

**Preliminary Comments from Members of the Chartered SAB on the SAB
Draft report entitled *Review of EPA’s Draft Hydraulic Fracturing Study Plan*
(June 14, 2011 Quality Review Draft)**

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Comments from Dr. Taylor Eighmy

Overall Comments:

1. General Thoughts:

The committee has assembled a very thorough review of EPA's Draft Hydraulic Fracturing Study Plan. The report reflects a great deal of work, careful consideration of committee member comments on the EPA study plan, and comments from the public on the SAB review activity.

Given the tight proposed deadlines for the EPA in issuing its two reports, I think some of what is recommended in this review still needs to be captured by the agency for consideration--- including partnering with all stakeholders, but especially other federal agencies, state agencies, and the private sector. How the agency plans to capture all of these and other good ideas beyond this immediate time frame is important to lay out to all parties as all this moves forward.

2. Emphasis of Some Important Points in the Committee's Review of the Draft Study Plan:

There are *three* areas that I would like to reinforce or emphasize: (i) the addition of "post closure and abandonment" to the water life cycle figure (Figure 7 in the report), (ii) increased focus on well construction and mechanical integrity, and (iii) increased focus on advanced hydraulic fracture mapping. These three areas of emphasis are explained a bit more as follows:

First, I fully support the addition of a new component to Figure 7 titled "Post Closure and Well Abandonment." This may be balanced by the good work and best practices that has been undertaken by industry and the states on all types of exploration and extraction wells, but this deserves some focus given the potential for permanent hydrogeologic connectivity.

I would also recommend that the committee consider offering something like the following as drinking water issues, primary research questions, and secondary research questions to the second stage in Table 2 of the EPA draft plan relative to the suggested "post closure and well abandonment" life cycle stage:

Drinking Water Issues:

- Long-term water quality impacts to water quality of primary aquifers and secondary aquifer water resources.

Primary Questions:

- What is the long-term mechanical integrity of wells that have been hydraulically fractured?
- What monitoring schedule and types of monitoring are needed to better understand long-term integrity?

Secondary Questions:

- What field techniques are needed to assess long-term integrity of hydraulically fractured wells to ensure long-term mechanical integrity, particularly for casing and cementing?
- What modeling techniques are needed to predict integrity over long time horizons relative to material fatigue, seismic activity, and rock mechanics?

Second, I would encourage the Committee to consider expanding its emphasis in section 3.6.2 on the importance of well construction and on suggested additional research activities (item 2 on p. 47) on the importance of EPA examining well construction and “completion” mechanical integrity with respect to current practices and where trends in the industry are going. Much improvement has taken place, significant testing occurs as the well is developed, but all exploration wells represent permanent establishment of potential means of hydrogeologic communication between formations and aquifers and the incidence of “completion” failure, especially around annulus cementing through the aquifer, needs to be well understood. Even if this may be beyond the current scope and time frame of the two expected EPA reports in 2012 and 2014, this needs to be emphasized.

Third, I would encourage the Committee to consider expanding its emphasis on hydraulic fracture mapping as discussed in section 3.6.1. It is clear that there are many local issues tied to formation geology, vertical depth between aquifers and formations being fractured, and the existence of karst formations or naturally occurring regional-fracture systems that may enhance hydrogeologic communication after fracturing is completed. Much work has taken place in the private sector on this. Advances are being made in micro-seismic testing and interpretation, use of tiltmeters, and fracture network mapping and modeling. As the EPA uses case studies, this issue should be very carefully examined, perhaps for use in the 2014 report. I think this is crucial to understanding the long-term legacy aspects of fracturing (e.g., tens to many hundreds of years) in some formations. Collaboration with DOE and USGS to convene workshops on advanced hydrofracture mapping technology development and new technology applications may be a side bar activity that the EPA undertakes. There may be new geophysical techniques and hydrogeologic testing that can be brought forward through such collaborative activities.

3. Mapping the Report to the Summary and to the Letter to the Administrator:

I found that the mapping was very evident, especially between the report and the executive summary and then between the summary and the letter to Administrator Jackson.

4. Report Organization:

The report is well organized and clear to follow and aligns well with the nine charge questions.

Response to the Four Specific Questions:

1. Were the original charge questions to the Panel adequately addressed?

I believe that all nine charge questions were adequately addressed.

2. Are there any technical errors or omissions in the report or issues that are inadequately dealt with?

In section 3.3.3, I would consider adding these additional references to the additional literature section that relate to advanced hydraulic fracture mapping:

1. Mayerhofer, M., Warpinski, N., Lonon, E. (2008) Use of fracture mapping technologies to improve well completions in shale reservoirs. 2008 AAPG Annual Convention, April 2-23, 2008.
2. Warpinski, N., Waltman, C., and Weijers, L. (2010) An evaluation of microseismic monitoring on lenticular tight sandstone stimulations. 2010 SPE Conference,
3. Pettitt, W.S., Reyes-Montes, J.M., Andrews, J. (2010) Enhanced imaging of hydraulic fracturing through induced seismicity. 44th U.S. Rock Mechanics Symposium, June 27-30, 2010, Salt Lake City.
4. Warpinski, N. (2009) Microseismic monitoring: inside and out. J. Petroleum Eng. 61 (11): 80-85.

3. Is the report clear and logical?

Yes, very much so.

4. Are the conclusions drawn or recommendations provided supported by the body of the report?

Yes, very much so.

Comments from Dr. Cecil Lue-Hing

General Comments

The report overall is well written and structured to be easy to read. The report is comprehensive, addresses the charge issues very well, and in addition, provides a rich array of recommendations, alternatives, and suggestions to the EPA aimed at improving the Study Plan.

A Word about Format

Immediately after the background/preamble on pages 13-14 of the report, the Charge to the panel is presented and addressed. This format promptly alerts the reader that a) the Charge is important and b) it will be dealt with without delay.

Executive Summary

The ES is well designed. It starts with a briefing/preamble to inform the reader as to the origin of the EPA's Study Plan, beginning with the scoping of the Study Plan, through the Panel's review of the Scoping document, and now the review of the Study Plan itself. The briefing also informs the reader about some of the important aspects of the Study Plan, e.g., the water life cycles associated with each stage of the hydraulic fracturing process.

The ES then proceeds to engage in brief discussions of each of the charge questions posed by the EPA, and indicate concurrence or support of a concept when this is the case, or offer recommendations and or suggestions designed to improve the Study Plan when these are deemed to be appropriate.

This format is easy to read, it flows in the right direction, and brings the reader directly into contact with the reason for the review, and the findings, conclusions and recommendations offered by the Panel.

Based on prior quality review sessions, some may consider this ES too long, but I say the authors concluded that they have many important statements to make and that these statements belong in the ES. I support the authors on this score.

This format is used also for the body of the report, and the letter to the Administrator with equally favorable results.

Letter to the Administrator

Similar comments as in the ES for the letter to the Administrator with respect to structure and format. The letter informs the administrator of some critical issues, e.g., the EPA proposed water lifecycle framework, the five aspects of the water lifecycle associated with HF operations, and the postclosure/well abandonment phase within the lifecycle. The letter then proceeds to list the major suggestions/recommendations to be incorporated into the development of the final Study Plan. I believe that most if not all of the important issues that deserve the attention of the Administrator are included in the letter.

Public Comments and Stakeholder Inputs

It is encouraging to see that while it is established policy, the letter to the Administrator, the Executive summary, and the body of the report all refer to the fact that public comments were considered for the report. Also, that stakeholders assisted the EPA to identify potential case study sites for the study plan, and provided candidate research questions for the study plan.

Proprietary Information

A repeated theme in the report is the need for the Agency to collect a wide range of information, including information which may be considered by the Hydraulic Fracturing (HF) service industry to be proprietary. The Panel's report repeatedly stressed the importance of obtaining this "proprietary" information, without which some of the research outcomes sought could or would not be achieved. This need for HF service industry cooperation is stressed in the responses to charge questions 2, 3, 4, and 5, Research Outcomes. Obviously there is an urgent need for the EPA to access information which may be considered proprietary by the HF industry.

EPA Request for Proprietary Information

In September 2010 EPA issued information requests to nine HF service companies including the three largest companies operating in the US. EPA later sent a mandatory letter to one company to compel the provision of the requested information. As of December 6, 2010, all nine companies had agreed to provide the requested information by January 31, 2011.

Thus the obstacle of non-cooperation by the HF service industry regarding EPA's access to proprietary information no longer appears to be an issue. This is good news for the project.

The Body of the Report

The Panel has conducted a very thorough and in-depth review of the Proposed Study Plan, and concluded that the Study Plan was well thought out but could be improved in several areas, and has offered some very important suggestions/recommendations in the interest of improving the proposed plan. Herewith, a selection of the important suggestions/recommendations to EPA:

- a. Consider quantity impacts of HF operations on the local watershed mass balance
- b. Add a postclosure/well abandonment phase as a new component of the proposed plan
- c. Delay toxicity testing at this time because of budget and deadline limitations
- d. Assess the impact of the diverse nature of hydraulic fracturing operations across the country
- e. Assess the potential adverse impact of hydraulic fracturing operations on local communities, particularly small, rural, and minority communities, and develop research outcomes to address environmental justice issues.
- f. Assess the potential impact of hydraulic fracturing return waters on POTW operations, e.g., contamination of solid residuals that are destined for land application
- g. Assess the cumulative consequences of conducting multiple HF operations in a single watershed or region
- h. Assess the uncertainty associated with each phase of the research
- i. Include an assessment of inter-basin transfer of post – fracturing produced water
- j. Concentrate some resources on the evaluation and synthesis of existing data

This reviewer is impressed by these recommendations and believes that it is appropriate to include examples of the recommendations in these comments because they are very commonsense, yet operationally sound, they are important, and targeted toward more effective, environmental stewardship or environmental protection, and thus they deserve to be recognized. For example, the issue of quantity impacts of HF operations on the local watershed mass balance is very important, and its inclusion as a recommendation could serve among other things, to protect the water resources of predominantly small, rural, and poor communities. The postclosure/well abandonment phase represents another important recommendation aimed at better environmental protection. For example, data generated from these sites will be valuable in the conduct of forensic evaluations following contamination events in the respective watersheds. Without this postclosure requirement, forensic evaluation could end up being nothing more than a finger pointing exercise. Assessment of uncertainty associated with each phase of the research is also most important, since HF operations are breaking new ground, operational data may not be readily available, and the predominance of the accumulated knowledge on these operations reside with the industry. Uncertainty assessment will help to better understand the value and credibility of existing and recently generated data.

Without Panel review and interaction, the Study Plan could have been considered a respectable and useful document. However, there is no question that the Panel's review and the resulting suggestions/recommendations offered to the EPA will improve the focus, clarity, and effectiveness of several phases of the Study Plan.

Editorial Issues

Responses to Charge Questions 4a through 4e pages 34-55.

Under General Comments to these questions, the responses all begin with – **“To address the research questions listed in Table 2 for the Water Acquisition --- etc. stage of the lifecycle, EPA plans to conduct the following activities:”**

By referring to Table 2, the reader can review all of the research questions involved. However, there is no clue as to the origin of the – **following activities**. All of these – **following activities** for questions 4a through 4e are conveniently summarized in **Figure 9**, pages 51-52, of the draft study Plan.

Suggest that the notation – **see Figure 9** be inserted after – **following activities, e.g., --- following activities, see Figure 9** – for all the responses to questions 4a through 4e.

Page 59, line 1; Reference is made to an ongoing DOE study without citation. Suggest that the study be referenced.

Page 64, line 18; Should TDS be – **chemical composition**?

Responses to the General Quality Review Questions

Partial answers to some of these questions are provided in the responses above.

1 Were the original charge questions adequately addressed?

Yes, all the original charge questions were adequately addressed.

Overall, the Panel found that the EPA's approach for the Study Plan was appropriate and comprehensive. However, the charge questions all presented some deficiencies that were identified and discussed by the Panel in the body of its report. The Panel has offered a wide suite of recommendations and suggestion to strengthen these areas deemed to be deficient. See **Body of Report** above for a sample of these recommendations.

2 Are there any technical errors or omissions in the report or issues that are inadequately dealt with in the Panel's report?

I did not find any such issues

3 Is the Panel's draft report clear and logical? and

Yes, the Panel's report is clear and logical. One could argue that there is a small degree of repetition because of the structure/format, but this did not affect the quality or effectiveness of the report.

4 Are the conclusions drawn or recommendations provided supported by the body of the Committee's report?

Yes.

Comments from Dr. James Mihelcic

1. Were the original charge questions adequately addressed?

Overall the report addresses all of the charge questions adequately except as I discuss below. In regards to charge question 1, I strongly support the committee's recommendation that EPA consider water quantity impacts on the local watershed mass balance and link water fluxes associated with hydraulic fracturing to water flows in the surround natural hydrological area, as well as adding postclosure/well abandonment to the life stages. These items are very important and strengthen the science of the proposed framework. Proper water management as applied to managing sources of drinking water should consider the surrounding hydrological area. In regards to the importance of adding postclosure/well abandonment, this is an important (and often neglected) component of proper life cycle thinking.

In regards to charge question 4(a) related to water acquisition, the committee is very insightful and correct to recommend that EPA not exclude existing and future strategies and technologies to deal with issues of water scarcity as related to water sources of high TDS. One important reason for this is because of the rapid advancement we are seeing related to the available strategies and technology water managers now have for dealing with high TDS water sources.

In regards to charge question 4(b) on chemical mixing, page 39 of the draft report states that "Appendix C of the Draft Plan indicated that all companies have agreed to comply with the request and that information should be submitted by the end of January 2011." It seems that the authors of the draft report should be provided an update on the status of this agreement because the ability for the SAB to advise EPA on charge question (5) on research outcomes depends on EPA making progress on research objectives that are dependent on industry cooperation. Furthermore, regarding charge question 4(b), chemical mixing, there is no mention by EPA of research activities related to promoting development of greener chemicals and strategies, though we are seeing EPA include this type of research activity in other reports, most recently in the oil response strategy report.

In regards to charge question 4(e) concerning if proposed research activities are provided for questions associated with wastewater treatment and waste disposal, I would suggest that the SAB recommend to EPA to consider measures of pollution prevention in this area, and not solely focus research efforts on treatment and disposal. EPA's own hierarchy of pollution prevention that is widely accepted by the scientific community makes it clear that prevention is the preferred alternative to treatment and disposal. Thus, research questions should be built around how to develop technologies and strategies that reduce and eliminate the need for treatment and disposal. Also not addressed in this charge question is a recommendation to EPA to develop proposed research activities related to how the presence of hydraulic fracturing fluids impacts issues (social and technological) related to water reuse. This could be in terms of water reuse strategies related to impact of hydraulic fracturing on our ability to recharge and store water in small to larger regional groundwater systems to reduction and/or fate of introduced chemicals to treatment processes and the impact this might have on overall public acceptance of reclaimed water and the ability to successfully remove from treated water and resulting biosolids that are intended for beneficial reuse.

2. Are there any technical errors or omissions in the report or issues that are inadequately dealt with in the Panel's report?

I did not observe any major errors or omissions in the report. In regards to charge question 4(e) concerning proposed research activities associated with wastewater treatment and waste disposal, as I have mentioned, I suggest that EPA consider measures of pollution prevention and how proposed research activities related to reusing this water, whether it is discharged to a local POTW or some other. There are several sources of research generated by the WaterReuse Association and WaterReuse Foundation that may be of interest to EPA. For example, recent reports by WaterReuse Foundation (e.g., “Leaching of Metals from Aquifer Soils during Infiltration of Low-Ionic-Strength Reclaimed Water” Low-Cost Treatment Technologies for Small-Scale Water Reclamation Plants,) and WaterReuse Association (Decision Support System for Selection of Satellite versus Regional Treatment for Reuse Systems).

3. Is the Panel’s draft report is clear and logical?

The draft report is well written and organized. The three-page letter to the Administrator is to the point and encompasses the major recommendations of the report. The Executive Summary is well written and organized and is aligned with the body of the report. I thought one strength of the body of the report was providing the general overview followed by addressing specific charge questions.

In the response to charge question (1), the authors of the draft report should consider adding the Water Lifecycle Figure 7 as it is an important basis for their comments (or at least include it in an appendix). In regards to charge question 2, it might help if Table 2 (list of proposed fundamental and secondary research questions) is also be provided in an appendix.

I thought the 4.5-page section (3.3.3 Additional Literature) was out of place and could be moved to the end of the document in an appendix. Furthermore, the reference provided on page 48 seems out of place. On page iii (Letter to Administrator Jackson), I suggest the items listed in parentheses after the “e.g.” be changed (as I show in italics below) to better encompass EPA’s existing definition of environmental justice as follows (I have a similar comment for sentence at top of page 4 of Executive Summary):

Sentence from report and recommended addition: EPA plans to combine the data collected on the locations of well sites within the United States with demographic information (*i.e., race, color, national origin, income*) to screen whether hydraulic fracturing disproportionately impacts some 32 citizens and to identify areas for further study.

4. Are the conclusions drawn or recommendations provided supported by the body of the Committee’s report?

The conclusions drawn and recommendations are supported by the body of the report. I support the inclusion of environmental justice into the committee’s recommendations. In addition, I support the committee recommendation that EPA consider water quantity impacts on the local watershed mass balance and link water fluxes associated with hydraulic fracturing to water flows in the surround natural hydrological area, as well as adding postclosure/well abandonment to the life stages.

Comments from Dr. H. Keith Moo-Young

Hydraulic Fracturing (HF) aims to recover natural gas from sources such as coal beds and shale gas formations. HF is also used for other applications including oil recovery. It is projected that shale gas will comprise over 20% of the total US gas supply by 2020. EPA developed a draft Study Plan that assesses the potential impacts of hydraulic fracturing on drinking water resources.

The draft study plan also aims to determine factors that affect the severity and frequency of any potential impacts. As a result of the draft study plan, there were five aspects of the water lifecycle associated with hydraulic fracturing to be evaluated: Water Acquisition, Chemical Mixing, Well Injection, Flowback and Produced Water, and Water Treatment and Waste Disposal. This study requested EPA SAB to review six charge questions related to the hydraulic fracturing.

1. Were the original charge questions to SAB Standing or Ad Hoc Committees adequately addressed?

Yes, the charge questions to the SAB committee were addressed. The SAB committee should be commended on the review of EPA study plan for Hydraulic Fracturing for its consistency, rigor and comprehensive nature of the written report.

2. Are there any technical errors or omissions in the report or issues that are not adequately dealt with in the Committee's report?

No technical errors or omissions were determined in the report.

3. Is the Committee's report clear and logical?

Yes, the report is clear and logical. The report provides the agency with significant detail to improve the proposed study plan. The executive summary was very well written.

4. Are the conclusions drawn or recommendations provided supported by the body of the Committee's report?

The conclusions and recommendations of the report were amply supported by the body of the committee's work.

In addition, I would propose the following recommendations to the agency regarding Hydraulic Fracturing:

1. Toxicity testing of hydraulic fracturing fluids should be conducted as a long term research study. This could potentially be done through the STAR program or through a CRADA with industry.
2. One of the major issues related to hydraulic fracturing that was briefly touched on but needs further consideration are the seismic conditions that create changes in subsurface geology of the formation (e.g. Marcellus Shale) which are created by the perforated gun shoots holes through the casing and the application of pressure. Long term monitoring is a key aspect to assuring that these fractures do not cause contamination to groundwater and preferential flow pathways into and for ground water migration and contamination.
3. In addition, the practice of HF in areas that are susceptible to sinkhole (i.e. karst terrain) may also propose severe risk.

4. The agency should encourage future research in partnership with other agencies to encourage more environmentally friendly solution to hydraulic fracturing technique. The Department of Energy would be a natural partner to develop these technologies.
5. Best management practice protocols for hydraulic fracturing should be developed to assure that the environment is being amply protected with the best available technologies. Water management should be a central theme to the BMP protocols to assure that the watershed is amply being protected. Many of the regions that were outlined as having HF potential reserves are also highly sensitive watersheds, that need to be protected for sustainable communities of the future.
6. Post-closure strategies should be developed for communities to assure that the HF will create sustainable futures for the region.
7. The petroleum industry has the most advanced subsurface technologies for detection of oil in the deep underground formations. Unlike tradition requirements of monitoring wells, these technologies are capable of determining oil reserves and natural gas reserve. EPA should develop and require the petroleum industry to share and utilize best available technologies for monitoring the long term hydro geologic flow in the subsurface of HF drilling reserves.
8. A major concern that I have with HF is that the HF fluids are facilitating agents for natural gas. If there are preferential flow pathways created as a result of the HF techniques, facilitated transport of natural gas will occur. Groundwater aquifers and other geologic formations will be high susceptible to contamination.
9. Radiation risk will drive the risk assessment for the HF solution employed. EPA needs to assure that appropriate OSHA standards and risk guidelines are implemented in regions where there is a high potential for radionuclide (i.e., radon).
10. Surface impoundments, holding ponds, and other strategies used for recycling, temporary storage, and disposal of HF wastes should be constructed with the best available technologies for surface impoundments. EPA conducted the Surface Impoundment Studies which highlighted the best practice for these types of temporary storage scenarios. At a minimum, a membrane liner should be utilized to reduce the potential for fate and transport of HF wastes into the surface (i.e. unsaturated zone) prior to treatment or reinjection.
11. The drilling and casing of the wells is another major concern that I have with HF. Though caution and care may be taken when drilling deep into the subsurface, there is no way to guarantee that the well casing will be impervious and stable under high pressures (10,000 psi) and explosions. HF is different from other drilling techniques for petroleum reserves is that there will be an explosion in the coal bed or shale layer which can potentially cause small preferential pathway in the drill casings.

Comments from Dr. Eileen Murphy

1. Were the original charge questions to SAB Standing or Ad Hoc Panels adequately addressed?

The charges were addressed, but they sometimes seemed contradictory or had weak justifications.

2. Are there any technical errors or omissions in the report or issues that are not adequately dealt with in the Panel's report?

In the February 2011 DRAFT Hydraulic Fracturing Study Plan's section on toxicity, EPA explained the process whereby it proposed to generate preliminary high-throughput and medium-input toxicological information for fracturing chemicals. They also mentioned some computational models that have been successful for them recently. Toxicity testing appeared explicitly in the development of the plan in Feb 2011 EPA plan: *"To better understand potential human health effects, EPA plans to summarize the available data on the toxicity of chemicals used in or released by hydraulic fracturing, and to identify and prioritize data gaps for further investigation. The substances to be investigated include chemicals used in hydraulic fracturing fluids, their degradates and/or reaction products, and naturally occurring substances that may be released or mobilized as a result of hydraulic fracturing."* Therefore, the Panel's recommendation to remove toxicity testing is surprising and puzzling to me.

The Panel recommends that EPA not conduct any toxicological testing, assuming that this type of testing is time and resource expensive. The Panel further explains that exposure should be demonstrated before any toxicity testing is performed. However, the whole goal of this study plan is to look at impacts to drinking water sources. Therefore, one might assume (perhaps wrongly) that there is or potentially is human exposure to these contaminants through drinking water, if drinking water is impacted. In fact, I think that toxicity testing is the first priority that should be undertaken. It was surprising to me to see the very clear and strong recommendation to remove it.

New computational and cellular testing models successfully developed and used by EPA represent innovations beyond the traditional time-consuming and expensive animal model testing. Rather than summarily recommending that no toxicity testing be conducted at all, I think the Panel should have looked more closely at these new computational and cellular models. Or, perhaps the Panel can recommend that EPA expand the discussion in this section so that the reader better understands that the newer testing protocols are much faster and cheaper than traditional routes of toxicity testing. These computational, high- and medium-throughput testing protocols have been used to test eight dispersants used in the Gulf Oil Spill. The information generated from these relatively quick and inexpensive tests have provided invaluable information to EPA and BP as they selected which and how much dispersant to use.

In the February 2011 Study Plan, EPA outlines the process for evaluating toxicity beginning with identification and inventory of the chemicals (of which they expect several hundred); prioritization of the list based on available information; and testing. The testing is further divided:

- Where information is available, divide the list into high and low priority chemicals
 - High priority: high throughput screening testing (ToxCast)
 - Low priority: little to no action
- Where information is not available or not known
 - QSAR (quantitative structure-activity relations) analysis, which is a mathematical model; computational modeling; and medium-throughput cellular and alternative animal models.

Given the availability of these quick tests (and their successful use for eight of the dispersants used during the Gulf Oil Spill), the reasons provided to drop toxicological testing (time and resources) are not valid. The Panel should re-examine this recommendation, which appears in many places throughout the document. It is even more important to include toxicity testing in light of another recommendation by the Panel to expand the list of chemicals considered beyond those that have drinking water maximum contaminant levels (MCLs). EPA has the tools to conduct preliminary toxicological testing on multiple chemicals. They should use these models and tools to assemble toxicity assessments of the chemicals used in hydraulic fracturing. The omission of consideration and appreciation these new and highly innovative tests may have resulted in an poorly justified recommendation.

3. Is the Panel's report clear and logical?

I found the report very repetitive. Whole paragraphs are repeated in several sections. Consolidating language would help to make the cogent recommendations stand out more. Some of the lesser recommendations were hard to tease out due to the repetition of the more significant recommendations.

4. Are the conclusions drawn or recommendations provided supported by the body of the Panel's report?

In several instances, I thought the recommendations were not supported or inconsistent, namely, the recommendation to drop toxicity testing, as described in #2 above. The Panel recommends that EPA be both more focused and broader. For example, in response to Charge Question 2, p. 18 (3.2.1), the Panel requests more specifics and detail on the research questions, yet, later in the paragraph, the Panel states that EPA should take a broader view regarding water quantity. This is a recurring theme throughout the document – a heavy emphasis on water quantity and fluxes and lighter emphasis on water quality issues. Impacts to drinking water encompass both issues, and the Panel is suggesting that EPA take a broader and more extensive look at quantity issues, which is vital for modeling efforts aimed at predicting effects of hydraulic fracturing in varying geographical areas. However, in so doing, it is broadening the scope of the study plan beyond its intended immediate goals.

Similarly, in looking at Figure 7 from the DRAFT Hydraulic Fracturing Study Plan (February 2011), it is very difficult to see how EPA can take the Panel's suggestion to add links showing water fluxes associated with hydraulic fracturing to water flows in surrounding natural hydrologic cycle. How would EPA do this in this figure?

A couple of recommendations seemed beyond the scope of this project. For instance, I am not sure if the recommendation to use microseismic techniques for models informs the issue here? Also, the Panel's recommendation that EPA incorporate a review of water flows and fluxes through the surrounding hydrological cycle, look at impacts of inter-basin transfer of post-fracturing produced water seemed beyond the scope of the study plan. Further, this recommendation seemed in conflict with other recommendations by the Panel to narrow its focus.

General Comments:

p. 29, Section 3.3 Additional Literature. Many of the citations describe general engineering principles and basic engineering/petroleum science. I'm not sure how many of these recommended sources will be helpful for the topic of identifying immediate impacts to drinking water?

Comments from Dr. R. Thomas Zoeller

The following comments are provided in response to the June 14, 2011 memo by DFO Dr. Angela Nugent concerning SAB review of *Review of EPA's Draft Hydraulic Fracturing Study Plan (June 14, 2011 Quality Review Draft)*. This memo asked contributing SAB members to specifically address the four quality review questions from the vantage point of our own expertise. These questions are:

1. Were the original charge questions to the Panel adequately addressed?
2. Are there any technical errors or omissions in the report or issues that are inadequately dealt with in the draft report;
3. Is the draft report clear and logical; and
4. Are the conclusions drawn or recommendations provided supported by the body of the Committee's report.

1. In general, this is a very well-written and well-structured SAB report that very clearly addresses the charge questions to the SAB panel. These charge questions were clearly laid out and answered directly in the document. This is a very complex issue and the charge to the EPA and the charge questions to the SAB are likewise highly complex. However, the SAB panel provides a clear set of science-based opinions that reflects a considerable amount of expertise.

2. This reviewer sees no technical errors.

3. In general the draft report is clear and logical. This reviewer recommends considering for inclusion the recently published (April, 2011) report entitled, "Chemicals used in Hydraulic Fracturing" from the US House of Representatives Committee on Energy and Commerce Minority Staff. This document lists a very large number of chemicals used in HF fluid reported by a number of drilling companies. This report may provide important detailed information about chemical constituents of HF fluids, but also indicates that companies using these fluids purchase them from third party suppliers and the proprietary information belongs to those suppliers. Therefore, one might recommend to EPA that they request this kind of information from suppliers rather than from the companies using the materials. Moreover, this report indicates that drilling companies will be cooperative with EPA in a timely fashion.

A small issue of clarity also arises on page 26, line 38 in referring to a "statistically acceptable number of case studies....". The recommendation of the SAB panel appears to be to identify case studies that represent different kinds of geological/hydrological situations in which hydraulic fracturing is performed. Given this, they may not be comparable to each other, and therefore, it is not clear to this reviewer what kind of statistical analysis would be performed to combine these case studies into a descriptive unit.

An additional issue arises on page 28, lines 17-26. The impression is that "scenario evaluation" is a "thought experiment", but the SAB panel is recommending that this be employed to prioritize what EPA evaluates. It might be useful to develop this logic slightly more clearly in this paragraph.

On page 44, line 36, the SAB panel discusses how a shortcoming in risk assessments is that they do not include the potential for catastrophic failure. Is the SAB panel recommending that the EPA include this?

4. The conclusions and recommendations are generally well supported by the body of the Committee's report and this reviewer supports the recommendations as laid out by the SAB panel. However, an issue that occurs repeatedly in the document as well as in some of the public comments is the issue of time-frame and budget. Because the SAB panel bases many of their recommendations on these practical issues, it gives the impression that the SAB is cognizant of both the time and expense for the various proposals that EPA is making in their document. As a result, it might be helpful for the SAB panel to include the time-line and budget limitations specifically to justify these conclusions. Perhaps a time-line could be developed that places the various EPA goals within that time and budget. This kind of graphical depiction may provide a single – relatively simple – visual tool to communicate the recommendations of EPA priorities.

Comments from other SAB Members

Comments from Dr. Ingrid Burke

Were the original charge questions addressed? (And more general comments):

I found the report to be very well written, and each of the charge questions addressed in detail.

Their Charge 1 recommendations: The recommendation that EPA's Study Plan should incorporate the effects of HF on water quantity as well as quality is important, and the emphasis in the summary is appropriate.

Scientific Method, and Comments about their Charge 2 and Charge 5 recommendations: The comments about assessing uncertainty are important; I'm not sure though that they are worded correctly. In addition to uncertainty about research findings, there are also critical issues regarding the establishment of cause and effect. This is tightly connected to their Charge 5 question, about whether the research can answer the question, and the value of different kinds of scientific approaches, and their likelihood of achieving research outcomes. My concrete suggestion is that at the very outset of addressing Charge Question 5, there is a summary of research approaches, and how they may affect uncertainty. Right now, there is not as much of an overarching statement here as there should be. This should be in the executive summary as well.

I am unsure about the recommendation about EPA not studying toxicity of specific chemicals. I did not find a logical basis for the recommendation.

I am a bit concerned that the overview letter discussion of specifying the type of fracturing activity will be interpreted as suggesting that not all types of HF should be studied. I suggest rephrasing to be clear that it doesn't read that studies should be *limited* to particular type of activity, only that one must be careful with realm of inference.

Are there technical errors?

Not that I could see.

Is the report clear and logical?

Perhaps I am only now noticing some language in these SAB quality reviews that concerns me. Throughout this review, the phrase "The SAB Believes" occurs. As the science advisory board, we are charged with Thinking, not with Believing. I understand that this could be considered just semantics, but I think that we need to be careful about this, and use a different kind of phrase that shows the recommendations are the result of careful thinking and logical analysis. I strongly recommend taking out this "belief" language.

Are the conclusions drawn supported?

They did seem to be supported. It was difficult to find the logical basis for the recommendation that toxicology not be studied.

Comments from Dr. Thomas Burke

General comments: The draft is very well written and organized. It is responsive to the charge and addresses the key issues facing the agency in evaluating the impacts of hydraulic fracturing on drinking water. I do have some concern about the language regarding toxicity testing of HF additives. The potential human health impact from drinking water exposure is the crux of the public debate. A recommendation to limit the collection of new data on toxicity of this relatively unknown mixture may lead to short term efficiencies, but in the longer term new data on toxicity may be essential to adequately address public health concerns.

I also have a suggestion to improve the consideration of environmental justice impacts (Table A 6). Clearly there are potential disproportionate risks and benefits to fracking that go beyond drinking water quality. I recommend that the case studies include systematic interviews with local public health officers to identify potentially vulnerable subpopulations, the consideration of fairness in local decision-making, and the impacts of current operations.

1. Were the original charge questions to adequately addressed?

The charged questions were all adequately and clearly addressed.

2. Are there any technical errors or omissions in the report or issues that are inadequately dealt with in the Panel's report?

I did not identify a technical errors or omissions. However, as I mentioned in my general comments I have some concern that the recommendation to follow the risk assessment approach (including hazard identification) may not be consistent with the recommendation not to collect new data about toxicity.

3. Is the Panel's draft report is clear and logical?

The report is very clear and logical. There are some areas where there is repetition, however I feel this does not impact the clarity and readability of the report.

4. Are the conclusions drawn or recommendations provided supported by the body of the Committee's report?

Yes, the conclusions drawn are well supported in the report.

Comments from Dr. George Daston

1. Were the original charge questions adequately addressed?

I believe that the charge questions have been adequately addressed. In the response to charge questions 3 and 4b, the panel advises EPA to make use of existing data sources to conduct preliminary assessments of risk, starting with exposure. I agree with the premise of conducting what is essentially a screening level risk assessment, but believe that it would be reasonable to conduct a screening level assessment for both exposure and hazard. This would allow EPA to prioritize its efforts on those chemicals/ scenarios for which the risk appears to be highest or uncertainty greatest. If any additional research is needed, it can be tailored to addressing the uncertainties that will ultimately make the most difference in assessing risk. There are numerous examples of screening level risk assessments, including those that were submitted to EPA under the Voluntary Children's Chemical Evaluation Plan (VCCEP).

2. Are there any technical errors or omissions in the report or issues that are not adequately dealt with in the Committee's report?

I did not note any technical errors or omissions.

3. Is the Committee's report logical and clear?

I found the report to be logically presented and easy to follow. There was good consistency between the body of the text, the Executive Summary and the cover letter.

4. Are the conclusions drawn or recommendations provided supported by the body of the Committee's report?

I believe that the Committee's conclusions and recommendations are supported by the text.

Comments from Dr. Costel Denson

The letter to the Administrator is extremely well written. It is clear, direct, and provides un-ambivalent guidance in connection with the comments and recommendations. Particularly noteworthy is that Environmental Justice, a priority of the Administrator, is brought into the discussion in a meaningful way. However, this reviewer raises the following question: Could the Panel extend its discussion by suggesting metrics that gauge the impact in achieving Environmental Justice?

Were the original charge questions to the SAB committee adequately addressed?
Yes. Nine charge questions were presented in total.

Are there any technical errors or omissions in the report or issues that are not adequately dealt with in the committee's report?
There are no technical errors or omissions that this reviewer detected.

Is the committee's report clear and logical?
The committee's report is laid out in a clear and logical way.

Are the conclusions drawn or recommendations provided supported by the body of the committee's report?
The conclusions and recommendations are appropriate and easily understood, and could be implemented in a straight forward manner.

Comments from Dr. Otto Doering

1. Were the original charge questions adequately addressed?

Yes

2. Are there any technical errors or omissions in the report or issues that are not adequately dealt with in the Committee's report?

None that I saw

3. Is the Committee's report clear and logical?

Yes, but I have 2 suggestions for possible improvement. First, Table 2 and Figure 7 (also Figure 9) from the EPA draft plan are referred to several times in the committee report and in the charge to the Committee. It might be helpful to include these in the Committee's report or the appendix. Second, scenario analysis is referred to several times - for example pages 25 and 28. It might help if, when scenario analysis is first referred to, there is a bit more explanation of what is intended - simulation modeling? - coupled with risk analysis? - Etc.?

4. Are the conclusions drawn or recommendations provided supported by the body of the Committee's report?

Yes

Overall Comments:

This is a topic and an issue where both stakeholders and the public are deeply divided. What this environment requires is that the EPA study be as thorough (internal validity) and encompassing (external validity) as possible to ensure the maximum credibility for the study with both stakeholders and the public.

The Committee has suggested a number of improvements and additions to the study that I find most compelling. I believe that the administrator and the EPA staff should take these extremely seriously and provide strong justification if they are not followed. The polarized nature of the controversy demands this.

The letter to the administrator is more detailed than many past letters in laying out the key recommendations of the Committee. I believe that this is especially appropriate in this case given the importance and high visibility of this study. If the Committee believed it appropriate, a phrase might be added (possibly at the close of the letter) that emphasizes the importance of the Committees recommendations for ensuring the maximum credibility for the report. (Some of the Committee's suggestions fill gaps that could reduce the credibility of the report if such gaps are not filled. A gap in any part of the research effort has the potential of casting doubt on the report as a whole.)

Overall I believe that the committee has done an excellent job and is to be commended for suggesting essential improvements to the research study plan.

Comments from Dr. James Hammitt

I have reviewed the fracking report and have no significant comments. Here is my formal response:

1. Were the original charge questions to adequately addressed?

Yes.

2. Are there any technical errors or omissions in the report or issues that are inadequately dealt with in the Panel's report?

None that I see.

3. Is the Panel's draft report is clear and logical?

Yes.

4. Are the conclusions drawn or recommendations provided supported by the body of the Committee's report?

Yes.

Comments from Dr. Bernd Khan

My answers to the four quality review questions, in order, are yes, no, yes, yes. The Review is very well written. I have the following suggestions:

P. ii - iii: Delete the seven bulleted items and summarize them in a sentence or two. The letter is too long.

p.4: Should not consideration of the potential consequences of accidental releases be mentioned here?

p.9, last para.: Delete; this is discussed in detail in the following paragraphs.

p.13: Save space without losing any information by replacing the content of Sections 2.1 and 2,2 with Appendix A.

p.14: Reproduction of Figures 7 and 9, and Table 2, from the Report would be useful for understanding the Review.

p.70: Should # 2-6 be 1-5?

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Comments from Dr. Judith Meyer

This appears to be a very thorough analysis of the Study Plan with excellent and specific suggestions for ways to improve the plan.

1. Were the original charge questions to the SAB Committee adequately addressed?

YES, quite extensively.

2, 39: since the research is focused on drinking water, perhaps this should consider “deposition to surface waters that serve as sources of drinking water.”

2. Are there any technical errors or omissions in the report or issues that are not adequately dealt with in the Committee’s report?

NO in general but I have a couple of specific concerns. The major ones are preceded with a * in what follows:

*A critical component of designing a study like this is providing a defensible rationale for selection of particular sites for case studies. Has EPA done that? Results are likely to be greatly influenced by the sites selected. How has this been incorporated into the study design? What is said on p. 13 is that stakeholders were involved in the selection process. That is admirable, but will the criteria used permit any kind of extrapolation to unsampled sites? To what extent were characteristics like underlying geology considered? This seems to be an important aspect of study design, yet the Panel has not commented on it in the Executive Summary (or even in the report, at least that I picked up). The differences across the country are mentioned on p. 18, but not related to case study site selection.

4,11: The recommendation on cumulative impact seems buried, yet it strikes me as being of central importance.

*5, 29 and 34, 20: I am concerned about this recommendation because it recommends baseline data for only one site (“a given area”). That gives you an n of 1 – not very powerful. Perhaps that is not what was intended. If not, please clarify.

7, 26: I am not clear what is being recommended here. Are you saying that cementing practices should not be a part of this study? If that is not what is being recommended, this statement needs clarification. If you are, I wonder about that recommendation because I thought that problems with the cementing of the well were one of the reasons that groundwater contamination had occurred in some of the places where it has been observed. So it seems to me that information on adequacy of cementing could help explain observed patterns of contamination. (This is clearly presented on p. 22 and 44; it needs to be explained more clearly in the ES.)

8, 37; 35, 5; 53,30: I think radioactive species should be added to this list.

21, 17: This point on cumulative impact seems important. I don’t recall reading it in the Executive Summary. If it isn’t in there, it should be.

22, 23-24: an important point that didn’t make it into the Executive Summary.

*37, 4: The definition of drinking water as being adequate to be a public water supply would seem to eliminate consideration of those private wells discussed on p. 35. Is that the case? If so, I would think the panel would want to comment on that as it eliminates a whole class of drinking water from consideration that the panel previously identified as warranting attention.

3. Is the Committee's report clear and logical?

YES, although I have some specific concerns:

Letter to Administrator is very long and detailed and needs to be shortened. I'm not convinced that the bullets are needed – too specific for a letter to the administrator. They're appropriate for an executive summary, but not the letter.

Executive Summary also seems very long with considerable detail. I think the message would be clearer if it were shortened.

3, 4: Are all the rest of these overarching issues? Overarching is used 3 times on this page. It's not clear if all of the issues on this page are overarching or just the ones where the paragraph begins with the term. If it is the latter, they should be put together, not separated by other recommendations.

Charge question 2 in Exec Sum: These recommendations don't follow a logical order. Consider reorganizing them.

9, 36-42: This paragraph succinctly summarizes these recommendations. I question the need to go into the details on the next pages. The Executive Summary is really long and would benefit from shortening. Is that detail really needed? Furthermore, there are some redundancies in what follows. There are earlier recommendations not to do new toxicity studies or devise new analytical methods. No need to repeat that here.

12: Here's another "overarching" recommendation. It might be clearer if they were collected into one place.

43, 34: define BTEX the first time it appears

4. Are the conclusions drawn or recommendations provided supported by the body of the Committee's report?

YES although there are a lot of recommendations and considerable redundancy in the report, although that is in part a consequence of how the questions were asked. The redundancy is also partly in how the questions were answered, i.e. a general answer followed by specific answers for each part of the life cycle. Often points from the general answer were repeated in the specific answer.

Comments from Dr. L.D. McMullen

I think the panel did a great job of evaluating the Study Plan realizing the time and resources constraints while not minimizing specific comments on ways to make the science base stronger. The three plus page to the administrator seemed to be a little long. I'm not sure that the administrator needs to know the process that is in the first paragraph. I think the letter can be shortened to two plus pages. The twelve page executive summary also seems to be quite long. While there is good information in the summary, I think it also can be shortened to about half the current length. Figure 7, Figure 9a and Table 2 are referenced numerous times in the Panel Report. It may be of value to include the figures and table as a part the Panel Report. If included, I would have found it easier to understand the comments and also may help others who may not have the study plan readily available.

1. Were the original charge questions adequately addressed? Yes
2. Are there any technical errors or omissions in the report or issues that are inadequately dealt with in the Panel's report? No
3. Is the Panel's draft report clear and logical? Yes I liked to overarching comments followed by the specific comments.
4. Are the conclusions drawn or recommendations provided supported by the body of the Committee's report? Yes

Great report and should be of value to EPA.

Comments from Dr. Jana Milford

Quality Review Comments on SAB Review of EPA's Draft Hydraulic Fracturing Study Plan

As the SAB panel notes, the research problem of investigating the relationship between hydraulic fracturing and drinking water resources is a daunting one! The SAB report provides valuable comments and recommendations on EPA's draft research plan. However, it requires refinement or expanded detail in a few areas. EPA's task of developing a research plan to investigate the relationship between HF and drinking water resources is complicated by the critical need for transparency and credibility with the public on a topic about which significant information and expertise reside inside the energy industry. Given these circumstances, it would be helpful if the SAB panel's review of EPA's draft study plan could give greater attention to questions of transparency and scientific credibility by providing more guidance on data quality, use of non-peer reviewed or proprietary data, representativeness (or lack thereof) of case studies, model evaluation, etc. The SAB panel should also more clearly lay out the limitations of the proposed research plan, to assist EPA in establishing reasonable expectations for its effort. One area of transparency that is missing is information about the resources required for and allocated to EPA's planned study. The SAB panel makes several recommendations to defer work on certain research topics and suggests others that should be added, but no information is provided on the research budget ramifications in either case. In particular, the SAB panel does not adequately justify its recommendations that EPA defer research on toxicity testing and development of chemical tracers/indicators for contamination due to hydraulic fracturing, which appear to be high priorities for regulators and for the public.

Responses to quality review questions

1. Were the original charge questions to the SAB Committee adequately addressed?

In general, the charge questions were adequately addressed.

2. Are there any technical errors or omissions in the report?

I did not identify any significant technical errors. As mentioned above, I wish the report would provide more guidance/feedback to the Agency on information quality issues. As itemized below, there are some points raised in the body of the report that should be added to the Executive Summary.

3. Is the Committee's report clear and logical?

Generally. See specific comments below.

4. Are the conclusions drawn or recommendations provided supported by the body of the Committee's report?

Most but not all of the conclusions and recommendations are adequately supported. See specific comments below.

Detailed comments

p. ii lines 29-32. The letter to the Administrator recommends that “none of the proposed toxicity testing be conducted at this time due to time and cost constraints.” While extensive justification may not be needed in the letter, there is also inadequate justification in the executive summary (p. 10) and main body of the report (p. 32). This recommendation is likely to be controversial, given public concern about fracturing fluid toxicity, and scientific uncertainty about unreported constituents and mixture effects. Furthermore, in the draft study plan, EPA laid out a carefully staged approach to toxicity testing that starts with QSAR and other computational approaches, followed where necessary by screening and relatively short-term, inexpensive assays. I think the panel’s recommendation requires further consideration or justification, including some discussion of the costs and time requirements the panel had in mind when it stated they were prohibitive, and a clear explanation of why the Agency’s proposed staged toxicity testing approach would not work.

p. ii, line 37. I thought EPA’s draft study was quite clear that their primary focus was on shale gas, but that the study plan was also concerned with natural gas production from CBM and tight sands. So, it’s not clear to me why this question about study focus is included in the letter to the Administrator. (Also see p.4.)

p. iii, lines 29 – 37. The panel’s comments about Environmental Justice miss an important population segment of special concern in this context – rural Americans (including Native Americans) who rely on groundwater for drinking, other household uses, livestock watering, etc. The same comment applies on pp. 12 and 19, where EJ again comes up.

p. 5, lines 6 – 9. The panel report mentions the need to consider data quality and data management (i.e., archiving data). In my view, information (not just “data”) quality and management are very critical issues and the panel should provide more guidance on best practices the Agency can use to ensure scientific credibility. This issue also comes up on p. 19, where the report mentions use of grey literature and proprietary data but offers no guidance on if, when, and how this information should be used. On p. 25, the panel suggests that when EPA uses anecdotal information and non-peer reviewed publications, it should “classify the data as such,” but additional guidance would be valuable.

p. 5, lines 10 – 11. Here and elsewhere in the ES, it’s hard for the reader to understand the panel’s points about the utility and limitations of case studies and scenarios, because it isn’t clear (without first reading EPA’s study plan) how “case studies” and “scenarios” are defined and what they are meant to achieve. It would be helpful if the ES could briefly explain EPA’s proposed approach to using retrospective and prospective case studies, and what is meant by “scenarios.” With that, the panel should also explain in the ES of why it believes the case studies are “overemphasized.” The important concerns about prospective case studies mentioned on p. 41 (likely to use best practices and precautions and hence not readily generalizable) and p. 64 (too short in duration to observe impacts) should be mentioned in the ES.

p. 5, lines 14 – 17. More explanation is needed for why the panel feels EPA should rely more on existing information and literature, especially given the paucity of publicly available information on this topic. On p. 28 the report states that “EPA’s 2004 study clearly documented the lack of existing data and EPA should identify what new data are available ...” The statement on p. 28 seems inconsistent with the panel’s recommendation to rely more on existing information, unless a large body of research has emerged since 2004.

p. 6, lines 25 – 29. The panel’s expression of support for relying on chemical constituent information provided by HF service companies “provided the companies cooperate...” begs the

question of what EPA should do if they don't cooperate, and of how EPA will know they've been provided with complete information if the Agency doesn't do any sampling and analysis of its own.

p. 7, lines 25 – 27. Clarification is needed of what the panel means by “researching drilling and cementing processes separately from the HF process.” While it may be useful to distinguish these stages, it seems likely that problems with drilling and cementing interact with HF to cause impacts, so the combination of problems/conditions in these stages needs to be considered.

pp. 5 – 8. The panel's responses to several of the subparts of charge question 4 begin with statements that EPA's proposed activities “will adequately address” the research questions. I found these summary statements to be somewhat inconsistent with the panel's more detailed responses to the charge questions, which are provided later in the report. The detailed responses identify a number of limitations in the study plan that would prevent the research questions from being fully answered (e.g., limited case studies that cannot represent nationwide variations in conditions or practices). I think it would be helpful if the ES better reflected the panel's assessment of the limitations of the research plan, while acknowledging (if the panel believes this to be true) that EPA has generally proposed a sound approach, working within time and resource limitations.

p. 10, lines 37 – 44. How confident is the panel that HF service companies will provide comprehensive historical data on well failures?

p. 36, lines 31 – 39. The report usefully mentions the potential of exposure through breathing chemicals volatilized through potable water. Shouldn't concerns about dermal exposure routes also be mentioned?

p. 38, lines 28 – 40. The report states that “SAB supports EPA's proposed approach to analyze existing data rather than collecting samples for analysis ...” However, my read of EPA's study plan is that they propose doing both – investigating existing data and collecting and analyzing their own samples. This should be clarified. Similarly, the report says the panel supports “EPA's plan to evaluate ... toxicity ... [only] through existing databases.” As I read EPA's study, they also proposed to include some staged toxicity testing if necessary. This also needs clarification.

Comments from Dr. Amanda Rodewald

1. Were the original charge questions to adequately addressed?

Yes.

2. Are there any technical errors or omissions in the report or issues that are inadequately dealt with in the Panel's report?

No.

3. Is the Panel's draft report is clear and logical?

Yes.

4. Are the conclusions drawn or recommendations provided supported by the body of the Committee's report?

Yes. However, there is a tension between, on the one hand, recommending that EPA limit the scope of its research questions to those that can be satisfactorily answered by the proposed study and, on the other hand, suggesting numerous additional and important topics for study. I understand that all scientists and studies face this paradox to some extent, but the panel may want to include some text early in the report that directly address this. In addition, the panel might want to state more explicitly that the suggested additional questions do, in fact, need to be answered if the agency is to conduct a truly comprehensive study that evaluates the impact of HF on drinking water.

Other minor comments:

Executive Summary:

- Executive Summary: page 3, line 19, the panel suggests that “the scenario evaluation does not, but should, cross all research questions”. Can you please be more specific as to what the panel wants included given that they also are recommending that the research questions be changed?
- Executive Summary: In the response to Charge Question 4 on page 5, is the panel suggesting that EPA develop the “vulnerability index” to be used as a screening tool to identify areas where additional study or monitoring should focus as part of the EPA study or to somehow be used in the regulatory process? I wasn't clear what the intended use.
- Executive Summary: Page 6, lines 1-3, the panel explains that using the “Maximum Contaminant Levels as established under the Safe Drinking Water Act are not sufficient for assessing all potential significant impacts of hydraulic fracturing on drinking water quality”. My concern is that the language might be interpreted as the SAB's questioning of the effectiveness of MCLs and Safe Drinking Water Act. It would be helpful to be more explicit about the unique features of hydraulic fracturing that makes it more likely to be an exception. From the subsequent text, it seems that the issue is the use of proprietary and/or new chemicals in the process for which no MCL levels have been established. More explicit language would help to clarify.
- Executive Summary: Page 6, line 44, I am unclear to what the panel references with “certified methods”.

Comments from Dr. James Sanders

1. Were the original charge questions adequately addressed?

Yes.

2. Are there any technical errors or omissions in the report or issues that are inadequately dealt with in the Panel's report?

No, to the extent that I can judge.

3. Is the Panel's draft report clear and logical?

Yes. The report would benefit from another round of editing, as there are some repeated statements (such as lines 36. Page 13 through line 5, page 14 or lines 15-18 and lines 37-40 on page 18 or the material repeated twice in lines 19-25 on page 34). The Panel generally have used a format of general comments on each charge, followed by more specific comments. This format works well, but also had lead to repetition, for example the first paragraph on page 50 is largely repeated in lines 25-33 on the same page.

4. Are the conclusions drawn or recommendations provided supported by the body of the Committee's report?

Yes.

Comments from Dr. Kathleen Segerson

1. Responsive to Charge Questions? Yes
2. Technical Errors? Not that I am aware of.
3. Clear and Logical? Yes, but see comments below.
4. Conclusions/Recommendations supported? Yes, but see comments below.

Comments:

1. There are a few places where the letter to the Administrator and the Executive Summary don't seem to line up well. For example, in the letter, the various paragraphs starting at the top of page ii appear to be summaries of the responses to the charge questions, but they don't seem to be in the same order as the charge questions. In addition, there does not appear to be a summary paragraph for charge question 3 on the overall research approach.
2. In the letter, the first four paragraphs on p. ii list a number of suggestions or recommendations, but then the first sentence in the final paragraph starts "The SAB has the following major suggestions...." Should this read "the following *additional* suggestions...", given that several suggestions have already been made by the time the reader gets to this point in the letter? Or maybe "the following *specific* suggestions"? it seems some adjective is needed here.
3. The letter states that the SAB recommends that EPA consider using a risk assessment approach to assess and prioritize research activities for *each* lifecycle stage, while the ES has reference to this only in response to charge question 4(d), where it states that the risk assessment framework should inform priorities for the lifecycle stages of flowback and produced water. If the risk assessment framework is intended to be applied to all stages, then it seems this point should be discussed at the beginning of the response to charge question 4, before going into the specific issues related to the individual stages of the lifecycle.
4. Also, on lines 9-11 of p. ii of the letter, it states that the SAB is concerned about the ability of EPA to cover all the research activities within the time and resources available, but then the reference to using a risk assessment approach to set priorities for research activities doesn't come until two paragraph later in the letter. I would have expected the recommendation to use a risk assessment framework to prioritize activities to come immediately after the statement of concern about being able to do everything that is proposed.
5. The ES has one line about not conducting toxicity testing (p. 8), while the letter has a similar line plus another sentence of explanation (so there is more detail in the letter than the ES). If this is an important point (important enough for the letter), it seems it would warrant more than one short sentence in the ES.

6. The ES seems quite long, and there are a few places where language is repeated (for example, bottom of p. 2 vs. 2nd paragraph on p. 3, and then 3rd paragraph on p. 2 vs. 3rd paragraph on p. 4). It seems that the 3-page response to charge question 5 could be shortened.

Comments from Dr. John Vena

1. Were the original charge questions to SAB Standing or Ad Hoc Committees adequately addressed?

I extend my compliments to the Panel for the comprehensiveness and thoroughness of their review. In my opinion each of the six charge questions were adequately addressed. It is noteworthy that they developed well articulated responses and complemented them with very detailed feedback on the research plan in each aspect of the framework and gave very specific recommendations for research activities.

2. Are there any technical errors or omissions in the report or issues that are not adequately dealt with in the Committee's report?

None that I can tell based on my expertise.

3. Is the Committee's report clear and logical?

The cover letter is concise and very effectively highlights the major recommendations. The letter captures the sentiments of the full review report. In the cover letter (lines 15-19) and in the executive summary (page 9 lines 37-41) it would be helpful to clarify or quantify what is meant by "most" and "some".

The executive summary is well done and provides an excellent overview of changes and recommendations to the report based on responses to each of the charge questions.

A few minor comments:

Line 34 What is the first report that is due in 2012 and why?

In recommendations the panel asks for more "specific" research questions.. perhaps "focused" or "directed" would be better wording.

What are the most important aspects of the framework related to the human exposure pathways??

Prioritize the questions for regulation, public health, and human health.

Community concerns are mentioned, differentiation should be made for nationally versus in study location.

Page 4 Charge question 3. What is meant by "analysis is included to validate the conclusions"?
Response to charge question 3 and summary in executive summary is excellent-the summary of concerns and recommendations regarding data acquisition and analysis.

Page 8 line 1 clarify specific points in time (such as at different times in the fracturing process i.e. early versus late in the life cycle)

I concur with recommendation to not conduct toxicity testing at this time.

Executive summary should include more details on concerns regarding number of case studies etc... See below.

Comments on review:

Pages 34-41. I agree with the important points on number of case studies, the rationale for retrospective and prospective case studies, the number of each etc. Excellent advice on page 27 should be incorporated in executive summary. I agree that a-priori selection of study sites is very important, given the number and spectrum on fracturing activities and to select a sufficient number in each category to facilitate generalizability.

The panel made excellent suggestions for additional research activities for each charge question (pages 47-51)

4. Are the conclusions drawn or recommendations provided supported by the body of the Committee's report?

Yes. In my opinion the report is very well written, comprehensive in responses to the charge questions. It is noteworthy that the panel provided valuable references for further consideration