Minutes of the Open Meeting on April 7-8, 2010

U.S. Environmental Protection Agency
Science Advisory Board

Environmental Engineering Committee (EEC)
Summary Minutes of the Advisory on EPA's Research Program Related to Hydraulic Fracturing

Participants: Environmental Engineering Committee (EEC) of the U.S. Environmental Protection Agency's (EPA) Science Advisory Board (SAB), as Augmented for Advice on EPA's Research Program Related to Hydraulic Fracturing (See Roster, Attachment 1)

EPA SAB Staff:	Edward Hanlon, Designated Federal Officer Dr. Vanessa Vu, Director, EPA Science Advisory Board Staff Office
EPA Presenters:	Dr. Kevin Teichman, EPA Deputy Assistant Administrator for Science; EPA Office of Research and Development
	Ms. Cynthia C. Dougherty Office Director; EPA Office of Ground Water and Drinking Water
	Dr. Audrey Levine, National Program Director for Drinking Water Research; EPA Office of Research and Development
	Dr. Robert Puls, Project Manager and Technical Lead; EPA Office of Research and Development
	Ms. Ann Codrington, EPA Office of Ground Water and Drinking Water
Other Participants:	Dr. Sally Guiterrez, Director, EPA/ORD/NRMRL
Attendees:	See Attachment 2, Public Attendance.

Date and Time: Wednesday, April 7, 2010, 8:30 A.M. – 4:30 P.M.; and Thursday, April 8, 2010, 8:05 A.M. – 12:00 P.M.

Location: St. Regis Hotel, 923 16th Street, N.W., Washington, D.C. 20006

Purpose: The purpose of the meeting was to provide advice on EPA's Office of Research and Development (ORD) proposed approach to be used to frame the hydraulic fracturing study design and the areas that will be addressed by research relevant to hydraulic fracturing.

Materials Available: The agenda, roster, and meeting materials were circulated to the Committee in advance of the meeting. These materials were made available to the public via the SAB Web site (www.epa.gov/sab) and hard copies were also provided and made available to the public for review at the meeting.

Meeting Summary

The meeting was announced in the Federal Register[1] and proceeded according to the meeting agenda, as revised[2]. The meeting occurred between 8:30 a.m. – 4:30 p.m. on April 7, 2010, and between 8:05 a.m. – 12:00 p.m. on April 8, 2010. The meeting adjourned at 12:00 p.m. on April 8, 2010. A summary of the meeting follows.

April 7, 2010

Opening Statements and Welcome

Mr. Edward Hanlon, the Designated Federal Officer (DFO), opened the meeting, and made a brief opening statement noting that the EEC as augmented is chartered as a Federal Advisory Committee under the Federal Advisory Committee Act (FACA). He acknowledged the meeting as being open to the public and stated that there were fifteen requests from the public for time to present oral statements. He also noted that minutes of this meeting were being taken to summarize discussions and action items in accordance with requirements under FACA. Dr. Vanessa Vu, Director of the SAB Staff Office, also welcomed everyone for their attendance.

The meeting was turned over to the Chair, Dr. David Dzombak. Dr. Dzombak noted that this is an Advisory effort where a report seeking consensus would be prepared. Dr. Dzombak noted that expertise was added to EEC: four members of the charter SAB augmented the EEC (see Roster, Attachment 1). Dr. Dzombak reviewed the agenda and provided a summary of activities anticipated to occur after the meeting in order to develop the final report, and then requested that EEC members and members of the charter SAB introduce themselves.

Dr. Kevin Teichman, Deputy Assistant Administrator for Science, ORD, then made a brief opening statement, followed his slides, and summarized the charge questions. Dr. Teichman emphasized that this was a planning phase of ORD activity, and that additional opportunities for public input would be provided. He noted that ORD would follow EPA's Quality Assurance principles in developing its research, and noted that there is a limited body of peer reviewed literature indicating the relationship between drinking water and hydraulic fracturing activities.

Ms. Cynthia Dougherty, Office Director; EPA Office of Ground Water and Drinking Water, then presented EPA's slides #1 through 11. She outlined EPA's current activities associated with hydraulic fracturing, and briefly discussed EPA Office of Water activities associated with development of effluent guidelines for coal bed methane wastewater.

Dr. Audrey Levine then presented EPA's slides #12 through 22. She outlined the life cycle of hydraulic fracturing activities, discussed data availability associated with hydraulic fracturing research, and outlined the potential environmental and health effects associated with hydraulic fracturing activities.

Dr. Robert Puls then presented EPA's slides #23 through 33. He discussed specific activities associated with hydraulic fracturing, and technical issues associated with potential releases from hydraulic fracturing actions.

Ms. Ann Codrington then presented EPA's slides #34 through 42. She outlined the goals for stakeholder involvement in EPA's hydraulic fracturing research activities, and outlined upcoming workshops that would occur to seek public input.

Public Comments:

Fifteen members of the public provided oral statements at the meeting. Each was limited to five minutes, and various questions were raised by the Committee to several presenters. A list of presenters and their affiliations is provided in Attachment 3.

Discussion on Charge Questions:

As indicated in the meeting agenda, discussion was organized by charge question. The following summarizes key points that were made by members of the Committee during the discussion of the charge questions. A more detailed description of these key points is provided in the Committee's letter sent to the EPA Administrator on June 24, 2010.

During the meeting, Dr. Dzombak captured key points made by members of the Committee regarding all charge questions. During the discussion period, the Committee members considered and provided comments on the key points.

Charge Question 2A: Proposed Research Topics:

Regarding lifestyle approach, Dr. Autenrieth led the discussion, summarized her comments, and noted that ORD should consider assessing both short and long term potential impacts associated with hydraulic fracturing. Dr. Connolly suggested that ORD first identify what is know and unknown regarding hydraulic fracturing, and to lay out what research has already been conducted on the topic before beginning its own research efforts. He recommended that ORD identify priorities among the wide range of potential topics listed in the scoping document. Dr. Horvath noted that lifecycle assessment is a

formal process for which there is an international standard, ISO 14000. He suggested that the ORD consider all aspects of the hydraulic fracturing lifecycle, and decide upon which areas to focus and the time horizon of interest. He suggested that ORD study uncertainty as part of the assessment.

Regarding potential relationships to drinking water, Dr. Reible suggested that ORD focus on hydraulic fracturing issues, and suggested that drinking water resources include currently available and potentially available sources. He suggested that ORD initially conduct a literature review to identify current information and literature on the topic, and focus on issues specific to hydraulic fracturing and to all oil and gas activities. Dr. Roy suggested that ORD look at historical data, and try to mine that data before generating new data that may already have been generated. Dr. Roy also suggested that ORD identify about 6 to 8 case study locations, as a representative sub-set of the hydraulic fracturing activities. Several members of the EEC as augmented agreed with Dr. Roy's suggestion about the case study approach. Dr. Shannon suggested that ORD identify the fate of pollutants from hydraulic fracturing (HF) operations, and narrow down what is unique about hydraulic fracturing vs. oil and gas industry research. Dr. Westerhoff noted that ORD should prioritize research needs, and also focus on four aspects of drinking water HF research: a) occurrence of HF impacts on wells; b) drinking water treatment technologies that are appropriate and best available; c) risks and benefits; and d) health issues.

Regarding potential health and environmental risks, Dr. Griffiths suggested that ORD identify potential risks on a temporal basis, identifying whether and how such risks may vary over time. ORD should identify who is at risk, and when they are at risk. He suggested ORD identify a group of individuals in HF areas and keep looking at this group of individuals over time, to assess ingestion, dermal and inhalation risks. He emphasized, however, that it was first necessary to identify the chemicals of primary concern. Dr. Korrick noted that it was difficult to assess potential health risks associated with HF without first understanding the exposure. She noted that there is not one, clear sentinel chemical. She noted that mixtures could have additive or synergistic effects. She also suggested that an ecologically based approach to assessing health risk be considered.

Dr. Patten noted that surface water quality should be linked with quantity declines associated with HF, and that the link between surface water and groundwater quality be assessed as it relates to HF activities. ORD should also assess the cumulative effects from multiple wells pumping at different rates in a similar regional area on the water quantity issues.

Dr. Elliot suggested that ORD focus initially on the sources and pathways. He expressed the view that it is premature to work on health impacts until sources and pathways are characterized.

After several other members of the EEC as augmented suggested a number of items that would assist EPA in their Research efforts, and after a break, discussion occurred on the EEC's thoughts for areas of consensus. Dr. Dzombak and Ed Hanlon

took notes from this discussion. Dr. Dzombak noted he would summarize his notes at the beginning of the April 8th meeting. The discussion concluded at 4:40 pm, when the meeting adjourned for the day.

April 8, 2010

The meeting convened at 8:05 am. Drs. Shortle and Griffiths did not attend the April 8 meeting in person, but called into the meeting using the teleconference number.

Charge Question 2A: Proposed Research Topics (continued):

During the evening of April 8, Dr. Dzombak prepared notes of what he heard as the EEC's proposed areas of consensus regarding lifecycle approach, boundaries for ORD research, potential relationships to drinking water, and potential health and environmental risks associated with EPA's research efforts regarding HF. The notes that were presented to the Panel members are included as Attachment 4. Hard copies of proposed areas of consensus were printed out and distributed to members of the EEC as augmented at the 4/8 meeting. Dr. Dzombak then outlined what he heard the EEC agree upon on areas of consensus. Discussion occurred among the EEC to identify agreed-upon areas of consensus on these topics.

After approximately thirty minutes of discussion, various themes of agreement were identified among the members of the EEC as augmented, including the following: Regarding characterization of the hydraulic fracturing lifecycle, the use of a lifecycle framework is appropriate as an organizing tool which will facilitate identifying the most important research questions to address in the initial study. ORD should identify appropriate boundaries for the assessment, and focus initially on human health and ecological drinking water issues before eventually investigating the impact on water resources more generally. Regarding potential relationships to human health and drinking water sources, ORD should consider performing case studies at five to ten different locations selected to represent the full range of regional variability across the nation. Improved data and information are also needed on hydraulic fracturing source fluids, flowback water and produced water that is co-mingled with the flowback water. After compiling and reviewing available data and knowledge, ORD should identify how to best address any potential problems identified through this effort, such as water treatability issues, applicability of emerging treatment technologies, methods for recycling flowback water, and accidental releases. Potential health and environmental risks should only be assessed after sources and pathways of possible exposure are much better understood. ORD should consider the cumulative impacts that additional uses of water resources have on water quality and quantity in water resource systems where hydraulic fracturing activities are occurring or are being considered before identifying the exposure routes likely to pose the greatest human health risk.

Charge Question #1: Proposed Scope of Study, and Charge Question #2B: Prioritizing Research Needs:

The members of the EEC as augmented discussed both Charge Question #1: Proposed Scope of Study, and Charge Question #2B: Prioritizing Research Needs, at the same time, since both topics were related.

Dr. Lee stated her support for a broad scope of inquiry as represented in the ORD scoping document. She noted that environmental science is moving toward study of larger systems, such as at the watershed scale, rather than a single environmental medium. The system influenced by hydraulic fracturing is a complex system, and we need to understand interactions of all components of the system.

Dr. Shortle noted that research priorities need to be established, and that the priority should be to identify human health risk, and identify mechanisms and types of exposure.

Dr. Young noted his concern about the unclear focus of the study. He observed that while the LCA framework for the study is perhaps appropriate, time and resources will not permit a full scope evaluation. Further, he noted that the cumulative impact of hydraulic fracturing is important to think about, not just the impact of a single HF operation.

Dr. Lee noted that exposure pathways are key focus areas for research and that the HF lifecycle and pathway was complex. She also noted ORD should consider developing lessons learned for HF remediation technologies.

Dr. Griffiths noted that the data limitations should be identified regarding a two year research effort, and noted his concern that reused water that is returned to the subsurface should be further assessed for potential health effects. He suggested that ORD initially identify areas of potential greatest risk and focus research on those areas.

Dr. Connolly suggested ORD focus on two primary areas: characterization of HF waters, and treatability of HF waters. Dr. Lee noted that it was unclear what are the areas of high vs. low risk given the data limitations. Dr. Nance noted that an initial Hazard Analysis step was missing from ORD's research planning efforts and should be added.

After several other members of the EEC as augmented suggested a number of items that would assist EPA in their research efforts, the Panel took a break, and Dr. Dzombak prepared notes of what he heard as the EEC's proposed areas of consensus regarding ORD's proposed scope of study regarding HF. The notes that were presented to the Panel members are included as Attachment 4. Discussion occurred among the members of the EEC as augmented to identify agreed-upon areas of consensus on these topics. After approximately thirty minutes of discussion, various themes of agreement were identified among the members of the EEC as augmented, including the following:

The members of the EEC as augmented generally supported ORD's approach for this research, and recommended that ORD should follow a systems perspective, use a lifecycle framework, and address science issues before conducting detailed economic analyses. SAB also had several recommendations for adjusting the scope of ORD's research program, including the development of plans that address both short-term and long-term research needs and goals, use a lifecycle framework without actually performing a lifecycle assessment, and focus on fundamental topics that will be relevant to policy formulation and on environmental concerns related to hydraulic fracturing rather than on concerns common to all oil and gas production activities. The members of the EEC as augmented also noted the Congressional request and a desire by the Agency to complete initial research products by the end of calendar year 2012, and recommended that initial, short-term research be directed to study sources and pathways of potential impacts of hydraulic fracturing on water resources, especially drinking water sources. The members of the EEC as augmented also noted that while current and potential human health and drinking water sources are a recommended starting point/priority for ORD research, investigations should eventually occur on the impact on water resources more generally, and their aquatic ecosystems and ability to support fishing and recreation. The members of the EEC as augmented further noted that regarding long-term research goals, since the behavior of horizontal hydraulic fracturing in geologic formations is not well understood, EPA should plan for the potential of a long term involvement in this research program.

The members of the EEC as augmented suggested that ORD's initial research efforts should include compiling and reviewing available data and knowledge on hydraulic fracturing and interaction with drinking water resources. The members of the EEC as augmented recommended that ORD develop a better understanding of the characteristics of the injected fluids, the reactions that occur in the injection zone, the characteristics of the fluids leaving the injected zone, and the pathways for the fluids leaving the injection zone. The members of the EEC as augmented further recommended that ORD should also develop a preliminary risk-based research prioritization approach to characterize the risk of conditions that can lead to human and ecological exposure to hydraulic fracturing fluids and products, and also prioritize research towards the reactions and transport of hydraulic fracturing fluids in the complex subsurface environment. Further, the members of the EEC as augmented suggested that ORD develop several overarching, fundamental questions to be answered in its research, and then place these questions in order of priority.

Charge Question #3: Stakeholder Process

Dr. Aneja noted the EPA document relied on a 2008 NRC report regarding a framework for stakeholder engagement, and discusses communication of science and risk, but did not identify a specific proposed approach for stakeholder involvement. A plan to develop consensus building among stakeholders was also not presented. Dr. Elliot thought the entire process should be pro-active, and that EPA should be judicious regarding selecting individuals with appropriate expertise and perspective. Dr. Nance noted EPA should develop a collaborative approach towards stakeholder involvement,

and also develop a community-based research component, e.g., engagement of stakeholders in environmental sampling and testing. Dr. Nance provided her detailed suggestions and comments in writing to Dr. Dzombak. Dr. Lee noted that balance is important to the stakeholder process, and because of the wide range of stakeholders, care needs to be taken to ensure that underfunded organizations and individuals are represented in the process.

Dr. Westerhoff suggested that EPA partner with others including states to develop a repository of information regarding HF. Dr. Dzombak noted that ORD could be a convener or co-convener, but such engagement may not be within the purview of ORD. At Dr. Dzombak's request, Dr. Teichman commented that ORD could assist other parts of EPA to get this information from the states. Dr. Shannon suggested that EPA partner with other federal agencies, including the U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. Bureau of Reclamation, U.S. Department of Energy, and the U.S. Army Corps of Engineers. Dr. Patten suggested holding a series of public meetings to gather stakeholder involvement. Dr. Shortle suggested that ORD have clear objectives for any stakeholder group that may be formed.

After several other members of the EEC as augmented suggested a number of items that would assist EPA in their research efforts, the Panel took a short break, during which Dr. Dzombak typed-up his summary of what he heard as the EEC's proposed areas of consensus regarding ORD's stakeholder process for HF activities to the Panel. This typed-up summary was projected onto the screen that was placed in the front of the room, and discussion occurred among the members of the EEC as augmented to identify agreed-upon areas of consensus on these topics. The notes that were presented to the Panel members are included as Attachment 4. After approximately thirty minutes of discussion, various themes of agreement were identified among the members of the EEC as augmented, including the following:

The members of the EEC as augmented recommended that ORD develop a balanced, collaborative advisory group of stakeholders representing a broad range of perspectives and a plan for engagement with these stakeholders throughout the research process. The members of the EEC as augmented suggested that the group be comprised of representatives of industry, environmental groups, affected residents, state regulators, academia, EPA headquarters, regional and laboratory scientists and engineers, and other individuals. The members of the EEC as augmented recommended that ORD consider having this group assist ORD in developing its research priorities, in accessing data held by the various groups, and in establishing stakeholder-based evaluation criteria. The members of the EEC as augmented also suggested that the group could also be used to help develop a community-based participatory research component that would develop technical capacity in affected communities, and also gain access to and leverage the existing knowledge base on hydraulic fracturing and its environmental impacts.

The members of the EEC as augmented further recommended that EPA first set clear, realistic goals, expectations and objectives for hydraulic fracturing stakeholder engagement and communication. The members of the EEC as augmented suggested that

ORD consider bringing together a small group of experts in participatory research to develop a stakeholder involvement process that will accomplish the results ORD desires.

The members of the EEC as augmented also suggested that EPA's research planning team explore opportunities to leverage ongoing or planned community-based sampling and testing, with appropriate consideration of quality assurance/quality control requirements and utilizing community resources for meaningful contributions to meeting research objectives. Also, the members of the EEC as augmented recommended that ORD to engage with other federal agencies to share data, collaborate, leverage expertise, and align research priorities for optimal use of limited resources.

Concluding Discussions:

Dr. Dzombak expressed thanks to the EEC members and members of the charter SAB who participated on this advisory activity. He noted that he and Ed Hanlon would produce a draft document that summarizes the areas of consensus discussed at the meeting, and include a draft letter to the Administrator. This draft letter would be sent to the members of the EEC as augmented for review.

Dr. Vanessa Vu also expressed thanks to the EEC members and members of the charter SAB who participated on this advisory activity, and noted that Panel could send any additional comments to Ed Hanlon after the meeting.

Dr. Puls expressed thanks to all EEC members as augmented for providing a very good discussion. In particular, Dr. Puls thanked the EEC as augmented for their thoughts on the lifecycle approach, for its thoughts on how to focus the research efforts, and for the ideas regarding taking a case study approach. Dr. Teichman also thanked the EEC as augmented, and noted that a Study Plan was tentatively scheduled for review by the SAB in September 2010.

The meeting adjourned at 12:00 pm.

Respectfully Submitted:

/Signed/
Mr. Edward Hanlon
Designated Federal Officer

Certified as True:

/Signed/
Dr. David A. Dzombak, Chair
Environmental Engineering Committee

Materials Cited

The following meeting materials are available on the EEC as augmented Web site at the April 7-8, 2010 meeting page, http://yosemite.epa.gov/sab/sabproduct.nsf/a84bfee16cc358ad85256ccd006b0b4b/4caa95a38952145f852576d3005daa17!OpenDocument&Date=2010-04-07 .

1 Federal Register Notice Announcing the Meeting
2 Agenda for April 7-8, 2010 Meeting
3. Hydraulic Fracturing Research Plan
4. Scoping Materials for Initial Design of EPA Hydraulic Fracturing Research Study
5. Background Document- Evaluation Impacts to Underground Sources of DW by HF of Coalbed Methane Reservoirs.
6. Background Document- Modern Shale Gas Development in the United States-A Primer
7. Background Document-Unconventional Gas Shales Development Technology and Policy Issues
8. EPA Presentation Materials
9. Charge Questions - Advice on Hydraulic Fracturing Research
10. Public comments submitted to the SAB Staff Office
11. List of Public Speakers-Hydraulic Fracturing April 2010 Meeting
13. Oral Statements Submitted by the public speakers from the meeting

Attachment 1: Roster

U.S. Environmental Protection Agency
Science Advisory Board
SAB Environmental Engineering Committee (EEC) Augmented for the Evaluation and Comment on EPA's Proposed Research Approach for Studying the Potential Relationships Between Hydraulic Fracturing and Drinking Water Resources

CHAIR

Dr. David A. Dzombak, Walter J. Blenko Sr. Professor of Environmental Engineering, Department of Civil and Environmental Engineering, Carnegie Mellon University, Pittsburgh, PA

EEC MEMBERS

Dr. Viney Aneja, Professor, Department of Marine, Earth, and Atmospheric Sciences, School of Physical and Mathematical Sciences, North Carolina State University, Raleigh, NC

Dr. Robin L. Autenrieth, Associate Dean for Graduate Programs and Professor, College of Engineering, Texas A&M University, College Station, TX

Dr. John P. Connolly, Senior Technical Advisor and Principal Engineer, Anchor QEA, LLC, Montvale, NJ

Dr. Herschel Elliott, Professor, Department of Agricultural and Biological Engineering, Penn State University, University Park, PA

Dr. Arpad Horvath, Associate Professor, Department of Civil and Environmental Engineering, University of California, Berkeley, CA

Dr. Cindy M. Lee, Professor, Department of Environmental Engineering and Earth Sciences, Clemson University, Anderson, SC

Dr. Earthea Nance, Assistant Professor of Environmental Planning and Hazard Mitigation, Department of Planning and Urban Studies, University of New Orleans, New Orleans, LA

Dr. Catherine Peters, Associate Professor, Department of Civil and Environmental Engineering, Princeton University, Princeton, NJ

Dr. Danny Reible, Professor, Department of Civil, Architectural and Environmental Engineering, University of Texas, Austin, TX

Dr. Sujoy Roy, Director, Research and Development, Tetra Tech Inc., Lafayette, CA

Dr. Mark A. Shannon, Professor, and Director, the WaterCAMPWS Center, Department of Mechanical Science and Engineering, University of Illinois, Urbana-Champaign, Urbana, IL

Dr. Paul Westerhoff, Professor and Director of the School of Sustainable Engineering and The Built Environment, Arizona State University, Tempe, AZ

Dr. Thomas M. Young, Professor, Department of Civil & Environmental Engineering, University of California-Davis, Davis, CA

OTHER SAB MEMBERS

Dr. Jeffrey Griffiths, Associate Professor, Department of Public Health and Community Medicine, School of Medicine, Tufts University, Boston, MA

Dr. Susan Korrick, Assistant Professor of Medicine, Department of Medicine, Brigham and Women's Hospital, Channing Laboratory, Harvard Medical School, Boston, MA

Dr. Duncan Patten, Research Professor, Hydroecology Research Program, Land Resources and Environmental Sciences, Montana State University, Bozeman, MT

Dr. James Shortle, Professor, Agricultural Economics and Rural Sociology, Pennsylvania State University, University Park, PA

SCIENCE ADVISORY BOARD STAFF

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

Attachment 2: Public Attendance

Name	Organization
David Adams	Haliburton
Rochelle Araujo	ORD
Matt Armstrong	Bracewell
Dan Banson	EPW
Paul Bardvoc	Chevron
Jannette Barth	
Mavie Benkinney	Exponent
Dipka Bhambhani	Clear Skies
Kevin Bliss	IOGCC
Judy Blumenthal	CVS
Julia Bolt	GolinHarris
Judin Bonzul	EPA/AAAS
Jacob Booher	EWG
Paul Bordan	Chevron
Andrew Browning	CEA
Deborah Burgin	CDC-ATSDR
Karen Christensen	Exxon Mobil
Corrie Clark	Argonne National Laboratory
Gelena Constantine	EPA-ORD
Elena Craft	Environmental Defense
Gordon Culver	Clean Water Network
Dan Daulton	BJ Services
Jill Dean	EPA/OGWDW
George Deeley	Shell
Brook Detterman	Baker Botts LLP
Diane Donnelly	NRDC
Morgan Douglas	ICF International
Kevin Easley	DOE-PI
Tony Eisenboro	McLoog Glout
Sam Flewelling	Gradient
Dick Francis	Shell
Jeff Frithson	USEPA
Lee Fuller	IPAA
Jessica Good	The Wilderness Society
Kelly Grant	EPA/DFE
Tom Grumbles	ENTRIX
Sally Gutierrez	USEPA
Bill Hains	Praits
Andrew Hanson	EPA
Keith Hastin	USFWS
Troy Hillier	Policy Navigation Group
Katie Howell	Greenwire

Name	Organization
Patrick Hughes	Height Analytics
Jason Hull	
Tom Jackson	Baker Botts
Carliane Johnson	Sea Jay Consulting
Jeff Jollie	EPA-OW/OGWDW
Laura Keating	Exxon Mobil
Stuart Kemp	Haliburton
Juan Knofss	Hart Energy
Alan Kovski	BNA
Mary Kroeger	The Wilderness Society
Alison LaBonte	AAAS-DOE
Audrey Levine	EPA
Sean Levine	Demateu Moness
Richard Liroff	Investor Environ-Methyl Health Network
Frank V.Lossa	Wilkins & Jensen
Cynthia Love	AWWA
Richard Luedecles	Devon Energy
George Lukert	Ecology & Environment
Bob Marion	Haliburton
Shannon Meade	US Chamber of Commerce
Craig Michaels	RiverKeeper
Austin Mitchell	Carnegie Mellon Univ.
Matthew Montell	Chesapeake Energy
Brian Murkowski	REPSOL
Dennis Nagy	CD-ADAPCO
Maureen Nelson	EPA
Stephanie Nordous	API
Steve O'Brien	REPSOL
Matt Oehler	Haliburton
Chris Ouina	Ecology & Environment
Lauren Pagel	Earthworks
Mike Paque	GWPC
Mike Parker	Exxon Mobil
Jenifer Peters	Clean Water Network
Rob Renner	Water Research Foundation
Jesse Richardson	Water Systems Council
James Robinson	Oxidone Engineering
Ben Salisburg	FBR
Soumitri (Mimi)Sarkar	Environmental Law Clinic (UPIH)
Craig Segall	Sierra Club
Chilto Sham	Cadmus
Andrew Shaw	McKenna, Long & Aldridge
Jill Shaw	TetraTech
Paul Shipiro	EPA

Name	Organization
Andrew Shun	Astrn U McKinnigan
Kate Somding	NRDC
Dan Sreghrm	Baker Boors
Evan Stisser	Durkuwworldwide/NEWA
Kevin Teichman	EPA
Ryan Thompson	
Mary Tiemann	CRS
Dennis Tuck	Haliburton
Nicholas Uilileane	Marwood Group
Ann Davis Vaughan	Tudor Pickering
John Veil	Argonne National Laboratory
Asha Venkataraman	Van Ness Feldman
Sha Via	AWWA
Alex Vincent	Mayer Brown LLP
Frank Vlosser	Williams & Jensen
Tom Vogel	Porter Novelli
Greg Walcher	Natural Resources Group
Mike Watts	Halliburton
Bobby Wegener	OK Sec of Energy
Caroline Whitehead	EPA-OA-OCER
Ron Wilhelm	USEPA/DRIAI
Brad Williams	OK Sec of Energy
Kate Winston	Inside EPA
Brian Woodard	Devon Energy
Jeff Zimmerman	FUDRDCSNYAZO FUND

Attachment 3

Environmental Engineering Committee, Augmented for Advice on EPA's Research Program Related to Hydraulic Fracturing
Public Meeting, April 7-8, 2010

List of Public Speakers*

1. Richard A. Liroff, Investor Environmental Health Network

2. Mike Watts, Halliburton Energy Services, Inc.

3. Jennifer Peters, Clean Water Network

4. Kate Sinding, Natural Resources Defense Council

5. Craig Michaels, Riverkeeper

6. Lee Fuller, Independent Petroleum Association of America, and Energy In Depth

7. Robert Wegener, Secretary of Energy, State of Oklahoma

8. Jeff Zimmerman, Damascus Citizens for Sustainability, and Friends of the Upper Delaware River

9. Craig Segall, Sierra Club

10. Mike Paque, Ground Water Protection Council

11. Paul Hagemeier, Chesapeake Energy Corporation

12. Keith Hastie, U.S. Fish and Wildlife Service

13. Mary Kruger, The Wilderness Society

14. Lauren Pagel, EARTHWORKS

15. Stephanie R. Meadows, American Petroleum Institute

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

Attachment 4

Dr. Dzombak's Preliminary Summary of Key Points and Areas of Consensus Regarding Charge Questions 1, 2A, 2B, and 3:

EPA Science Advisory Board, Environmental Engineering Committee
Hydraulic Fracturing Review
Summary of Questions 1 and 2B

April 8, 2010 Preliminary Discussion Points

Charge Question 1

Proposed Scope of Study:

Congress urged EPA to carry out a study on "the relationship between hydraulic fracturing and drinking water." Key to determining the scope of the study is understanding whether or not the scope of the study should be narrowly focused or broadly focused, taking into account water resources and related public health and environmental issues over the lifecycle of hydraulic fracturing.

Charge Question 1: What recommendations does the SAB EEC have regarding this question of scope?

Charge Question 2B

Proposed Research Topics:

ORD has identified the following proposed research categories relevant to hydraulic fracturing pertaining to extraction of oil and gas from geologic formations and its relationship to drinking water:

- Characterization of the Hydraulic Fracturing Lifecycle
- Potential Relationships to Drinking Water Resources
- Potential Health and Environmental Risks.

Charge Question 2B: What process does the SAB EEC suggest for prioritizing research needs given the Congressional request and a desire by the Agency to complete initial research products by the end of calendar year 2012?

April 8, 2010 Preliminary Discussion Points

ORD has interpreted the charge to investigate "the relationship between hydraulic fracturing and drinking water" with a systems perspective, and developed a research plan with a related broad scope. The SAB EEC supports the systems perspective reflected in the ORD research plan. Environmental science has been moving toward analysis that encompasses larger-scale systems, such as at watershed scale, in order to account for the inter-relationships that ultimately determine ecosystem health and hence the health of human communities that depend on these ecosystems. There is now widespread

recognition that focusing too narrowly in assessing impacts of activities can lead to incomplete understanding.

The use of a lifecycle framework to plan a research study on the environmental impacts of hydraulic fracturing is appropriate. It is not necessarily the case that a formal lifecycle assessment needs to be undertaken. Outlining the HF lifecycle and thinking about the components that would be included in a lifecycle assessment can be useful in identifying critical knowledge gaps. Considering the time and resources available for the initial study by ORD, the committee recommends use of a lifecycle framework , without actually performing a lifecycle assessment, to identify the most important research questions to address in the initial study. Questions pertaining to the impacts of the various stages of the hydraulic fracturing lifecycle on water resources will be of primary importance and consistent with the research request from Congress.

Economic analyses such as cost-benefit analysis are not included in the ORD research plan. The committee supports the omission of such analysis from the ORD research plan for this initial study. There are a number of first-order science issues that need to be addressed first

The ORD research plan has been formulated in part by the goal of conducting policy-relevant research. While it is hard to predict which scientific results will be of greatest use in establishment of policies and regulations by the EPA and other government agencies in the future, the committee believes that the research plan includes topics that will be relevant to policy formulation.

Priorities

The committee recommends that initial research should be directed to study of sources and pathways of impacts of hydraulic fracturing on water resources. Knowledge of the characteristics of the injected fluids, the reactions that occur in the injection zone, the characteristics of the fluids leaving the injected zone, and the pathways for the fluids leaving the injection zone will be needed for assessing impacts on water resources, exposure of humans and ecosystems to hydraulic fracturing fluids and products, and uncertainty. Development of the scientific knowledge to understanding exposure should be a driving priority. Experience with reservoir engineering and subsurface remediation makes clear that there is much to learn about the reactions and transport of hydraulic fracturing fluids in the complex subsurface environment. Initial efforts should be focused on developing basic scientific understanding of these processes.

The ORD research plan provides several lists of possible specific research questions. These questions can be grouped into some more general, fundamental questions which can then be placed in order of priority. The committee recommends that ORD conduct such an exercise before revising the research plan. The committee discussed some fundamental questions, but did not undertake to prioritize them.

Fundamental questions

What is the quality and quantity of injected fluids and flowback water? How does the specific composition of total dissolved solids (TDS) vary among flowback waters?

What do field case studies tell us about the effects of hydraulic fracturing on the reactions, fate, and transport of injected constituents, and the fate and transport of potential contaminants in particular regions and geologic regimes?

What do field data convey about region-specific issues related to hydraulic fracturing and its environmental impacts?

In what way does hydraulic fracturing, at one or multiple sites, alter existing surface and subsurface flow paths?

What are existing best management practices (BMPs) that affect quality and quantity of flowback water?

What are opportunities to develop technologies that could lead to green additives or improved approaches to managing process waters or waters impacted by hydraulic fracturing?

What are the mass balances for water and constituents of concern at a hydraulic fracturing site?

What are fundamental physical and chemical processes for each phase of the hydraulic fracturing lifecycle (below ground and above ground)?

Which small-scale research studies on fate of hydraulic fracturing constituents have most relevance to constituent fate in large-scale systems?

What are site specific factors that affect potential for risk? If there is reasonable potential for risk, how do we assess that potential?

What are the hydraulic fracturing scenarios likely to pose the greatest public health risk?

What are the appropriate temporal, spatial, and loading consequences of different intensity levels (in spatial distribution and time) of hydraulic fracturing activity?

EPA Science Advisory Board, Environmental Engineering Committee
Hydraulic Fracturing Review
Summary of Question 2A

April 8, 2010 Preliminary Discussion Points

Charge Question 2

ORD has identified the following proposed research categories relevant to hydraulic fracturing pertaining to extraction of oil and gas from geologic formations and its relationship to drinking water:

- Characterization of the hydraulic fracturing lifecycle
- Potential relationships to drinking water resources
- Potential health and environmental risks

Charge Question 2A: What recommendations does the SAB EEC have regarding these proposed research categories and the related questions in the scoping paper?

April 8, 2010 Preliminary Discussion Points

Characterization of the hydraulic fracturing lifecycle

Lifecycle assessment is a good organizing principle for planning of the Hydraulic Fracturing (HF) research study. Lifecycle assessment is a formal process for which there is an international standard, ISO 14040.

It is not necessarily the case that a formal lifecycle assessment needs to be undertaken. Outlining the HF lifecycle and thinking about the components that would be included in a lifecycle assessment can be useful in identifying knowledge gaps. A careful compilation and review of data and knowledge available in the literature, in industry, and in government agencies should be conducted to ensure accurate identification of data gaps.

Development of a lifecycle framework for HF can help EPA ORD define what is unique about the HF process. To the extent possible, the research plan should focus on issues that are uniquely associated with HF, though it is recognized that it will be difficult to separate some issues associated with conventional oil and gas production in the evaluation of HF.

Development of a lifecycle framework for HF can help EPA ORD prioritize knowledge gaps and decide what to study. LCA can be used to separate conventional, well-understood issues such as impacts of site development, road construction, and trucking, from impacts that are not well understood, such as fate of chemicals in flowback water storage ponds.

In developing the lifecycle framework, identification of appropriate boundaries for assessment will be necessary and will help inform the HF research planning. An important boundary issue for development of the HF research plan is where to draw the line between what is an HF-specific question and what are questions pertaining to all oil and gas production operations. Boundary definition should also be guided by consideration of the types of comparisons that the EPA or others may wish to undertake in the future, e.g., comparison of HF impacts with those of other gas or energy production processes.

In developing the lifecycle framework, it will be necessary to think about the desired functional unit (e.g., single well, a multi-well pad, or a watershed), the desired time horizon, and the most appropriate metrics (e.g., water use per unit of gas produced, total volume of water use for a region or watershed, number of conventional wells avoided by per meter of horizontal drilling).

In developing the lifecycle framework and choosing boundaries, time horizons, functional units, and metrics, EPA should acknowledge the degree to which the choices made in regard to these issues mean that some positive and negative impacts of HF technology won't be addressed in the study.

While there are multiple environmental impacts relevant to hydraulic fracturing, water issues are central and are at the focus of the Congressional request for the research study. Water should be the central theme for the lifecycle framework development. Evaluation of the lifecycle assessment could be aimed at identifying knowledge gaps relevant to managing impacts on drinking water sources and systems, and prioritizing these knowledge gaps for research.

Potential relationships to drinking water sources

It is important that at the beginning of the beginning of the research study a careful compilation and review of data and knowledge available in the literature, in industry, and in government agencies be conducted to ensure accurate identification of data and knowledge gaps, to make maximum use of existing information and thus optimal use of limited research funds.

This compilation and review of existing data and knowledge will need to be conducted with critical evaluation of the quality and relevance of the information. For example, some previous studies on HF have been focused on how to get the gas out of the ground, and the data collected and presented are not necessarily sufficient or complete for understanding solute generation or migration.

The definition of drinking water source should be broad, as some saline waters not currently considered drinking water sources will likely be viewed as such in the future.

Considering the range of potential environmental impacts associated with HF and the range of geographic/geologic regions and site-specific conditions in which HF may be implemented, it will be difficult to study HF with sufficient depth and breadth for the allotted time and budget of the research study. In this context, the research planning team should consider performance of in-depth case studies at 5-10 particular sites selected to represent the site and regional variability involved. EPA ORD has used the in-depth case study approach successfully in other research multi-objective research programs. This is an efficient way to conduct research for groups of systems which exhibit significant variability. The case study approach can yield in-depth process understanding, and some degree of generalizability with careful design. Case studies offer the potential to increase understanding of exposure in relation to HF activities in a rapid manner. Case studies should be carefully designed to assess the range and variability of conditions of areas where HF is and will be occurring.

Regarding timeframe, ORD should identify what are reasonable short term goals and accomplishments (e.g., within 1-3 years) and long term goals and accomplishments (e.g., within 5-10 years or longer) of this research.

Defining relationships of HF processes to drinking water sources requires much better understanding of occurrence of HF fluids in drinking water sources, in different phases of the HF lifecycle. For improved detection, reliable surrogate constituents should be investigated. The potential and desirability of introducing tracer constituents in HF fluids should also be investigated.

In order to help assess impacts to drinking water, ORD should consider doing mass and material balances on water quality (e.g., on chemicals of concern) and quantity in areas where HF is or will be occurring. Also, since impacts to water quantity affect water quality, ORD should also assess HF impacts to water quantity affect water quality in both surface water and groundwater.

The composition of HF flowback water, and the sources of the constituents – additive, reaction product, or leaching product – need to be understood to provide knowledge about physical-chemical mechanisms governing flowback water chemistry and insight into ways to control this chemistry.

The research plan should include a focused effort on treatability of HF flowback water, in several contexts. Research should be conducted to determine the effectiveness of existing drinking water treatment technology, including public water treatment and point of use technology, for removing HF flowback water constitutents. Research should also be conducted on the effectiveness of municipal wastewater treatment systems with respect to HF flowback water, since these waters are often being directed to Publicly Owned Treatment Works (POTWs). There are new methods emerging for treatment of very high Total Dissolved Solids (TDS) waters, such as membrane distillation. The potential for these technologies to be effective in treating HF process waters should be systematically investigated.

In developing the research study plan, specific potential uses of the results should be considered. If one potential outcome is to develop scientific information to facilitate assessment of risk at particular sites, development of site assessment methodologies and related data requirements and acquisition methodologies is needed.

Potential health and environmental risks

Health and environmental risk associated with HF can only be assessed after sources and pathways of exposure are much better understood. The composition and variability of the source fluids must be characterized, and in a manner that recognizes future interest in evaluation of possible synergistic effects of mixtures of chemicals. Potential pathways of exposure under a range of HF process conditions need to be evaluated.

GIS mapping with overlays of HF activities and locations of human populations and ecological receptors offers promise to provide useful initial insights into exposed populations and ecosystems. There are readily available databases which can be used, including those related to Census, Medicaid, Medicare, and others. GIS mapping will provide a sense of issues pertaining to exposure, and will help with the design of future health and ecosystem studies. The mapping will provide insights into locations for targeted current and/or future research.

Occupational exposure information and data for HF processes could be a potential source of information to guide initial evaluations. Such information could, for example, give some initial information on the potential effects of mixtures of chemicals present in HF fluids.

In addition to focusing on the quality of source fluids and effects of source fluid migration on drinking water quality, another important factor related to HF processes is effect on water quantity. Changes in water quantity in groundwaters or surface waters can have significant influences on human and ecosystem health.

In evaluating sources of HF fluids, exposure pathways, and effects on people and ecosystems, system impacts should be considered and not just individual locations. The cumulative contributions and impacts of HF processes on people and ecosystems in a region need to be considered.

For whatever choices that EPA ORD makes in deciding what to study with respect to sources, exposure pathways, and effects, there should be investment made to develop effective means of communicating and defending the chosen topics of focus.

EPA Science Advisory Board, Environmental Engineering Committee
Hydraulic Fracturing Review
Summary of Question 3

April 8, 2010 Preliminary Discussion Points

Charge Question 3

Stakeholder Process:

It will be critical to engage the stakeholder community in the planning process to establish a research program that is reflective of diverse interests and viewpoints.

Charge Question 3: What advice does the SAB EEC offer for designing a stakeholder process that provides for balanced input in developing a sound scientific approach for the overall research strategy?

April 8, 2010 Preliminary Discussion Points

Charge Question 3 Summary

The committee recommends development of a collaborative advisory group of stakeholders representing a broad range of perspectives. Hydraulic fracturing for oil and gas development affects communities directly and is a topic of significant public interest. Formation of an advisory group of stakeholders for the research effort will help inform the research, including helping the research teams to become aware of data and expertise which can benefit the research.

There is a need for EPA to undertake various kinds of stakeholder engagement in regard to the hydraulic fracturing issue. The needs and responsibilities of ORD with respect to stakeholder engagement for informing research are more limited, however. The committee recommends that ORD objectives for stakeholder engagement be well defined. This will help with determining the appropriate composition and charge for the advisory group of stakeholders.

From the written and oral comments provided from the public regarding the draft ORD plan for research on hydraulic fracturing, it is clear that there is a wealth of data and experience in industry, advocacy groups, state agencies, and other groups for ORD to draw upon in the research effort. One important objective for engagement with stakeholders should be to gain access to and leverage the existing knowledge base on hydraulic fracturing and its environmental impacts.

There are many technological development activities and development and study of best management practices with respect to hydraulic fracturing that are ongoing in the states. It will be important of ORD to engage with relevant states to inventory state

technological development and BMP activities. Among other benefits of such an endeavor, the committee expects that opportunities for collaborative EPA and state research efforts will be identified through serious engagement with the states.

Through the discussions with stakeholder groups and the engagement with states, opportunities to leverage ongoing or planned community-based sampling and testing should be explored, with appropriate consideration of QA-QC requirements and utilizing community resources for meaningful contributions to meeting research objectives. There may be particular opportunities to engage community resources at case study sites, if ORD decides to pursue case studies as a component of the research effort.

It will also be important for ORD to engage with other federal agencies to share data, collaborate, leverage expertise, and align research priorities for optimal use of limited resources.