<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter/Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:00 – 2:15</td>
<td>Greetings &amp; Roll Call</td>
<td>Ann Codrington, Office of Ground Water and Drinking Water</td>
</tr>
<tr>
<td>2:15 – 2:45</td>
<td>EPA Preliminary Plans for Study</td>
<td>Audrey Levine, Office of Research and Development</td>
</tr>
<tr>
<td>2:45 – 3:00</td>
<td>Stakeholder Process</td>
<td>Jill Dean, Office of Ground Water and Drinking Water</td>
</tr>
<tr>
<td>3:00 – 4:00</td>
<td>Discussion</td>
<td></td>
</tr>
</tbody>
</table>
Potential Relationships Between Hydraulic Fracturing and Drinking Water Resources

Outreach to State Partners on Study Design and Stakeholder Involvement
Major topics to be discussed

• Provide overview of context for study and approach for developing study design

• Describe potential components of study

• Identify types of data and information that stakeholders can provide

• Provide summary of April 2010 Science Advisory Board (SAB) Consultation
  – Scope of Study
  – Research Focus and Prioritization
  – Stakeholder Process

• Describe Stakeholder Process

• Solicit input/feedback from participants through discussion session
“The conferees urge the Agency to carry out a study on the relationship between hydraulic fracturing and drinking water, using a credible approach that relies on the best available science, as well as independent sources of information. The conferees expect the study to be conducted through a transparent, peer-reviewed process that will ensure the validity and accuracy of the data. The Agency shall consult with other Federal agencies as well as appropriate State and interstate regulatory agencies in carrying out the study, which should be prepared in accordance with the Agency’s quality assurance principles.”
Why is hydraulic fracturing a concern now?

• Extraction of energy resources from shale is becoming more prevalent due to:
  – Advances in horizontal drilling technologies and new fluid formulations that improve economics
  – Access to different formations (shale, coalbeds, tight sands)
  – “Unconventional” gas is perceived to represent a significant future domestic “clean” energy source

• Concerns about potential endangerment of water supplies
  – New and different geographic and geologic settings
  – Adjacent formations may contain metals, radionuclides, salts, or other constituents that may be mobilized and impact water quality
  – Environmental contaminants associated with hydraulic fracturing chemicals, well drilling, water, wastes, and residuals may pose risks to public health, water resources, and the environment
Role of Water in the context of the Hydraulic Fracturing Lifespan

- Water associated with hydraulic fracturing is derived from local underground or surface sources, and it is either managed on-site or transported off-site for treatment and/or discharge.
- The water “footprint” of hydraulic fracturing depends on the formation, depth, and type of drilling (e.g. vertical, horizontal, directional).
- Examples of water associated with the hydraulic fracturing lifespan include:
  - Underground and surface sources of drinking water
  - Make-up water for mixing hydraulic fracturing fluids and proppants
  - Flow-back water, produced water, wastewater, and storm water.
- Contaminants associated with flowback fluids and produced water may include:
  - Hydraulic fracturing fluids, sand, propping agents, chemical degradation and transformation products, and microbial growth that may be triggered through water use.
  - Materials in the subsurface that are mobilized by the injected fluids and brought to the surface during energy resource extraction.
  - Constituents such as metals, radionuclides, and organics that may precipitate or volatilize through water and wastewater management.
Approach for Developing EPA Study Plan

Hydraulic Fracturing Lifespan
- Site exploration, selection and preparation
- Equipment mobilization-demobilization
- Well construction and development
- Mixing and injecting fracturing fluids
- Hydraulic fracturing of the formation
- Management of water and residuals
- Site activities and monitoring
- Well/Site closure

Water Resources Concerns

Health and Environmental Concerns

Data Availability and Research Needs

Components
- Background data and information
- Chemical characterization
- Field investigations, case studies, and modeling
- Technological solutions and decision support

Research Prioritization Considerations
- Policy relevance
- Deliverables within 1-3 years
- Resource Constraints

Study Design, Peer Review, and Implementation

Research Products
- Data, Methods, Models, Tools, Technology

---

Policy relevance
Deliverables within 1-3 years
Resource Constraints

---
2010 Timeline

State & Federal Partner Meetings
Late May/Early June

Website Posted
June

Public Meetings
July – August

Draft Study Design Final
Sept

Technical Workshops
Oct - Nov

Peer Review
October

Initiate Study
Jan 2011

Initial study results are expected to be published by late 2012.
Potential Elements of the Study

- Compilation and analysis of background data and information
- Characterization of chemical constituents relevant to hydraulic fracturing
- Field investigations, case studies, and computational modeling
- Technological solutions for risk mitigation and decision support
Hydraulic fracturing
Data and Information needs

• Types of data

  – Baseline data about site characteristics and surrounding area prior to drilling
  – Validated and consistent data on chemicals, additives, and their concentrations
  – Water quality data associated with flowback and produced waters
  – Data on metals, radionuclides, and other constituents that are mobilized from the subsurface, wastewater, or residuals
  – Data on well construction, well integrity, failure rate
  – Information on regulatory approaches and best management practices

• How the information may be used:

  – Qualitative evaluation of status of information
  – Identify research and information gaps
  – Inform study design and screen sites for case studies
  – Identify regional and geographic variations
  – Prioritize research
Approach for Data and Information Compilation and Analysis

- Identify, compile, and analyze published data
  - Published reports (e.g. EPA, DOE, USGS, GWPC, Industry, State Associations, Environmental Groups, Universities, etc.)
  - Peer-reviewed literature
- Develop process for collecting, compiling, and reporting data from stakeholders including Federal agencies, States, Interstate Agencies, Industry, NGOs, Citizens
  - Define categories of data and information
  - Develop quality assurance criteria
  - Provide on-line system and other easy-to-use mechanisms for data entry
- Federal Register Notice during summer 2010 to request data
- Identify data and information gaps
Characterization of chemical constituents relevant to hydraulic fracturing

• Objectives
  – Characterize fracturing fluids and their degradation products to evaluate fate and transport properties and potential toxicity
  – Determine the potential for metals, radionuclides, organic contaminants or gases to be mobilized from geologic formations and treatment residuals
  – Identify indicator/surrogate parameters that can be used to indicate exposure

• Approach
  – Evaluate and troubleshoot existing analytical methods
  – Identify matrix interferences
  – Refine or modify analytical methods as needed
  – Identify key biogeochemical processes that might impact the quality of drinking water supplies
Field investigations, case studies, and computational modeling

• **Objective:**
  - Collect data on how the lifespan of hydraulic fracturing impacts water resources and potential health risks
  - Collect data on water quality and availability
  - Develop ground water and watershed models that can be validated and used to determine “area of review” and inform water resource management strategies

• **Approach**
  - Field investigations and sample collection
    - Well Sampling and Analysis
    - Pre-injection, flowback fluids, produced water, wastewater discharges, surface water supplies
    - Process residuals
    - Other exposure pathways
  - Data analysis and interpretation
  - Modeling
  - Risk assessment
Field Investigations

• Objectives
  – Provide basis for developing comprehensive assessment of hydraulic fracturing and water resources in different geographic and geologic settings
  – Develop inputs for computational modeling, risk assessment, and decision-support tools
  – Evaluate best management practices

• Approach
  – Develop criteria for nominating, screening, and prioritizing sites for field investigations
  – Coordinate with stakeholders on identifying candidate sites for field investigations and case studies
  – Compile background information and sampling program
  – Develop detailed study plan and quality assurance
  – Stage site activities to correspond to critical components of hydraulic fracturing lifespan and in coordination with other aspects of project including modeling and risk mitigation
  – Provide periodic progress updates
Criteria for Site Selection

• Screening Criteria
  – Vulnerable surface or ground water resources
  – Proximity of population and drinking water supplies
  – Magnitude of activity (wells/acre)
  – Geologic conditions
  – Site history

• Physical Considerations
  – Site access for monitoring wells and geophysical testing
  – Availability of support services
  – Access to surface and ground water resources

• Other Considerations
  – Stakeholder recommendations
  – Ability to leverage with other stakeholders (federal, state, interstate, industry, NGOs, citizens)
Potential Computational Modeling Activities

- Fate and transport studies of HF fluids
- Predict the likelihood of drinking water impacts based upon the available geologic, geochemical, geophysical, and hydrologic data
- Determine the zone of influence of HF fluids and area of review in the subsurface
- Evaluate vulnerability of abandoned wells
- Inform sampling and monitoring programs
- Apply watershed based models to evaluate impacts of water withdrawals and wastewater discharges on water quality and availability
- Develop decision-support tools to evaluate relationship of management practices to water quality and availability
Inform technological solutions for risk mitigation and decision support

- Monitoring strategies (short-term and long-term)
- Sustainable and reliable strategies for water management
  - Water use optimization (quality and quantity)
  - Treatment technologies for flowback fluids, produced waters, residuals, and other waste materials generated through HF
- Alternative chemicals/technologies that reduce environmental and health risks
  - Hydraulic fracturing chemicals
  - Biocides
  - Alternative water sources and reuse
  - Drinking water source protection, treatment, and monitoring
- Integrated data and information management including mapping to overlay HF activities with the locations of gas resources, drinking water resources, and other relevant site information
Science Advisory Board Consultation

- Public meeting held in Washington DC April 7-8 2010
- SAB provided with scoping materials and charge questions
- Charge questions
  1. Scope:
     - What recommendations does the SAB Environmental Engineering Committee (EEC) have regarding the scope of the study?
  2. Research questions and prioritization:
     - What recommendations does the SAB EEC have regarding the research questions identified?
     - 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?
  3. Stakeholders:
     - 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?
- Stakeholder representation: Other Federal agencies, States and State agencies, local governments, non-governmental organizations and associations, public interest groups, industries, industrial organizations and associations, and private citizens
- Stakeholder Comments: 64 written comments, 15 oral statements
- For more information: http://www.epa.gov/sab
1. **Scope:**

- Short-term research should be directed to study sources and pathways of potential impacts of hydraulic fracturing on water resources (quality and quantity), including surface waters, underground sources of drinking water, and potential sources of drinking water.
- Use a lifecycle framework to identify the most important research questions and characterize fundamental physical and chemical processes below and above ground.
- Focus on human health and environmental concerns specific to HF.

2. **Research questions and prioritization:**

- Careful compilation and review of all available data and knowledge available in peer-reviewed literature, in industry, in professional and non-governmental organizations, and government agencies.
- Use a case-study approach to facilitate exchange of information between resource development companies and citizen groups.
- Prioritize research toward the reactions and transport of hydraulic fracturing fluids in complex subsurface environments including characteristics of the injected fluids, reactions occurring in the injected zone, and pathways for exposure.
Draft Overarching Research Questions
Suggested by SAB EEC (5-20-2010)

• What are the fundamental physical and chemical water-related processes for each phase of the hydraulic fracturing lifecycle (below ground and above ground in treatment processes and surface water)?

• What is the quality and quantity of injected fluids, flowback water and produced water that is co-mingled with the flowback water?

• How does the specific composition of TDS vary among flowback and produced 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 subsurface flow paths?

• What are existing best management practices (BMPs) that affect quality and quantity of flowback and produced 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?
SAB Response to Charge Question 3: Stakeholders

• Develop a balanced, collaborative advisory group of stakeholders representing a broad range of perspectives

• Engage stakeholders throughout the study

• Use best available social science for developing stakeholder engagement activities

• Engage with relevant states to inventory and conduct performance evaluations of the effectiveness of state regulatory, technological development and BMP activities
## Hydraulic Fracturing Study

### Federal Partner Consultation

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter/Office</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:00 – 2:15</td>
<td>Greetings &amp; Roll Call</td>
<td>Ann Codrington, Office of Ground Water and Drinking Water</td>
</tr>
<tr>
<td>2:15 – 2:45</td>
<td>EPA Preliminary Plans for Study</td>
<td>Audrey Levine, Office of Research and Development</td>
</tr>
<tr>
<td>2:45 – 3:00</td>
<td>Stakeholder Process</td>
<td>Jill Dean, Office of Ground Water and Drinking Water</td>
</tr>
<tr>
<td>3:00 – 4:00</td>
<td>Discussion</td>
<td></td>
</tr>
</tbody>
</table>

Office of Research and Development

May 27, 2010
Hydraulic Fracturing Study: Stakeholder Process

June 7, 2010
Federal Partner Consultation

Jill Dean, EPA Office of Water
OUTLINE

• Purpose of stakeholder events
• Types of stakeholder events
• Collaborative Groups
• Timeline
• Input
Purpose of Engaging the Public

- Identify Data Gaps through Communication
- Highlight Critical Components of Process
- Explore Different Approaches to Research
Stakeholder Events

Facilitated Public Meetings
- July 8, Fort Worth, TX
- July 13, Denver, CO
- July 22, Canonsburg, PA
- Aug 12, Binghamton, NY

Sector-Specific Meetings
- June – July 2010
- Sectors: State & federal partners, industry, environmental groups, citizens, tribes

Technical Workshops
- October – November 2010
- Locations: To be determined
- Proposed topics: well mechanical integrity, fate & transport of fluids, monitoring
Facilitated Public Meetings

Meeting Activities
1. Brief presentations by EPA on
   a. hydraulic fracturing background
   b. draft study plan and scope
   c. criteria for selecting case study locations
2. Oral comment period by public

Public

Feedback on study scope, perspectives on risk, share data, identify data gaps

Half-day public meeting with 2-3 sessions during day to maximize public contact

EPA

Share preliminary plans for study, HF background
Sector-Specific Meetings

Washington, DC
- State & Federal Partner Consultations
- Industry, NGOs

Regions
- Tribes
- EPA Regions 2 and 8
Technical Workshops

• Define the technical information EPA does not have to inform the study design, field investigations
• Who do we invite?
• Are these the right topics?

Well integrity
Learn different approaches by States, industry BMPs
Bring attention to a critical component of drinking water protection

Fluid Fate & Transport
EPA needs models specific to HF

Monitoring
Methods & technology specific to HF
Opportunities for Collaboration

• Interagency collaboration
  – Continuing dialogue with Federal & State partners through meetings at certain milestones
  – Group would serve as a “sounding board” and provide constructive feedback throughout study
  – Provide expertise in hydraulic fracturing

• Federal Partners Workgroup
  – Inventory current and planned activities
  – Facilitate data transfers among agencies
  – Peer review of study plan, interim activities
2010 Stakeholder Process Timeline

May 27: State Partner Meeting
June 7: Federal Partner Meeting
June 8: Public Meeting, Fort Worth, TX
July 8: Public Meeting, Denver, CO
July 13: Public Meeting, Washington, PA
July 22: Public Meeting, Binghamton, NY
Aug 12: Technical Workshops
Oct – Nov:

Dates and locations for various stakeholders' meetings and technical workshops are listed in the timeline.
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:00 – 2:15</td>
<td>Greetings &amp; Roll Call</td>
<td>Ann Codrington, Office of Ground Water and Drinking Water</td>
</tr>
<tr>
<td>2:15 – 2:45</td>
<td>EPA Preliminary Plans for Study</td>
<td>Audrey Levine, Office of Research and Development</td>
</tr>
<tr>
<td>2:45 – 3:00</td>
<td>Stakeholder Process</td>
<td>Jill Dean, Office of Ground Water and Drinking Water</td>
</tr>
<tr>
<td>3:00 – 4:00</td>
<td>Discussion</td>
<td></td>
</tr>
</tbody>
</table>
Discussion Topics

- **Components of study**
  - What are the highest priority and most critical outputs/outcomes that this study should seek to accomplish?
  - Are there issues that are not included that should be considered in the study design?

- **Availability of data and information**
  - What types of data and information are available?
  - Do you have suggestions on streamlining the data collection process?

- **Ongoing activities**
  - Can you provide information on other studies that may be relevant to this effort?
  - Are there ways that this study could complement/leverage current activities?
Discussion Topics (2)

• **Case study concept**
  - Do you have any feedback/suggestions on the case study approach?
  - Do you have suggestions on criteria that should be considered in selecting sites for the case studies?

• **Stakeholder process**
  - How would you like to be involved as the study progresses from design to implementation?
  - Do you have suggestions for our proposed approach

• **Other comments and suggestions?**

For stakeholder questions, contact Jill Dean, dean.jill@epa.gov
For study-related questions, contact Jeanne Briskin, briskin.jeanne@epa.gov