration effectiveness, and identify the most important shortcomings of current reclamation processes related to aquatic resources. A member stated that EPA should define restoration objectives, show how restoration can be used within the permitting process to ensure maintenance and improvement of watershed scale conditions, and discuss the relevance of state water quality standards and spatial and temporal boundaries associated with meeting restoration objectives. The Panel also provided suggestions for research needs and additional references to be considered.

A Panel member recommended that EPA consider doing some simple tests to identify the conductivity-producing materials from valley-fills. Another member noted that EPA

should identify research needs for identifying uncertainty associated with changes resulting from restoration activities. A member commented that regarding the process for determining the highest quality headwater streams in order to identify restoration goals for an area and what is the susceptibility of an area, EPA should consider a tiered approach that would depend on susceptibility.

One member recommended that EPA consider how restoration efforts are intended to intervene at various points in the conceptual model and adjust the model as appropriate. In addition, another member noted that the geographic scope of the draft Aquatic Effects Report and the draft Conductivity Benchmark Report appeared to be inconsistent, and stated that it was unclear how the two documents related to each other geographically. Dr. Norton responded that the draft Aquatic Effects Report was limited by the data available within the Environmental Impact Statement. Dr. Norton asked for recommendations for relevant literature within and outside of the target study area.

Dr. Patten asked whether any Panel members had any additional comments to make regarding the draft Aquatic Effects Report. After hearing no additional comments, Dr. Patten asked lead discussants for each charge question to draft a list of key summary points made by the Panel along with the rationale and foundation supporting each key point, and send this draft text to Ed Hanlon before the meeting reconvened the next morning. He noted that at the July 21 meeting, each of these draft key points would be projected onto the meeting screen, and the Panel would separately discuss each key point and try to achieve consensus.

July 21, 2010

Dr. Patten projected onto the meeting screen a draft list of key points that Panel members drafted to summarize the July 20, 2010 meeting discussion, and requested that Panel members who were lead discussants for each charge question discuss the key points. The Panel discussed each of the six responses to the charge questions, and suggested changes to each of the responses. The changes made by the Panel to these draft key points are outlined in strike/shade, italicized text in Attachment 4.

Dr. Slimak then presented slides[4] and noted that EPA thought carefully about use of grey literature for the draft reports. He stated that if the Panel had thoughts on any grey literature that would be useful to either report, please let him know. He also noted that EPA set a high threshold for references cited in the two draft reports, and asked the Panel whether there were important studies or information missing from either report.

II. Draft Conductivity Benchmark Report:

Dr. Susan Cormier presented slides[8] and outlined how EPA developed the report. Regarding sensitive species distribution relative to the hardness gradient in surface waters in the region, a Panel member noted that a different benchmark might result depending

on the hardness gradient. Dr. Cormier responded that EPA assessed background hardness levels and found such levels were very low. She noted that the two ecoregions that were assessed had some differences in hardness levels, with slightly higher levels in Ecoregion 70. She stated that EPA considered EPA's Environmental Monitoring & Assessment Program (EMAP) data, and noted that the EMAP data did not include data from Ohio.

Dr. Slimak noted that the benchmark was not an advisory or a criterion, and that EPA Region III sought a value to consider in their permitting decisions. He stated that the value was included in April 2010 EPA guidance to the EPA regions that is available as a Background Document on the SAB meeting website.

Public Comment:

Mr. Steve Canton of GEI Consultants, representing the National Mining Association, stated that EPA's draft Conductivity Benchmark report presented a compelling and seductive approach that had some methodological problems that make it inappropriate for this application. He stated that field data could not be used in the manner presented in EPA's draft report to develop the benchmark. He noted he obtained the West Virginia data set and tried to do an independent analysis using different types of data mining techniques, and that he would submit a final report of this analysis by EPA's August 2010 public comment deadline. He agreed that ionic composition was part of the puzzle, but that a number of other issues (including habitat) explained the variability in the results.

Mr. Brooks Smith of American Electric Power noted that his principle concern was the potential indiscriminate use of EPA's conductivity benchmark by EPA Regions as a binding limit. He noted that EPA did not derive the benchmark in the manner required for that use. He stated that the process used to develop the benchmark ignored the processes for adopting water quality criteria under the Clean Water Act. He also noted that the documentation was inadequate regarding the influence of other factors on the presence or absence of taxa (e.g., flows).

Mr. John Jones of Alpha Natural Resources, Inc., and Chair of the Virginia Coal Association, stated that regulatory action should be firmly based in solid science, and that much further investigation was needed to support EPA's conductivity benchmark. He noted that EPA went beyond the available science in developing the benchmark, and that conductivity alone was not a sufficient basis for a regulatory benchmark and that several states have already reached this conclusion. He stated that some sites with elevated conductivity do not exhibit impairment, and that EPA's analysis of confounding factors ignored literature studies that show the importance of some of these factors. He stated that EPA's benchmark report ignored domestic sewage impacts that were known to have significant impacts to water quality in the region. He also noted that soil characteristics should be considered in the analysis. He stated that older valley fills could be a source of information on temporal effects of MTM-VF on water quality, since MTM-VF activities were relatively recent. He noted that further study of the impacts of dissolved solids was needed and that more recent studies conflicted with the Passmore and Pond studies. He

further noted that it was not good science and not in the best interest of the region or the nation for EPA to single out a single industry in a single region when developing this benchmark.

Mr. Jeffrey Longsworth of the law firm of Barnes and Thornburg noted he represented the Federal Water Quality Coalition (FWQC) and stated that EPA's 1985 guidance on water quality criteria was a laboratory-based approach and that FWQC did not believe it was appropriate to use field data to develop EPA's conductivity benchmark. He noted that EPA's conductivity benchmark was based on fewer than the 8 genera required in EPA's 1985 guidance on water quality criteria. He stated that the toxicity of some ions depends on hardness, and that many streams with conductivity levels of over 300 μS/cm had healthy benthic communities. He noted that EPA's draft conductivity benchmark report lacked detail on how Kentucky data validated the benchmark value, and that lethal concentration-50 (LC50) data depended on ionic composition. He also noted that EPA's draft conductivity benchmark report did not clarify to which waters the benchmark would apply. He also noted that pH effects metals concentrations in surface waters. He stated that instead of a composite measure, EPA should develop a benchmark based on individual ions as several states were already doing.

Dr. Patten asked the Panel if they had any questions for the public commenters. Hearing no questions, Dr. Patten noted that discussion would begin on the Panel's responses to charge questions for the draft Conductivity Benchmark Report.

Discussion on Charge Questions - Draft Conductivity Benchmark Report:

Charge Question 1: Adequacy of Data

The Panel discussed whether conductivity was an appropriate benchmark because it would be a composite value, and recommended that EPA clarify whether ionic composition varied between sites where ionic data was available. The Panel also noted that EPA should consider including individual ions in its conductivity benchmark, and commented that a multi-metric approach is needed. The Panel commented that EPA's limitation of applying the conductivity benchmark to the region specified in the draft report was acceptable. The Panel also noted that EPA's conductivity benchmark approach should have high utility in geographic areas that had the ionic composition specified in the draft report.

Dr. Cormier responded that Table 1 gave a range of ions indicated in the sample results. She noted that the dataset included sulfate, bicarbonate, some chloride, calcium, magnesium, and manganese, but did not include potassium or sodium. She further stated that EPA relied on the Pond and Passmore publications which did report data on ionic composition at valley fill toe areas. She also noted that the constituent ions increased as conductivity increased, except for bicarbonate which levels off, and stated that EPA excluded samples where Marcellus brines dominated (i.e., where chloride dominated).

Several Panel members recommended that EPA identify where its conductivity benchmark approach methodology differed from EPA's 1985 guidance on water quality criteria, clarify whether the data were only identified to genera vs. to species, and discuss whether EPA had any concerns about differences in species within genera. Dr. Cormier noted that some stream sites were dominated by invertebrates and not fish, and that salamanders and other organisms were important. She stated there were limited instances where fish data were available at the stream sites. She also noted that when the Species Sensitivity Distribution (SSD) for a site included all genera, including fish, she did not see a different answer, and that while some data was identified to species, more of the data was identified to genera which often included multiple species.

Dr. Suter noted there were few fish genera and many fishless streams at stream sites assessed in the benchmark report. He also noted that EPA's 1985 guidance required a particular distribution of taxa, and that other EPA approaches have focused on sensitive species and did not include all genera. A Panel member asked EPA to clarify whether it conducted a separate SSD in a region that had different natural hardness, and whether a different benchmark would be the result in such a region. Dr. Cormier stated that EPA conducted the analysis only in West Virginia and Kentucky, and did not conduct the analysis in other states.

The Panel discussed and agreed that more detail should be provided on the approaches used for invertebrate sampling. The Panel also noted that the West Virginia Department of Environmental Protection (WVDEP) data that EPA relied upon were strong and available. A Panel member requested that EPA clarify whether the source of the macroinvertebrate data was from WVDEP, and what were WVDEP's objectives for collecting the data. Dr. Cormier responded that WVDEP used the data for various purposes (e.g., to assess stream condition, and assess Total Maximum Daily Loads, TMDLs).

Several Panel members asked whether Table 2's monthly distribution of sites indicated a temporal/seasonal signal, and noted that most high levels of conductivity did not occur in spring. Dr. Cormier noted that Figure 9 provided West Virginia data for monthly sampling, and that this data showed consistent values with little seasonal data variation. Several Panel members asked whether taxa used in the draft report were all from within Tier 1 sites. Dr. Cormier noted that such taxa occurred at least once in Tier 1 sites.

Charge Question 2: Methodology to Derive Conductivity Benchmark

The Panel members agreed that EPA's approach to derive the benchmark value was generally satisfactory. The Panel agreed that conductivity levels were an acceptable indicator of an ecological problem. The Panel also noted that EPA's efforts to use field data were valid, and that it was appropriate for EPA to constrain the dataset to eliminate confounding variables. The Panel commented that while the methodology was not perfect, it was a vast improvement over a benchmark that would be derived by closely following EPA's 1985 methodology.

Several Panel members suggested several potential weaknesses associated with laboratory studies:

- Surrogate species are key to the lab studies, and their unique osmoregulatory mechanisms impact sensitivity to these ions;
- Ceriodaphnia are relatively insensitive to the key ions associated with conductivity; and
- The most relevant organisms are difficult to raise and maintain in the laboratory.

Several Panel members requested that EPA provide details within the main body of the report on the strength of surrogate relationships. They referred to Figures A1 and A2, and recommended that EPA focus analysis towards quadrants of the Figures where Ephemeroptera was not found.

Several members asked EPA to clarify whether a 95th percentile distribution associated with protection of genera was available for conductivity. Dr. Cormier responded that since EPA could not measure such distributions, EPA assessed whether taxa were gone from the stream. A member asked EPA to clarify what would be the benchmark value if EPA protected 100% of species (i.e., an XE-100 value). Dr. Cormier responded that EPA was reluctant to use the XE-100 value because of outliers, but noted that such a benchmark would be higher. She also noted that higher XE-100 values indicated in the data may be due to high springtime temperatures, and also possibly due to the presence of a few organisms in the tail of the distribution that appeared to have arrived into the system via drift.

A Panel member noted that results for Drunella indicated springtime XE-100 values at 200 μS/cm and summertime XE-100 values at 600 μS/cm, and asked how this affected EPA's outcome. Dr. Cormier responded that any cutoff for separating spring from summer data values was somewhat arbitrary because EPA found emergence of taxa at all times.

A Panel member asked whether EPA should use abundance-weighted data. Dr. Cormier noted that since the presence or absence of genera was clear-cut, EPA was focusing on at extirpation, not changes in abundance. Dr. Suter noted that EPA wanted to ensure that the sensitive taxa were included in the approach taken. He stated that in these streams, the sensitive taxa are the invertebrates, and that while EPA's 1985 guidelines suggested that eight families be represented in such approaches, the guidelines did not absolutely require that eight families be represented in the analysis.

Dr. Cormier requested Panel suggestions for criteria and benchmark development. The Panel discussed various possible methods for developing benchmarks. Several members noted that the confounding factor analysis was not really a weight of evidence approach, and that EPA might consider a Bayesian analysis that uses all taxa. Another member suggested that EPA consider the approach recommended by SAB for nutrient criteria.

One Panel member suggested that EPA redo the analysis, include the rare taxa that were dropped, and conduct a sensitivity analysis that considers whether the benchmark is

protective of the genus as a whole and not just the most tolerant genus members. Another member noted that while the 300 μS/cm benchmark value protected 95% of taxa, some very important taxa in terms of ecological functioning are included in the 5% will not be protected by the benchmark.

A Panel member noted EPA should consider whether the benchmark was protective of designated uses. Dr. Maciorowski clarified that while the benchmark and water quality criteria were scientifically based, they were not generally enforceable. He noted that the incorporation of benchmarks or criteria into a water quality standard or TMDL is a policy vs. a science issue.

Charge Question 3: Relating Species Extirpation to Conductivity

The Panel noted that while the charge question referred to relating species to each other, it was actually referring to relating genera to each other. Dr. Patten stated that the Panel would respond to this charge question by relating genera to each other.

The Panel discussed whether there was a strong relationship between elevated stream conductivity and loss of taxa, and between stream conductivity and the degree of valley fill activity associated with that stream. Several Panel members indicated that an approach that assessed this issue using both laboratory and field data was agreeable. They also noted that because conductivity was a surrogate, there was a slightly broken link with EPA's causality assessment.

One Panel member noted that Figure A3 indicated a strong relationship between conductivity and invertebrate response. The Panel discussed that there could be multiple causes of the same response, and noted that even where no valley fill operations were occurring, data indicated a range of conductivity.

The Panel discussed whether conductivity was the direct cause of the invertebrate responses, or whether the ionic composition was the determining factor. The Panel suggested that EPA assess cause-effect associated with specific ions, and consider other factors or parameters that may be correlated with conductivity (e.g., sulfate). A Panel member noted that since EPA's benchmark was limited to sulfate and carbonate-dominated streams, it would be helpful to know what percent conductivity is associated with those ions, and when/if the approach could be transferred. A Panel member noted that while potassium was a toxic conductivity ion, data for potassium was unavailable. A member stated that Figure 11-8 should be referenced, and references should be provided for figures that show the ions that are co-linear with conductivity (e.g., SO_4). The member noted that individual mechanisms for the relationship may not need to be assessed because these relationships and ions were increasing in same proportions. EPA responded that these ions interact and do not act alone (based on differences in effects for multiple ions). EPA noted it assumed that since the relative composition (ionic balance) was not changing and that the total concentrations were increasing, EPA was reluctant to separately assess sulfate effects.

The Panel recommended that EPA provide more information on ionic composition of the samples, and how the chemical mixtures changed across the region. A member noted that EPA's Environmental Monitoring & Assessment Program (EMAP) developed an approach for calculating equivalents to identify how much conductivity is from each ion category. The member noted that such an approach would also provide an understanding of what is happening to the unmeasured ions.

The Panel noted that EPA's draft report did a good job of connecting the different conductivity ions to the mining activities. The Panel commented that EPA's confounding influence analysis within Appendix A.2.1.2 was generally acceptable.

The Panel suggested that EPA consider osmotic responses, pH, and other parameters and discuss these relationships within the report. Dr. Cormier requested references for appropriate articles on these topics, and noted she was unclear how to assess this relationship within the report because there are different mechanisms associated with the different ions.

Charge Question 4: Confounding Factors

The Panel discussed EPA's analysis of confounding factors that affected measures of biological response, and noted that generally, EPA did a good job assessing confounding factors in its draft report. The Panel discussed EPA's rationale for focusing on responses of Mayflies, and suggested that EPA could bolster the analysis by assessing the effects of other endpoints in the database in order to identify consistency between the results. A member stated that very strong relationships existed between conductivity and impaired biological communities, and suggested that selenium should receive more attention in the EPA report. Another member noted that other factors (e.g. trace metals; dissolved organic matter; dissolved organic matter) may be interacting with or masking the effects indicated in EPA's analysis, and suggested that EPA's assessment of such other factors could help reinforce the argument that conductivity is a good metric.

One member expressed surprise that EPA did not apply multivariate statistical analysis in its report, and recommended that EPA provide more discussion on its data analysis process. A member recommended that EPA discuss how flow regimes affect conductivity, and suggested that EPA provide more quantified statistical analysis of the relative importance of the various factors. Dr. Cormier asked for suggestions on how to further assess this issue. She noted that the data may not have been adequate to look at that topic, and were potentially only available in a few locations. She noted that flow data was not available in the datasets used by EPA, and stated that EPA did some analysis on identifying the preferred models to use. Dr. Suter stated that EPA would rewrite this section of the report to clarify the analytical tools that EPA considered.

One member noted that EPA could potentially stratify data based on catchment size, stream order or some other metric to assess flow regime. Dr. Cormier responded that EPA did stratify the data by three different catchment sizes, and did not see much effect in that analysis.

Charge Question 5: Evaluation of Uncertainty

The Panel appreciated EPA's efforts to characterize uncertainty, and noted these efforts appeared sound and consistent with the literature. The Panel commented that EPA's report should expand its discussion that described the process EPA used to assess uncertainty, and provide a more detailed illustration of the process. The Panel discussed the boot-strap technique for evaluating uncertainty and agreed that the approach was appropriate for this application. The Panel noted it would be helpful if the report provided more discussion on how EPA selected the methods and points used in the boot-strap technique that was applied.

A Panel member asked EPA to clarify data representativeness for the region, and whether the reference sites have conductivity near 300 μS/cm. Several members noted that it would be helpful if EPA characterized the heterogeneity of the data across the region of conductivity values. A member commented that given the different weathering environments, different geologies, and other differences between locations in the region, EPA should consider narrowing the ecoregions that it assessed and identify the potential for errors in the context of natural variability.

A member suggested that EPA describe why it selected 1000 samples rather than a larger or smaller number to develop Figure 7's uncertainty estimates of XE95. Another member noted that the report should clarify the upper and lower boundaries for values within Figure 7. Dr. Suter noted that EPA would consider adding another figure to the report to provide these clarifications.

Charge Question 6: Degree of Protection of the Benchmark

The Panel discussed and noted that the general field-based approach taken by EPA is sound, and is as good if not better than the general water quality criteria development approach that is usually taken. The Panel discussed EPA's field-based approach and noted it used more watershed species and avoids many problems that occur in laboratory studies, and commented that field-based results would likely be more sensitive than results using surrogate laboratory species.

The Panel noted that EPA could have considered a broader set of species when developing the conductivity value. One member noted that EPA should assess whether rare or keystone species could be included into the report using subject knowledge, and identify which dominant insect genera would not be protected at level of 300 μS/cm. Dr. Cormier responded that it may be useful to organize the genera list into taxanomic categories, and would welcome comments on how to organize and sort the tables so that they could be more useful.

A member noted that EPA should discuss the sensitivity that unique freshwater mollusks in the region have to osmotic stress, since for mussels, the region was a biodiversity 'hot spot.' Dr. Cormier responded that while the database had few values on this topic and

thus EPA could not capture this within the analysis, EPA would consider adding a site-specific discussion to the text of the report to elaborate on this issue.

A member noted that since the benchmark is based on extirpation of genera, it is based on least sensitive species in each genus (because the last ones to disappear are the least sensitive). The member commented that since there are more and more co-existing species in genera in field studies, a growing number of taxa would be unprotected. The member recommended that EPA consider applying a safety factor to the proposed benchmark to address this issue. Another member noted that if the 300 μS/cm value/level was close to background levels, EPA could include a safety factor that would bring the level to or below background. This member noted that Ohio applied a protection factor for high quality waters (under Ohio's tiered uses program), and that Ohio's antidegradation policies provide a mechanism for protection as well.

Charge Question 7: Transferability of Benchmark to Other Regions

The Panel members discussed EPA's technique for developing this benchmark, and noted it is flexible and transferrable and should be able to accommodate different ionic signatures. The Panel agreed that to transfer this technique, a strong dataset would be needed, and that EPA should address the confounding analyses issues that were raised earlier. Several members commented that it is difficult to use conductivity results to determine causality and sources of the releases that are occurring, and noted that EPA should think more about mechanistic links and not just base the analyses on conductivity (e.g., in the west, water withdrawals greatly change conductivity). Other members noted that in other areas of the country, conductivity may be too broad a measure.

The Panel suggested that it would be much more difficult to transfer the method to areas with more diverse hydrology and geology. The Panel noted that an extensive database is needed to span the stressor gradient and provide sufficient data samples (i.e., 30 samples). Dr. Cormier noted there were fewer sites in the Kentucky dataset, and that EPA could do sensitivity analyses to identify the minimum sample size that would not provide unacceptably high variance.

The Panel further discussed application of the technique to another region, and noted that the size and nature of the region should be considered more than ionic signature. Several Panel members noted that appropriate regional size should fulfill five fundamental conditions:

- 1. fauna at reference sites reflect the same genera pool (same variation in sensitivity)
- 2. similarity in conductivity background levels
- 3. consistency in relative ionic composition (ratios of ions)
- 4. potential confounding factors could be addressed
- 5. need comparable field dataset (large)

The members also noted that EPA should have confidence that different mechanisms of response did not occur within different ionic mixtures. Dr. Cormier responded that EPA

does not usually try to provide mechanism of action data when developing water quality criteria, and noted she was not sure how this would be done in all cases. Regarding whether attention is given to mechanism of action when criteria are chemical-specific, Dr. Suter responded that historically that is not the case, and that the endpoint of concern is if the organisms die.

Another member noted that EPA should report availability of reference conditions, preferably those derived separately from best professional judgment.

Charge Question 8: Applicability of Methodology to Other Pollutants

The Panel members discussed applying the field-based method to other pollutants, and noted it could be so applied given some of the caveats already discussed by the Panel, and assuming sufficient data was available to cover the gradient. The Panel noted that various issues should be considered when applying the method, including: consideration of confounding factors; attention to mechanisms (e.g. bioaccumulation); and assessment of what happens to benchmarks under changing conditions (e.g., changes in precipitation patterns, water levels, changes in snow melt, changes in temperature, climate change).

A Panel member noted that EPA should consider use of multiple approaches to assess and determine a benchmark (e.g., linking laboratory and field approaches; intensive and extensive field validation).

The Panel suggested that EPA could assess traits that are tied to a specific stressor (e.g., morphological or life history traits) when considering application of the method to other pollutants. A member noted that the research community is beginning to take this approach, and suggested that EPA could consider trait extirpation rather than genera extirpation. The member noted that certain organisms are particularly susceptible to osmoregulation or sedimentation.

A Panel member noted that the method is most applicable to naturally occurring pollutants (e.g., dissolved oxygen and nutrients). The member noted that if there are strong differences in data across ecoregions or basins, waters should be classified to identify strong naturally occurring gradients that should be taken into account. Another member noted that this field-based method may be applicable to habitat, which can be both local and larger scales, and suggested that change in abundance rather than extirpation curves should be assessed. The member commented that EPA should develop breakpoints to identify where declines in abundance occur, and noted that the method could be used to assess bioaccumulative pollutants, if exposure issues were identified.

Comments on Grey Literature:

Dr. Patten asked the Panel for feedback on grey literature (i.e., unpublished data), and what criteria EPA should apply when using such literature. Panel members provided the following comments:

- Use of grey literature is a slippery slope, and it is important to apply professional judgment when using grey literature. EPA should be careful and step gently when considering use of grey literature. Once the 'door is opened' towards regular use of grey literature, industry data will be provided to EPA and EPA will need to make decisions associated with that data.

- There are situations when there are very good datasets and work in the grey literature (e.g., selenium data in fish tissue), but such datasets are difficult to find through classic search mechanisms. Researchers all use some grey literature, but it is unclear where to draw the line regarding how to evaluate which data to use. Many EPA reports have quality assurance programs associated with development of the report, and thus there is an auditable trail for the data. Peer-reviewed articles may also have quality assurance problems.

- EPA's published guidance on Data Quality Objectives (DQO) might be helpful in assessing this issue. A key question was basing decisions on intended uses of the data.

Dr. Patten asked whether any Panel members had any additional comments to make regarding the draft Conductivity Report. After hearing no additional comments, Dr. Patten asked lead discussants for each charge question to draft a list of key summary points made by the Panel along with the rationale and foundation supporting each key point, and send this draft text to Stephanie Sanzone before the meeting reconvened the next morning. He noted that at the July 22 meeting, each of these draft key points would be projected onto the meeting screen, and the Panel would separately discuss each key point and try to achieve consensus.

July 22, 2010

Dr. Patten projected onto the meeting screen a draft list of key points that Panel members drafted to summarize the July 21, 2010 meeting discussion, and requested that Panel members who were lead discussants for each charge question discuss the key points. The Panel discussed each of the eight responses to the charge questions, and suggested changes to each of the responses. The changes made by the Panel to these draft key points are outlined in strike/shade, italicized text in Attachment 5.

Next Steps:

Dr. Patten discussed next steps and action items.

- By 8/6/10, Lead Discussants send Stephanie Sanzone and Ed Hanlon written text that describes the bulleted key and consensus points that were provided in Attachments 5 and 7.
- Upon receipt of this written text, Dr. Patten, Stephanie Sanzone and Ed Hanlon will draft reports and send them to the Panel for review.

- Upon receipt of Panel comments to the draft SAB reports, Duncan, Stephanie and Ed will revise the draft reports, and send the revised draft SAB reports to the Panel for followup review. These revised draft reports would be posted on SAB's website, and a teleconference call will be scheduled with the Panel to discuss their comments on the revised draft reports.
- After the teleconference call, revised draft reports would be developed and sent to the Charter Science Advisory Board for Quality Review. After modifications to the draft reports, final SAB reports would be sent to the EPA Administrator.

III. Concluding Discussions:

Drs. Patten, Vu and Slimak all expressed thanks to the MTM-VF Panel members who participated on this advisory activity. With the meeting business concluded, the Designated Federal Officer adjourned the meeting at 12:15 pm ET.

Respectfully Submitted:	Certified as Accurate:
/signed/	*/signed/*
Mr. Edward Hanlon Designated Federal Officer	Dr. Duncan Patten, Chair Mountaintop Mining Panel

NOTE AND DISCLAIMER: The minutes of this public meeting reflect diverse ideas and suggestions offered by Panel members during the course of deliberations within the meeting. Such ideas, suggestions and deliberations do not necessarily reflect consensus advice from the Panel members. The reader is cautioned to not rely on the minutes to represent final, approved, consensus advice and recommendations offered to the Agency. Such advice and recommendations may be found in the final advisories, commentaries, letters or reports prepared and transmitted to the EPA Administrator following the public meetings.

Materials Cited

The following meeting materials are available on the SAB website: http://www.epa.gov/sab, at the March 7-8, 2011 SAB Hydraulic Fracturing Study Plan Review Panel Meeting page at http://yosemite.epa.gov/sab/sabproduct.nsf/a84bfee16cc358ad85256ccd006b0b4b/153ac7df8d2626f98525781000648075!OpenDocument&Date=2011-03-07:

[1] Federal Register Notice Announcing the Meeting

[2] Agenda for July 20-22, 2010 Meeting

[3] List of Public Speakers

[4] Presentation from Ms. Denise Keehner, USEPA

[5] Presentation from Dr. Susan Norton, USEPA

[6] Presentation from Dr. Michael Slimak, USEPA

[7] Oral Statement submitted by David Ledford, representing Appalachian Wildlife Foundation

[8] Presentation from Dr. Susan Cormier, USEPA

Attachment 1: Roster

U.S. Environmental Protection Agency
Science Advisory Board
SAB Advisory Panel on Ecological Impacts Associated with Mountaintop Mining and Valley-Fills, and Aquatic Life Benchmark for Conductivity

CHAIR

Dr. Duncan Patten, Montana State University, Bozeman, MT

MEMBERS

Dr. Elizabeth Boyer, Pennsylvania State University, University Park, PA

Dr. William Clements, Colorado State University, Fort Collins, CO

Dr. James Dinger, University of Kentucky, Lexington, KY

Dr. Gwendolyn Geidel, University of South Carolina, Columbia, SC

Dr. Kyle Hartman, West Virginia University, Morgantown, WV

Dr. Robert Hilderbrand, Appalachian Laboratory, University of Maryland Center for Environmental Science, Frostburg, MD

Dr. Alexander Huryn, University of Alabama, Tuscaloosa, AL

Dr. Lucinda Johnson, University of Minnesota Duluth, Duluth, MN

Dr. Thomas W. La Point, University of North Texas, Denton, TX

Dr. Samuel N. Luoma, University of California, Davis, Sonoma, CA

Dr. Douglas McLaughlin, National Council for Air and Stream Improvement, Kalamazoo, MI

Dr. Michael C. Newman, College of William & Mary, Gloucester Point, VA

Dr. Todd Petty, West Virginia University, Morgantown, WV

Mr. Edward Rankin, Ohio University, Athens, OH

Dr. David Soucek, University of Illinois at Urbana-Champaign, Champaign, IL

Dr. Bernard Sweeney, Stroud Water Research Center, Avondale, PA

Dr. Philip Townsend, University of Wisconsin - Madison, Madison, WI

Dr. Richard Warner, University of Kentucky, Lexington, KY

SCIENCE ADVISORY BOARD STAFF

Mr. Edward Hanlon, Designated Federal Officer, U.S. Environmental Protection Agency, Science Advisory Board Staff, Washington, DC

Ms. Stephanie Sanzone, Designated Federal Officer, U.S. Environmental Protection Agency, Science Advisory Board Staff, Washington, DC

Attachment 2: Public Attendance

Open Meeting on July 20-22, 2010
U.S. Environmental Protection Agency
Science Advisory Board
Mountaintop Mining Panel

Name	Organization
Not legible	No affiliation
Not legible	No affiliation
Not legible	No affiliation
Not legible	EPA
Not legible	MDE
Not legible, Mike	EPA
Not legible, Nick	No affiliation
Alexander, Laurie	EPA - ORD
Ashcraft, Rusty	Alliance
Ashcraft, Rusty	Alliance Coal
Beaman, Joe	EPA
Bennett, Karen	NMA
Copeland, Claudia	Cong Research
Dudley, Judy	MACTEC
Ellis, Vickie	EPA
Flippin, Jennifer	No affiliation
Fox, Tim	No affiliation
Frisby, Bradford	National Mining Assoc.
Frithsen, Jeff	US EPA – ORD
Fry, Eric	Not legible
Fry, Eric	No affiliation
Gatchett, Annette	EPA - ORD
Goodman, Iris	EPA
Heenan, Colleen	EPA - ORISE
Herr, Colleen	EPA-URISE
Holdsclan, John	NCB
Hunter, Chris	EPA
James, William L.	US Army Corps
Jones, John	Alpha Nat resource
Julians, Nick	Inside EPA
Klasen, Matt	EPA
Kovski, Alan	BNA
Ledford, David	Appalachian Wildlife
Leuch, Lauren	CEQ
Longsworth, Jeff	Barnes Not legible
Nee, Roger	No affiliation
Norton, Douglass	EPA

Passmore, Margaret	EPA – R3
Pollard, Amina	EPA
Scanton, Steve	GEI
Shao, Nicole	EPA – ORD
Stewart, Ian	Argur
Stoker, Nathan	Barnes Not legible
Syed, Sharmin	EPA
Topping, Brian	EPA
Vech, William M.	CGI
Wind, Susan	ECSI
Wright, Justin	EPA

Attachment 3

List of Public Speakers*

Open Meeting on July 20-22, 2010
U.S. Environmental Protection Agency
Science Advisory Board
Mountaintop Mining Panel

9:45 am, Tuesday July 20, 2010: Public Speakers for Review of Aquatic Ecosystem Effects of Mountaintop Mining and Valley Fills Report

1. David Ledford, Appalachian Wildlife Foundation, Inc.

2. Rusty Ashcraft, Alliance Coal, LLC

10:30 am, Wednesday July 21, 2010: Public Speakers for Review of Conductivity Benchmark Report

1. Steve Canton, GEI Consultants

2. Brooks M. Smith, American Electric Power

3. John Paul Jones, Alpha Natural Resources, Inc.

4. Jeffrey S. Longsworth, Federal Water Quality Coalition

* Speakers presented comments in the order in which the requests were received in the SAB Staff Office.

Attachment 4

Changes* Made to Draft Key Points by the Panel during the July 21, 2010 Discussion of Responses to Charge Questions for the Draft Aquatic Effects Report

Open Meeting on July 20-22, 2010
U.S. Environmental Protection Agency
Science Advisory Board
Mountaintop Mining Panel

*Changes noted in redline print.

Charge Question 1: ***The Mountaintop Mining Assessment uses a conceptual model (Figure 12 of the draft document) to formulate the problem consistent with EPA's Ecological Risk Assessment Guidelines. Does the conceptual diagram include the key direct and indirect ecological effects of MTM-VF? If not, please indicate the effects or pathways that are missing or need additional elucidation.***

Lead Discussants:
Dr. Lucinda Johnson
Dr. Philip Townsend

Summary: Charge Question 1

1. Conceptual diagram needed at the beginning of the document (links topics to each section of the report)
    a. Create an initial overarching model diagram, with several sub-model diagrams of the most important aspects of the overall model discussed in detail in separate sections.
        i. The sub-model diagram could potentially highlight the sub-module that is part of the overall model, and do not lose the connections between the sub-model to the overall model.
    b. Locate the overarching model near the front of the document, with the full complex model as an appendix.
2. Full causal pathway figure should be developed as (perhaps) as an appendix; each section of the diagram should be linked to each of the discussion topics within the text.
3. Need to address levels on (un)certainty in the diagram (topics with substantial data versus hypotheses with some data to back it up)
    a. Differentiate areas of primary or secondary importance (e.g., Se vs. Ni; Conductivity)
4. Need to reflect indirect as well as direct pathways in the figure
5. Temporal versus spatial aspects; near-term vs. long term, and near-field and far-field impacts would be helpful to depict, but extremely difficult to express in figure form. Perhaps should be emphasized in the text to a greater extent.

6. Depicting metrics that are both stressors and responses-

Missing from diagram

1. Reclamation activities and outcomes are not well depicted in the diagram
2. Upland and riparian system not well represented- specifically on the right side of the diagram;
3. Functional endpoints, such as energy flow, food web
4. Functional link between activities and different components of hydrology (e.g., base flow, peak flow, natural flow regime, flood frequency) and subsequent responses.
5. Hyporheic zone modification and metals and metalloids (antecedent geologic conditions important)

Specific issues with the diagram:

1. Intermediate responses not represented well, e.g., modified genetic structure of the community
2. Only one modifying factor in the diagram; consider addition of other important factors (e.g., geology, landscape context (i.e., rain shadow), background productivity potential)
3. Organic matter includes large wood in addition to leaves, etc.
4. Light regime change would accompany loss of vegetation and result in temperature change and food web impacts.

Charge Question 2: ***This report relied solely on peer-reviewed, published literature and the 2005 Final Programmatic Environmental Impact Assessment on Mountaintop Mining/Valley Fills. Does this assessment report include the most relevant peer reviewed, published literature on this topic? If not, please indicate which references are missing.***

Lead Discussants:
Dr. Kyle Hartman
Dr. Richard Warner

For the most part the key literature related to MTM-VF (within the bounds defined by EPA for the report) and at the time of writing the report is included (they did not miss anything). More recent references will be included in our final written comments (from SAB members).

- Some aspects do need to be included or beefed-up:
    - Selenium effects on higher trophic levels
    - Inclusion of semi-aquatic and riparian fauna (e.g. salamanders and their diversity, stream-related mammals like raccoon, mink, etc.)

- Mussels and their complex life histories
- Literature and a paragraph on osmotic stress.
- Sulfate effects from a soon-to-be-released book from NAS (Clements) on coal bed methane discusses sulfates and effects and this could be drawn on for this study.
- Another suggestion was a paragraph on decreased resistance and resilience of populations or communities in the face of multiple stressors (synergistic effects)…..communities already affected by a stressor are more susceptible to additional stressors.

- Depending on how the bounds of the report changed based on the SAB comments additional literature will need to be added.
- There needs to be better definition and of what a headwater stream is and how much of the literature and supporting data is related to ephemeral, intermittent vs. perennial streams (and related literature).
- The report focuses on traditional reclamation technology. Reclamation technology has changed and there has been a transition to more environmentally sound reclamation of hydrology, sediment, conductivity that more closely mimic natural forested hydrology after some period of time. REFS to be added.
    - Increased reference to literature on restoration in general.
    - What is the state of our knowledge on our ability to restore streams that have been damaged?

<u>Charge Question 3:</u> Valley fills result in the direct loss of headwater streams. Has the review appropriately characterized the ecological effects of the loss of headwater streams?

Lead Discussants:
Dr. James Dinger
Dr. Alexander Huryn

Extent of headwater ecosystem loss…

- types of habitats affected should be more precisely defined (e.g., seeps & wetlands too?)
- emphasize that complex "riverine system" is being lost rather than channel alone
- extent of headwater ecosystem loss should be forecast into the future (50-100 yrs)
    - couch this in terms of worst case scenario
- more attention to ecology of ephemeral streams
    - suggest a definition re. "true" intermittent streams vs. perennial streams
- suggest proportional threshold for acceptable regional stream loss (e.g., 5%)

Biodiversity…

- provide brief outline of geological and evolutionary history of region
- highlight the significance between biodiversity and function
- introduce as "regional taxonomic hotspot"
- provide table showing number of species of major (orders) taxonomic groups affected
- provide a table showing the number of taxa listed in the five or six streams that were studied and put in bold the number of taxa lost
- show the number of taxa that replaced other taxa in the five or six streams that were studied
- explain why biodiversity is of "national or global interest"
- make case for phylogenetic singularity of specific taxa
    - introduce by name taxa that are unique to region (just a few)
    - highlight taxa with unique evo history (distantly related to other taxa)
- emphasize turnover of species as one moves from 1st through 4-5th order streams
- introduce concept of barriers to dispersal as headwater catchments are fragmented
- assess degree of fragmentation of headwater catchments at which populations become imperiled (does this information exist for any stream taxa?)

Ecosystem function…

- arguments that headwater streams are critical to function of downstream reaches are problematical without…
    - describing spatial scale (how far downstream effect is measurable)
    - assessment of density of headwater drainages and number affected
    - might use urban landscape as model to predict effects (urban stream syndrome)
- emphasize role of amphibians as agents of translocation of nutrients between habitats and as top predators

Headwater removal versus burial…

- separate discussion of headwater removal and headwater burial
- although the animal communities are surely lost in each case, and the removal/burial area is transformed, some degree of function (e.g., nutrient transformation, leaching) will likely be maintained
    - functions will be lost, gained, changed, diminished, and so on

<u>Charge Question 4:</u> In addition to impacts on headwater streams, mining and valley fills affect downstream water quality and stream biota. Does the report effectively characterize the causal linkages between MTM-VF, downstream water quality, and effects on stream biota?

Lead Discussants:
Dr. William Clements
Dr. Michael Newman

Well delivered document; certain areas can be improved:

1. Use of conductivity as a surrogate stressor
    - Availability of data on specific ions *and osmotic pressure*
    - Consider spatiotemporal variation in ionic composition influence of geology

2. Field assessments versus laboratory toxicity tests
    - Strength of field-based approach
        - Delivery of the approach was a bit tepid
        - Data could be presented with more confidence
    - Limitations of purely descriptive studies for showing causation
        - confounding factors (residential development)
        - how evaluate stressor interactions (Se + habitat + conductivity)
    - Laboratory studies to show mechanisms
        - Lab data appears weaker than field data
    - Complete life cycle tests
    - Discuss differences between laboratory and field
        - If only had one vs. the other type of data, would have a different benchmark
        - Discuss degree of external vs. internal validity
    - Integrated descriptive & experimental (microcosms & mesocosms)

3. Ephemeroptera as an "aquatic canary" in the valley fill
    - Sensitivity consistent with metals (similar mechanisms- osmotic stress?)
        environmental physiology literature
    - Variation in sensitivity within order
    - Problems with traditional metrics

4. More emphasis on Se effects
    - Influence of local geology and geological processes
    - Include "grey literature" data available in WV reports

5. Sensitivity of mussels
    - Poor osmoregulators

6. Clarification of Soucek papers
    - Soucek et al. (2000); Soucek & Kennedy (2005) Soucek (2007a)

7. Other considerations:
    - Functional measures
    - Equivalence tests (McGarvey 2007) to avoid type II errors
    - Hyporheic communities
    - Hydrologic alterations
    - Other organisms (hellbenders, crayfish)

<u>Charge Question 5:</u> The published literature is sparse regarding the cumulative ecological impacts of filling headwater streams with mining waste (spoil). Does the review accurately describe the state of knowledge on cumulative ecological impacts of MTM-VF? If not, how can it be improved?

Lead Discussants:
Dr. Bernard Sweeney
Dr. Philip Townsend

Cumulative impacts must be considered for both terrestrial and aquatic ecosystems.

In addition, the term "cumulative impacts" should be both defined and used in a consistent fashion in the document.

Our comments have less to do with missing literature or problems with the text, and more to do with definitions and framing of the issue.

Cumulative impacts on aquatic ecosystems can and should be evaluated from five perspectives:

(i) **spatial:** What is the downstream impact of one or more valley fills in a given watershed? Are the effects of multiple valley fills additive or multiplicative, linear or non-linear, or other combinations?

Are there lessons to be learned from the known cumulative effects of disturbances analogous in nature to MTM-VF (e.g., acid mine drainage, watershed urbanization)? Look for regional impacts that are larger than the sum of the individual local impacts (e.g., look at acid mine drainage impacts as an analogy)?

- consider the major stressors – bring Se into the discussion on the ions.

(ii) **temporal:** Do the downstream impacts from MTM-VF *change* with time?

(iii) **river continuum:** Does the loss of ecosystem function in VF streams produce a negative telescoping effect on downstream ecosystems? Are hydrological changes expressed in a continuous, stepwise, or threshold fashion?

(iv) **food web:** Do food web impacts develop as an upward cascade from lower to higher trophic levels due to differences in exposure mechanisms (vulnerable physiology vs. bioaccumulation)? Do changes in downstream functional feeding

groups reflect altered food inputs due to VF?

(v) **synergistic:** Do the impacts associated with MTM-VF interact with other stressors associated with mixed land use in the watershed (e.g., forest clearing, agriculture or urbanization) or with climate change?

[An alternate – but similar -- view of cumulative impacts could divide cumulative impacts into the following categories:

(i) **cumulative impacts in time** (i.e., slow vs. fast responses, and the associated continuum)
(ii) **cumulative impacts in space** (see above)
(iii) **cumulative impacts of activities** (see synergistic above: mining + x + y + z and so forth)
(iv) **cumulative impacts in biotic responses** (how many response variables need to change by how much before the system no longer behaves)]

Although few published data are available to answer the above questions, insights can be gleaned from ancillary studies designed originally to address other issues (e.g., bioaccumulation of selenium provides insights into temporal perspective)

Cumulative impacts on terrestrial ecosystems can and should include discussion of trade-offs that may occur between impacts that are cumulative vs. those that may result in an altered state of the system that may itself offer benefits, e.g.:

(i) loss of interior forest habitat due to MTM-VF (increased abundance of grassland birds from bird count data might be an indicator) – [this could also be *viewed* as a benefit by increasing diversity of habitat, even if the new landscape configuration does not match baseline conditions]

- grasslands favor cowbirds which negatively affects nearby forest-nesting bird species

(ii) deteriorization of edge habitat for interior forest due to MTM-VF openings (increase in edge-of-woods species such as deer or elk might be an indicator) – [again, the presence of new habitat suitable for elk could be viewed as a plus]

(iii) Affects on and linkages among multiple components of the ecosystem (including the terrestrial and riparian) should consider how reclamation activities enhance or mediate cumulative impacts. Type of reclamation and success of reclamation activity are at play here.

<u>Charge Question 6:</u> The Surface Mining Control and Reclamation Act and its implementing regulations set requirements for ensuring the restoration of lands disturbed by mining through restoring topography, providing for post-mining land use, requiring re-vegetation, and ensuring compliance with the Clean Water Act. Does the review appropriately characterize the effectiveness of currently employed restoration methods?

Lead Discussants:
Dr. Gwendolyn Geidel
Dr. J. Todd Petty

NO, but with regard to what objective – WQ goals?

Need to clarify the terms of restoration, reclamation (may vary depend on a person's perspective)

1. On-site Reclamation
    A. Historical SMCRA and Advances: (Important issue to develop)
        1- Pre- SMCRA: AMD, lack of reclamation success (trees)
            - literature available from WVU, VPI, Univ. Ky
            - Some State laws have been effective
        2- Early SMCRA – herbaceous cover, stormwater and surface water control, AMD control (metal and pH improvement), mine soils improved, *slope stability*
        3- Current SMCRA – Reforestation primary post-mine land use, Valley fill evolution/design improvements (flow), Alkaline drainage (no longer AMD).
    B. Upland/Terrestrial Objectives of Restoration (least important given scope on aquatic resources)
        - Panel believes that terrestrial restoration is important to consider in its own right, as well as for water quality and aquatic resources (add reasoning for this belief).
        1 - Wildlife habitat
        2- Reforestation
        3- Land Owner interests
        4- Soil development and Soil Organic Carbon
    C. Water – Land Interface (important)
        1. Hydrologic processes returned: GW source water (mountain top, reclaimed bench)
        2- Reclamation to deal with Specific Conductance (what new method/technology is needed to be effective for WQ issues)
            a. Perimeter Channels – better engineering to meet WQ goals
                -compaction (increase flow into PC for wetland construction),
            b. Valley Fill design – improved designs to minimize SC
            c. Sedimentation basins
        3 – Time Frame for biological recovery of aquatic communities

2. Off- site Mitigation (moderate importance)

A. If link mining impacts to WQ and aquatic Communities- no activity addressing mitigation for impacts in mine plan

1- Opportunities and feasibility to deal with SC through mitigation process

a. retrofitting old mines/ re-configuring

b. improve waste water treatment in surrounding areas

2- Structural restoration for mitigation

a- Has not been *addressed*

b- need to include recent published research on benefits of stream channel restoration

c. Water is value of these projects if WQ problems persist.

Attachment 5

Changes* Made to Draft Key Points by the Panel during the July 22, 2010 Discussion of Responses to Charge Questions for the Draft Conductivity Benchmark Report

Open Meeting on July 20-22, 2010
U.S. Environmental Protection Agency
Science Advisory Board
Mountaintop Mining Panel

*Changes noted in redline print.

Key Points on the Conductivity Benchmark Report

***Question 1. The data sets used to derive a conductivity benchmark (described in Section 2 of this report) were developed primarily by two central Appalachian states (WV and KY).* Please comment on the adequacy of these data and their use in developing a conductivity benchmark.**

Lead Discussants:
Dr. William Clements
Dr. Tom LaPoint

- **THE MOST COMMON RESPONSE AMONG THE PANEL MEMBERS IS THAT THE DATA SETS USED FROM ECOREGIONS 68, 69 & 70 TO DERIVE A CONDUCTIVITY BENCHMARK ARE ADEQUATE.**

    - A total of 2145 samples (from an initial 3286 sites) with macroinvertebrate and conductivity data that met the acceptance criteria were evaluated from the 2 ecoregions. This provides very broad spatial coverage and includes a large number of streams with and without MTM-VF impacts.

- **QUESTIONS OR SPECIFIC COMMENTS:**

- General agreement that conductivity is a surrogate measure of TDS and that the ionic constituents are important.

    - However, as the ratios of sulfate and bicarbonate were similar among the watersheds used for this analysis, the utility of conductivity to develop a benchmark for conductivity is justified (further discussed in Charge Questions 3 and 7).

    - Similarity of conductivity benchmarks derived from this analysis (300 µS/cm) and an independent dataset from KY (319 µS/cm) provides an important

validation of the approach employed and the quality of the data, especially since data were collected by different agencies using different techniques.

- There was "high power" in this analysis because of the large data set, the similarity in geology, ecoregion qualities, and high overlap in species composition among the watersheds. This helped substantially for the analysis.

- Was a series of USDA Forest Service and EPA ORD reports, (1982, Technical Reports NE-70 and NE-73 to NE 78) used to supplement the background data? These cover water quality data from first order streams in Appalachian Coal fields and provide data from unmined and mined 1rst order streams and watersheds, including conductivity data.

- Although the decision to exclude genera that occurred at < 30 sites is a necessary practical decision, it would be appropriate to acknowledge that rare taxa are often important for biological assessments and may be more sensitive to elevated conductivity. This underscores the need to understand the relationships among rare species, water quality, and habitat scores. *Provide narrative on ecological importance of these taxa. Sensitivity analysis needed to understand implications of eliminating those rare genera.*
- *Provide more detail on the sampling methodologies in the draft document.*
- *Mention the fact that the dataset is from perennial streams (primarily?)*

***Charge Question 2*: The derivation of a benchmark value for conductivity was adapted from EPA's methods for deriving water quality criteria. The water quality criteria methodology relies on a lab-based procedure, whereas this report uses a field-based approach. Has the report adapted the water quality criteria methodology to derive a water quality advisory for conductivity using field data in a way that is clear, transparent and reasonable?**

Lead Discussants:
Dr. Kyle Hartman
Dr. Sam Luoma

KEY POINTS

- **Project Goal and Approach.** The goal of the report is clearly stated: test whether it is possible to develop a benchmark to protect benthic communities from adverse effects of elevated conductivity. The goal *is not* to describe the causes of variability in benthic communities across the entire study area. Criticisms directed at the latter goal are not applicable.
- **The field-based approach is not perfect but provides serious improvement** over a benchmark that might have been derived from laboratory data. Report might more clearly describe the many limitations in extrapolating laboratory approach to nature. These limitations are often ignored, including in this case, the

poor suitability of traditional laboratory surrogates as a test species of changing major ion concentrations.

- The report referenced following the 1985 guidelines approach. However there are differences. Species sensitivity distribution is at the center of what is in common. **Is it important to make the tie between** 1985 **guidelines and field data approach here, but the report needs to better describe the differences in the approach.** Using field data avoids a lot of the major problems associated with the method. Lab studies use species biased towards culture. Field data considers more species and more system-relevant species than what can be achieved in lab tests.
- The **final data set used in the analysis is highly caveated**, using about 10 different criteria, to narrow data set to circumstances where major confounding variables are minimized. This is justified on the basis of the goal: testing if a benchmark can be developed from the field data.
- **Relationship between conductivity and stressor ion ratios**. EPA should make a strong case up front for how conductivity directly relates to key ionic stressors such that it CAN be a surrogate for those parameters. Otherwise, ion concentration should be measured and related to the biota. Then, for monitoring conductivity might be used to rapidly assess stream condition.
- ***The report should be clear that the data come from perennial streams only. Application of the benchmark to other types of streams (intermittent, ephemeral) is legitimate, however. The report should make it clear that this extrapolation is one expectation of the benchmark because the traits of vulnerable species are common to all and because of connected downstream influences in all types of streams.***
- **Protection of all taxa. SAB was concerned about the use of HC05 which would allow** extirpation **of important headwater genera. Should** EPA use 100% protection so we do not lose an entire genus from streams?
- **Reasonableness of the benchmark and "verification" approaches**. Several trains of thought by the SAB here. (1) **One was to employ different techniques and approaches to see how alternative approaches would alter the benchmark number** (some of this EPA has already done but was not presented in the report).
    - What is the benchmark if the requirements for excluding rare species are softened?
    - What is the effect of eliminating 50% of species because they do not appear at the reference sites?
    - Show some analysis where choice of season are adjusted.
    - What is the effect on the benchmark of including fish data (at least using examples from the small data sets available), so as to test the effect of better addressing the Stephan et al goal of including all the fauna in the benchmark.
    - Nutrient numerical limit methods recently released by USEPA.

- Individual major ions (suspected toxins) or ratios are included instead of conductivity where data are available.
- Use abundance- weighted analyses to address whether use of presence-absence results in some biases, and thereby address some of the criticisms.
- Explain how quantile regression would affect choice of benchmark
- *Effect on benchmark of using different endpoints/response variables*

- **Subject knowledge** would let you modify the mathematics to a lower benchmark since many food-web-important taxa of headwater systems have XC95 values less than 300. EPA should use subject knowledge to reduce the value to protect key taxa.

Charge Question 3: ***"Appendix A of the report describes the process used to establish a causal relationship between the extirpation of invertebrate genera and levels of conductivity. Has the report effectively made the case for a causal relationship between species extirpation and high levels of conductivity due to surface coal mining?"***

Lead Discussants:
Dr. Robert Hilderbrand
Dr. David Soucek

Charge was to demonstrate two linkages:
1) Demonstrate link between elevated stream conductivity and loss of taxa
2) Demonstrate relationship between stream conductivity and amount of VF
A. General consensus is that a convincing case was made for a causal relationship between conductivity and genus extirpation.

-Caveat is that conductivity is not a pollutant and perhaps a stronger case is made for conductivity as a signal or surrogate for a combination of other effects.
-Need to add more information on likely mechanisms because conductivity is a couple of steps removed from causation. Perhaps refer to the literature on ion regulation and osmo-regulation to try to make a case for causality.
-Mixture calculations can be made to better understand the process.
EMAP has information on how to calculate percent of conductivity from various ionic constituents.
This may help guide transferability of the method.
-Be careful on logic with respect to literature on sufficiency.
Use of conductivity of potassium salts to show when they aren't the salts present in this system.
-Under "Alteration" effect observed is consistent but perhaps not so specific. Metals may produce a similar effect (loss of specific mayfly genera).
-Relationships between conductivity and specific ions are all strong and similar in distribution suggesting that ratios are relatively similar across the sites. This may make less important the need for looking at specific ions.

B. Consensus was reached that a strong link between the stressor and the source was demonstrated.

-While other sources of conductivity are present, a very strong signal exists between percent valley fill and conductivity (dominated by sulfate and bicarbonate).

***<u>Charge Question 4</u>: In using field data, other variables and factors have to be accounted for in determining causal relationships. Appendix B of the report describes the techniques for dealing with confounding factors.* Does the report effectively consider other factors that may confound the relationship between conductivity and extirpation of invertebrates (genera)? If not, how can the analysis be improved?**

Lead Discussants:
Dr. Elizabeth Boyer
Dr. Alexander Huryn

- We commend the authors for carefully considering confounding effects. This was accomplished by: 1) removing some potentially confounding factors from dataset before making the determination of the benchmark concentrations; and 2) considering weight-of-evidence of a suite of other potentially confounding factors that were not excluded from the dataset – using correlations between potential confounding factors, conductivity, and aquatic life (mayflies).

- Given the content of the various public comments, the treatment of confounding factors may well be the most critical part of this report so additional consideration of ways to strengthen arguments is warranted.

- It may be helpful to reiterate here (Appendix B) that the hypothesis that conductivity is primary variable explaining pattern of mayfly taxonomic richness was addressed earlier (Appendix A), noting that hypothesis could not be falsified due to weight of evidence

- The use mayflies as the aquatic response variable in the analyses of confounding factors was appropriate. Recommend exploring examples with other aquatic effect endpoints (e.g., taxonomic traits) may help to further strengthen the conclusions.

- We recommend addressing additional potential confounding factors (e.g., further attention to pH & Se, and considering additional variables such as trace metals, DOC, flow regime).
- Revisit role of the matrix ions, ratios, and combinations as think about confounding factors
- Further quantitative look at confounding factors (e.g., multivariate analyses, model selection approaches) for scoping

<u>Charge Question 5</u>: Uncertainty values were analyzed using a boot-strapped statistical approach. Does the SAB agree with the approach used to evaluate uncertainty in the benchmark value? If not, how can the uncertainty analysis be improved?

Lead Discussants:
Dr. Elizabeth Boyer
Dr. Douglas McLaughlin

- We commend the authors for characterizing the uncertainty in the benchmark, reflected in the XC95 values.

- The bootstrapping approach employed in the report appears to be sound and consistent with techniques found in peer-reviewed literature.

- Be sure to be clear about what uncertainty is and is not being characterized

- We encourage the authors to expand the description of what they did to calculate confidence intervals, including a more detailed narrative & illustration. (e.g., expand on discussion of Figure 7)

<u>Question 6</u> Lead Discussants: Drs. Samuel Luoma and Michael Newman (3:15 Wednesday)
The field-based method results in a benchmark value that the report authors believe is comparable to a chronic endpoint. Does the Panel agree that the benchmark derived using this method provides for a degree of protection comparable to the chronic endpoint of conventional ambient water quality criteria?

Lead Discussants:
Dr. Sam Luoma
Dr. Michael Newman

- The general approach and conclusions are sound and provide a degree of protection comparable to or better than a conventional ambient WQ criterion developed from a chronic toxicity testing.

- The specific manner in which the SSD approach was applied, that is, using field survey data from impacted locations, is reasonable and avoids many of the flaws of lab test-based SSD analyses that ignore fundamentals concepts of synecology.

- The result of the field-based approach is a benchmark that is probably more sensitive to changes in conductivity than would be a benchmark dependent upon traditional toxicity testing. One reason is that the most commonly used surrogate species (e.g. crustaceans) are not especially sensitive to changes in major ion concentrations for physiological reasons.

- Survey data are very powerful information for inferring causal plausibility. The survey results also have exceptional ecological realism. A strong lab experimental design would produce results with much lower power to infer causality in the streams below MTM-VF activities.

- Although probably more sensitive than a benchmark derived from chronic toxicity testing with surrogate species, the benchmark could fail to protect some mayfly species that are now abundant in the streams of the region, and it does not use the most sensitive endpoint possible (extirpation is presumably a less sensitive endpoint than sublethal stress, for example).). Therefore a case could be made for incorporating into endpoint, a safety factor, *subject knowledge, or some other protocol for added protection,* into the endpoint. *On the other hand, the benchmark already approaches the background during the period of highest conductivity in reference streams; and the present method already includes methods (removal of data that could be confounding) that enhance its sensitivity compared to published approaches.*

***Charge Question 7. As described, the conductivity benchmark is derived using central Appalachian field data and has been validated within ecoregions 68, 69, and 70.* Under what conditions does the SAB believe this method would be transferable to developing a conductivity benchmark for other regions of the United States whose streams have a different ionic signature?**

Lead Discussants:
Dr. Robert Hilderbrand
Dr. Bernard Sweeney

Summary of Comments

The method used to develop a conductivity benchmark is quite general and sufficiently flexible to allow for transfer to other regions with different ionic signatures

For application to a new region, the following conditions should be met:

1. Availability of high quality reference sites (approach requires that all genera included be present at reference sites)

2. The fauna found in the reference sites of the region should reflect a common regional generic pool (to assure the same amount of variation in generic sensitivity to conductivity)

3. There should be good prior knowledge and understanding of the environmental requirements of the regional pool of genera (with respect to water quality and habitat)

4. There is similarity of background levels of conductivity across the reference sites (similar geology)

5. There is consistency in the relative ionic composition (ratio of ions) of the elevated conductivity across the region or treatment technologies (making it easier to defend conductivity as a surrogate or signal)(discuss under Question 2)

6. The potential confounding factors for the region should be understood and addressed

7. Availability of a large* field data set (comparable in size to the W VA data base used here)

8. Availability of a second, independent data set for the same region to validate the benchmark or some other approach for validating the benchmark.

9. Benchmark should not extrapolate beyond the geographic bounds of the dataset.

* A sensitivity analyses performed on the existing W VA/ KY data set might provide insights into the **minimum sample size that would not provide** unacceptably high variance.

***Charge Question 8*: The amount and quality of field data available from the states and the federal government have substantially increased throughout the years. In addition, the computing power available to analysts continues to increase. Given these enhancements in data availability and quality and computing power, does the Panel feel it feasible and advisable to apply this field-based method to other pollutants? What issues should be considered when applying the method to other pollutants?**

Lead Discussants:
Dr. Lucinda Johnson
Mr. Edward Rankin

Summary: **The panel concluded that it was both feasible and advisable to apply this field-based method to other pollutants. Several important caveats were associated with this conclusion**:

- Stressors or pollutants needed to be common across the landscape and reflect the complete gradient of the stressor so that a strong stressor gradient can be derived;
- Field data sets need to be large and robust using well documented methods;
- Selection of parameters would be on a case-by-case basis with naturally occurring stressors the most obviously applicable stressors (e.g., conductivity, dissolved oxygen, nutrients, habitat, bedded sediments)
- Field data is strongest when combined with laboratory data and other supporting evidence such as mesocosm studies

- Need to consider important natural classification features (e.g., ecoregions, geology, stream types) that influence distribution or biota and/or expression of stressor (e.g., hardness and conductivity or ammonia)
- Recommend that an adaptive approach, *informed by monitoring data*, be used for future implementation of benchmarks and criteria to account for underlying changes in the system due to changing conditions (e.g., elevated temperatures, increased incidence of large storms, changing precipitation patterns, changes in natural flow regimes, land use change, deposition change, and management change).