U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HEARING CHARTER

Review of Hydraulic Fracturing Technology and Practices

Wednesday, May 11, 2011
10:00 a.m. to 2:00 p.m.
2318 Rayburn House Office Building

PURPOSE

On Wednesday, May 11, 2011 at 10:00 a.m. the House Committee on Science, Space, and Technology will hold a hearing to review the technology and practices of hydraulic fracturing for energy production.

WITNESSES

Panel I

- **Mrs. Elizabeth Ames Jones,** Chairman, Railroad Commission of Texas
- **Dr. Robert M. Summers**, Secretary, Maryland Department of the Environment
- **Mr. Harold Fitch**, Michigan State Geologist; Director, Office of Geological Survey, Michigan Department of Environmental Quality; and Board Member, Ground Water Protection Council
- **Dr. Cal Cooper**, Worldwide Manager, Environmental Technologies, Greenhouse Gas, and Hydraulic Fracturing, Apache Corporation
- **Dr. Michael J. Economides,** Professor, University of Houston

Panel II

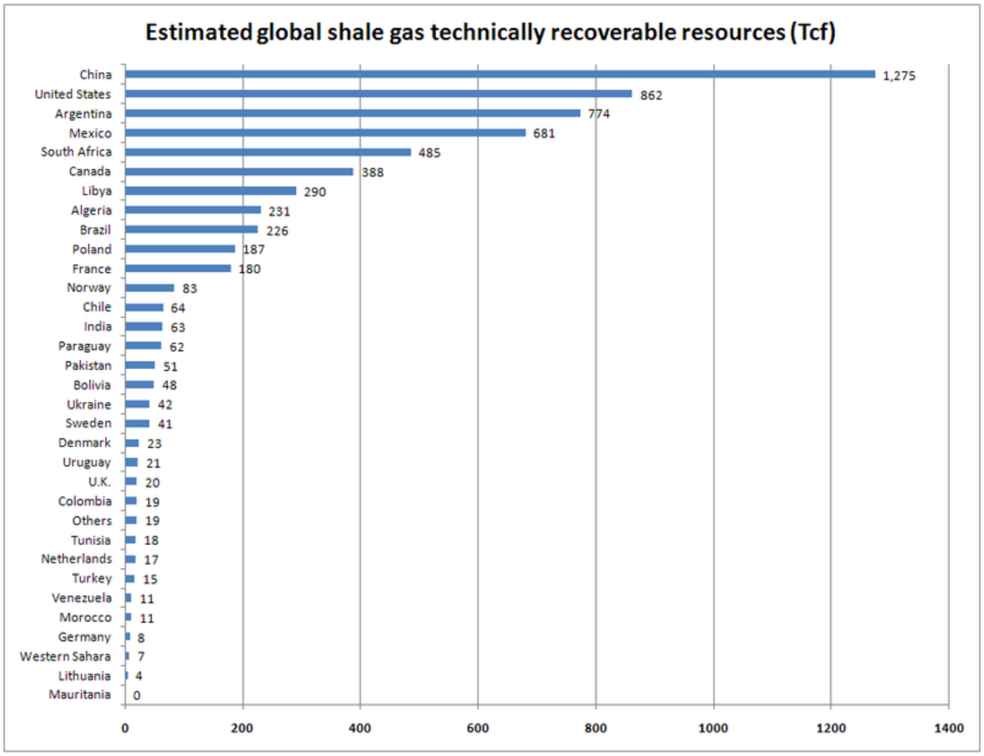
- **Dr. Paul Anastas,** Assistant Administrator, Office of Research and Development, Environmental Protection Agency.

BACKGROUND

The United States possesses 2,552 trillion cubic feet (Tcf) of potential natural gas resources.[1] To put this amount into perspective, the Energy Information Administration (EIA) reported that the U.S. consumed 22.8 Tcf of natural gas in 2009. At this rate, the 2,552 Tcf resource would supply almost 110 years of use.[2] Over 32 percent of these reserves are in the form of shale gas, ranking the U.S. second only to China in terms of technically recoverable shale gas resources (Figure 1).

[1] Energy Information Administration, http://www.eia.doe.gov/energy_in_brief/about_shale_gas.cfm Accessed April 21, 2011.
[2] Ibid

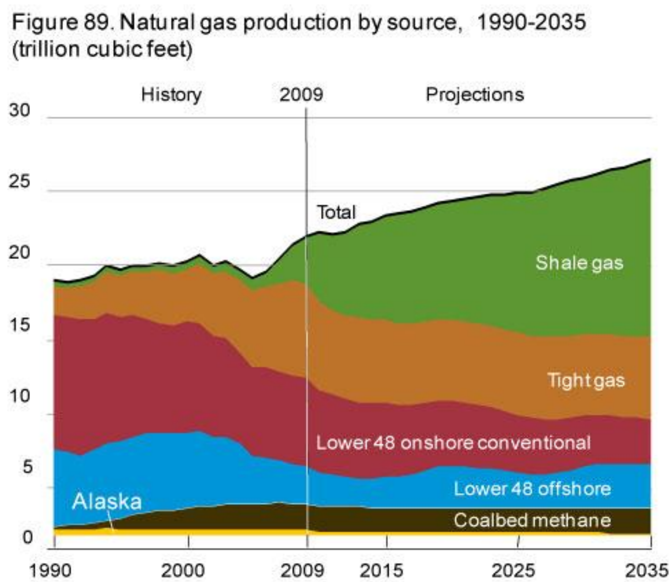
Figure 1: Global Shale Gas Resources[3]



According to EIA, domestic production of natural gas from shale resources has increased substantially during the last decade, growing from 0.39 Tcf in 2000 to 4.87 Tcf in 2010, and now represents 23 percent of total U.S. natural gas production. Further increases in shale gas production are expected, with total production growing by almost threefold from 2009 to 2035 to become almost 50 percent of total U.S. natural gas production.[4]

It is projected that this increased production will enable natural gas to provide 60 percent of electricity supply increases necessary to meet demand through 2035.[5]

Figure 2. Natural gas production by source, 1990-2035.[6]



The two technological advances that have been credited with opening up shale gas are horizontal drilling and hydraulic fracturing. Although these technologies have long been used in the production of natural gas in the United States, recent advances have made their combined application to the production of shale gas economical, triggering new production activities across the U.S. The use of advanced technologies has opened the door for production of natural gas in shale formation in areas of the country that have not been typically thought of as energy producing. Figure 3 shows the major shale gas plays in the continental U.S.

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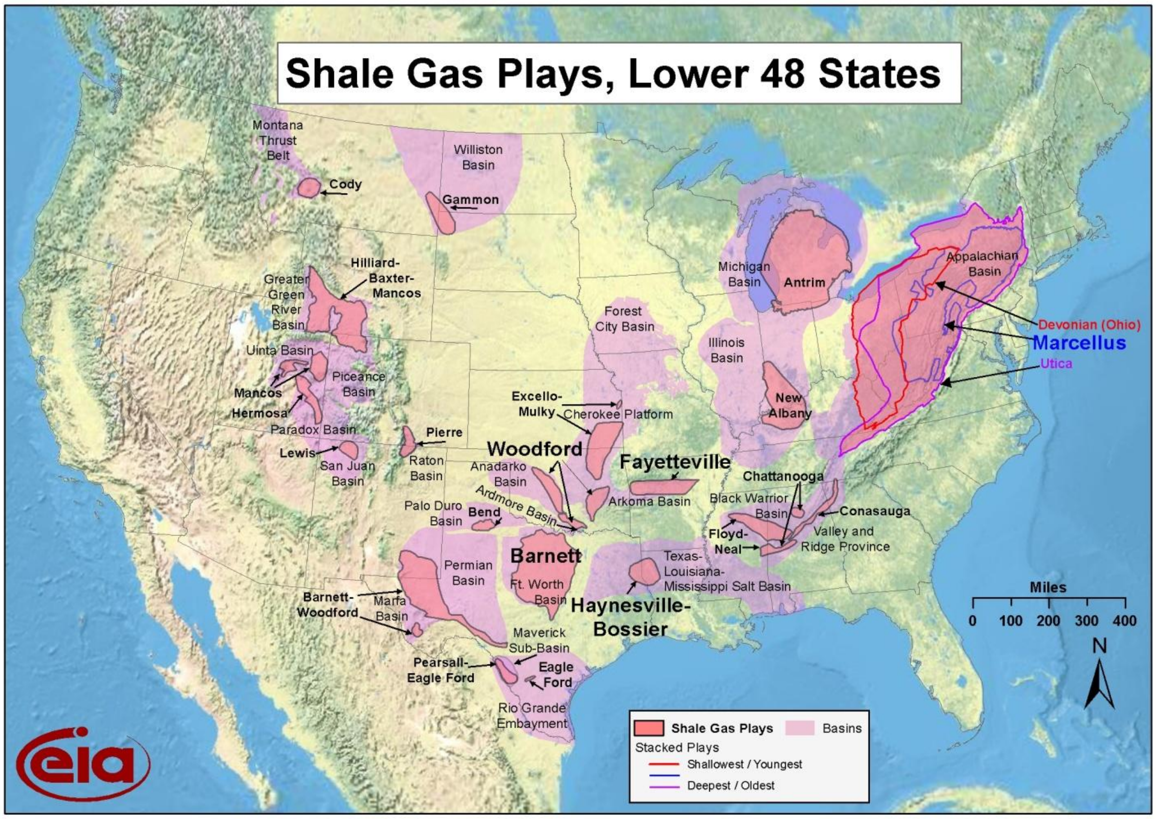
[3] Energy Information Administration, http://www.eia.doe.gov/forecasts/aeo/ Accessed May 9, 2011 and http://www.greencarcongress.com/2011/04/eia-20110406.html Accessed May 9, 2011.

[4] Ibid.

[5] Ibid.

[6] http://www.eia.doe.gov/forecasts/aeo/images/figure_89-lg.jpg

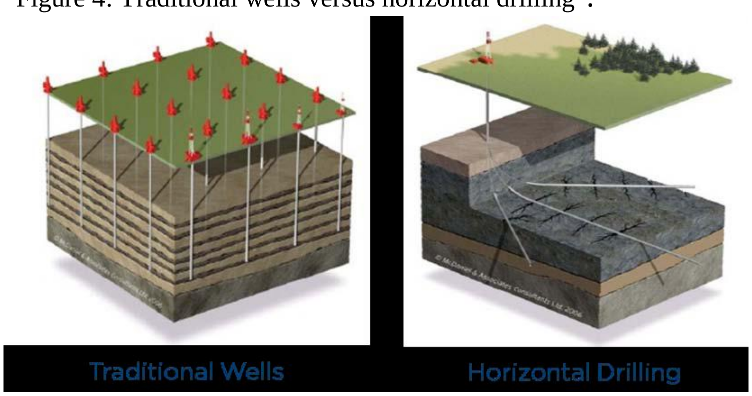
Figure 3: Shale Gas Plays, Lower 48 States[7]



Source: Energy Information Administration based on data from various published studies.
Updated: March 10, 2010

Both horizontal drilling and hydraulic fracturing are technologies with established track records. Horizontal drilling dates back to the 1930s and hydraulic fracturing has been in use since the 1950s.[8] Furthermore, horizontal drilling allows for a smaller footprint on the ground. Whereas before, dozens of wells would be drilled to access a reservoir, in many cases, now only one well needs to be drilled.

Figure 4: Traditional wells versus horizontal drilling[9].



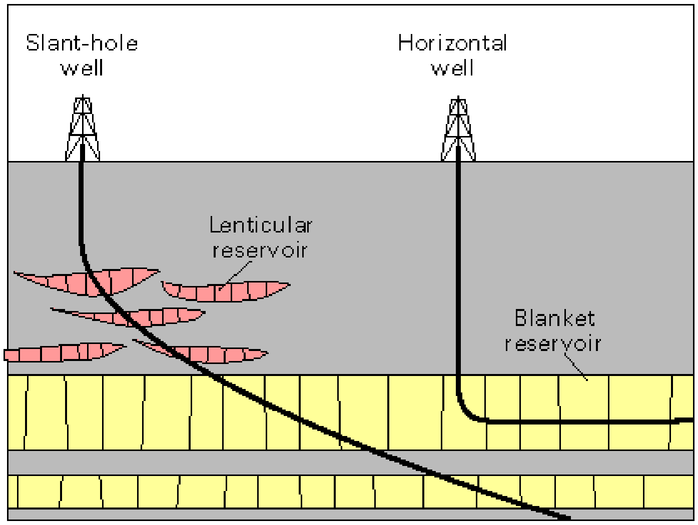
In addition, according to a 2009 report sponsored by the Department of Energy, "horizontal drilling can significantly reduce the overall number of well pads, access roads, pipeline routes, and production facilities required, thus minimizing habitat fragmentation, impacts to the public, and the overall environmental footprint."[10]

[7] Energy Information Administration, http://www.eia.doe.gov/oil_gas/rpd/shale_gas.jpg Accessed April 21, 2011.
[8] Department of Energy, *Modern Shale Gas, Development in the United States: A Primer*. April 2009.
[9] America's Natural Gas Alliance, http://www.anga.us/media/41084/safe%20responsible%20drilling.pdf. Accessed April 21, 2011.
[10] Department of Energy, *Modern Shale Gas, Development in the United States: A Primer*. April 2009.

Process of Horizontal Drilling and Hydraulic Fracturing

The advances in directional drilling sought to make use of the natural characteristics of the natural gas formations. Traditional directional drilling attempts to make a 90 degree turn by slanting the well over a distance of up to 2,000 feet. Modern horizontal drilling allows for the 90 degree turn within just a few feet.

Figure 5: Slant and Horizontal Drilling[11]



In Figure 5, the vertical lines in the reservoir represent natural fractures, an important factor in the economic production of natural gas. In order to create additional permeability in the producing gas formation, hydraulic fracturing is used to create spaces in the rock pores or fractures enabling natural gas to flow more freely to producing wells. The combination of directional drilling and hydraulic fracturing has allowed producers to economically develop shale gas plays that were previously too expensive or technologically difficult to tap into.

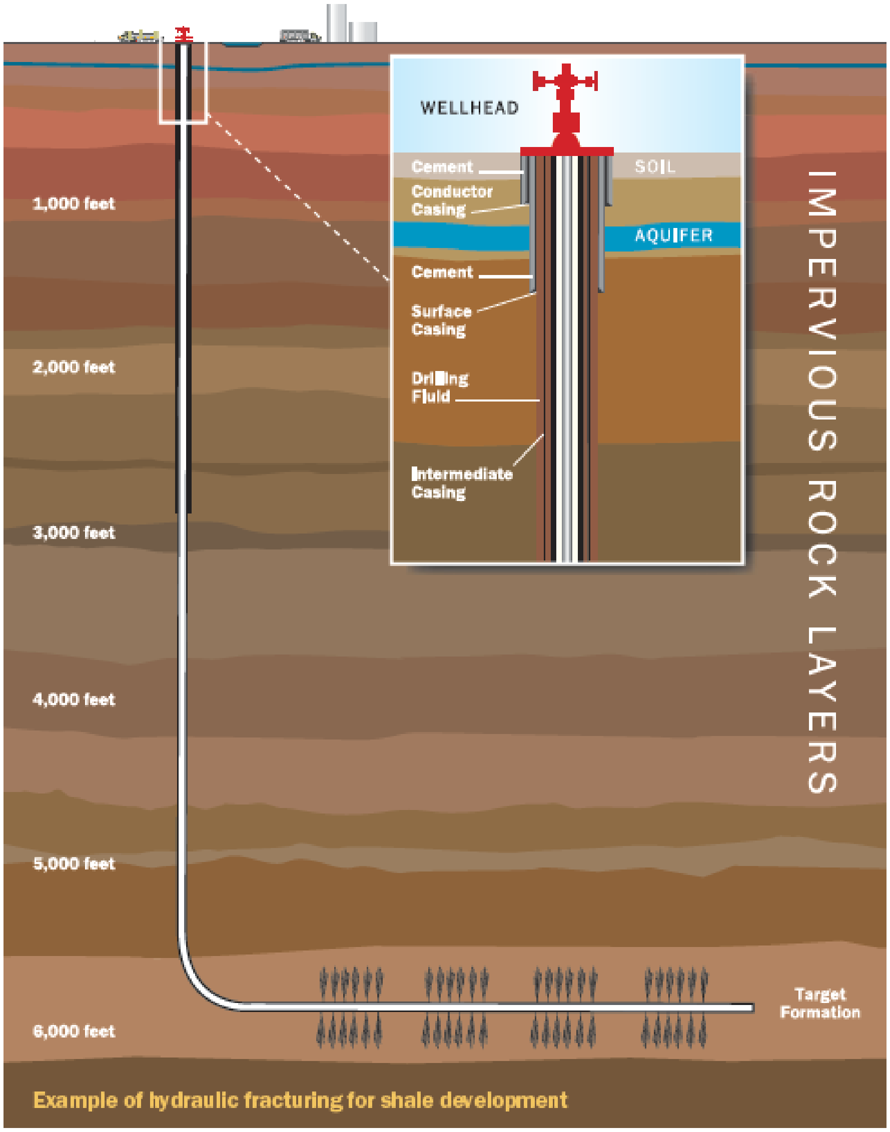
While in use for approximately 60 years, hydraulic fracturing technology has evolved since its first application, and is now a highly sophisticated and commonly employed technique used on many thousands of wells. The process involves pumping a fracturing fluid into a formation at a calculated, predetermined rate and pressure to generate fractures in the target formation.[12]

Modern hydraulic fracturing is a controlled process designed to the specific conditions of the target shale formation.[13] Knowledge of the formation details such as thickness of the shale and rock fracturing characteristics is critical to designing a successful fracture. Given the complexity of this technology, fracture design can incorporate state-of-the-art techniques including modeling and microseismic fracture mapping. These techniques are used to maximize the effectiveness of the design and then map the fractures once they are created to strategically place additional wells if needed.

Proper well construction is necessary for the protection of groundwater. As in the case with conventionally drilled wells, a steel pipe called a surface casing is cemented into place at the top part of a well and its depth is determined by, among other things, necessary groundwater protection measures. (Figure 6). This well casing and cementing is critical not only for environmental protections, but also for effective production of natural gas. Industry has developed a series of equipment-specific and standard operating practices for use in drilling and production activities.[14] These standards are often adopted by Federal and state agencies as the regulatory standards needed to comply with Federal and state permitting requirements. Such standards for well design are used regardless of whether or not hydraulic fracturing or directional drilling technologies are employed.

[11] U.S. Geological Survey, http://energy.usgs.gov/factsheets/Petroleum/drilling.html . Accessed April, 2011.
[12] Department of Energy, *Modern Shale Gas, Development in the United States: A Primer*. April 2009.
[13] Ibid.
[14] Ibid.

Figure 6: Groundwater Protection through Proper Well Construction [15]



Hydraulic fracturing uses a mixture of fluids pumped into a well to create enough pressure to fracture or "frack" the gas formation. The fracturing fluids are composed of approximately 90 percent water, 9.5 percent sand, and 0.5 percent additives such as sodium chloride and citric acid.[16] The sand proppant is used to prop open the fractures once the pumping of fluids has stopped. The additives are used for many different purposes, including maintaining fluid flow, eliminating bacteria, and thickening the water to suspend the sand.

Depending on the specific characteristics of the formation and the design of the fracture job, anywhere from 30 to 70 percent of fracturing (fracking) fluids are returned to the surface through the well.[17] The remaining, unrecovered fluids are usually trapped in the fractured formation, isolating them from underground sources of water.[18]

Environmental Management

The use of hydraulic fracturing has raised questions regarding the potential effect of this technology on drinking water supplies. The purpose of injecting fracking fluids into the ground is to create enough pressure to fracture subsurface structures. There are two distinct areas of concern regarding this process: first, the injection itself, or the creation of subsurface fractures, could allow fracking fluid to contaminate underground sources of water; and second, the handling and disposal of fracking fluids returning to the surface.

[15] American Petroleum Institute, *Hydraulic Fracturing: Unlocking America's Natural Gas Resources.* July 19, 2010.
[16] Ibid.
[17] Department of Energy, *State Oil and Natural Gas Regulations Designed to Protect Water Resources*. May 2009.
[18] Environmental Protection Agency. *Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs*. June 2004.

The risk of contamination of underground water sources is managed in different ways. Risks associated with leakage of the fracking fluid during the injection and fracturing job are reduced by: adherence to state well construction requirements; the vertical distance between the fractured zone and ground water; the presence of other zones between the fractured zone and the deepest ground water; and, the presence of vertically impermeable formation that act as geologic barriers to the movement of fluid from the fractured zone into groundwater resources.[19]

After drilling and fracturing are completed, the production well produces water along with the natural gas. Some of the water is returned fracture fluid and some is naturally occurring water in the formation. This produced water is managed through a variety of mechanisms including underground injections, treatment and discharge, and recycling.[20]

Federal and State Government Oversight of Hydraulic Fracturing

Natural gas development is subject to a series of Federal laws that govern certain aspects of the exploration and production processes. They include:

- The Clean Water Act (CWA) – regulates surface discharges of water associated with drilling and production in addition to storm water runoff from production sites.
- The Safe Drinking Water Act (SDWA) – regulates the underground injection of fluids.
- The Clean Air Act (CAA) – regulates emission from engines, industrial equipment, and other sources associated with drilling and production.
- The National Environmental Policy Act (NEPA) – requires exploration and production be thoroughly analyzed for potential environmental effects.[21]

State agencies are responsible for implementing the regulatory requirements set out in Federal laws. Additional State laws and requirements provide for most direct and day-to-day oversight of natural gas production operations. This oversight is usually more specific than the Federal laws, and address issues such as localized geological and geographical considerations. Separately, a national non-profit organization, originally created and sponsored by the Environmental Protection Agency (EPA), regularly reviews the adequacy of state programs to manage exploration and production waste. This organization, the State Review of Oil and Natural Gas Environmental Regulations (STRONGER), systematically analyzes individual state programs and measures program improvement over time.[22]

EPA Regulations and Studies Related to Hydraulic Fracturing

Prior to 1997, EPA considered hydraulic fracturing to be a well stimulation technique associated with production and therefore not subject to the regulatory requirements of Underground Injection Control (UIC) under the SDWA. This position was legally challenged, and the 11th Circuit Court of Appeals ruled that hydraulic fracturing of coalbed methane wells was indeed subject to the SDWA and UIC regulations under Alabama's UIC program in 1997.

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[19] Department of Energy, *State Oil and Natural Gas Regulations Designed to Protect Water Resources*. May 2009.
[20] New York State Department of Conservation. *Draft Supplemental Generic Environmental Impact Statement: Appendix 15 Hydraulic Fracturing – 15 Statements from Regulatory Officials.* September 2009.
[21] Ibid.
[22] http://www.strongerinc.org/

In response, in 1999 EPA began to study hydraulic fracturing used in coalbed methane reservoirs and evaluate potential impacts to underground sources of drinking water. In its 2004 report "Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs", EPA concluded that injection of hydraulic fracturing fluids into coalbed methane wells poses little or not threat to [Underground Sources of Drinking Water] and USDWs and does not justify additional study at this time."[23]

In the Fiscal Year 2010 Department of the Interior, Environment, and Related Agencies Appropriations Act (P.L. 111-88), EPA was directed to carry out a second study on hydraulic fracturing, in accordance with the following report language:

> *"Hydraulic Fracturing Study.--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."*

On February 8, 2011, EPA released its draft study plan for public comment and review by its Science Advisory Board (SAB)[24]. EPA has stated that, "the overall purpose of the study is to understand the relationship between hydraulic fracturing and drinking water resources. The scope of the proposed research includes the full lifespan of water in hydraulic fracturing, from acquisition of the water, through the mixing of chemicals and actual fracturing, to the post-fracturing stage, including the management of flowback and produced water and its ultimate treatment and disposal."[25]

The draft study plan includes the following fundamental research areas and questions:

- *Water Acquisition: How might large volume water withdrawals from ground and surface water impact drinking water resources?*
- *Chemical Mixing: What are the possible impacts of releases of hydraulic fracturing fluids on drinking water resources?*
- *Well Injection: What are the possible impacts of the injection and fracturing process on drinking water resources?*
- *Flowback and Produced Water: What are the possible impacts of releases of flowback and produced water on drinking water resources?*
- *Wastewater Treatment and Waste Disposal: What are the possible impacts of inadequate treatment of hydraulic fracturing wastewaters on drinking water resources?*

On April 28, 2011, the SAB released a draft of its report on the EPA draft plan. [26] Deliberations on this draft response are expected to be completed in May or June of 2011, after which will review and

[23] Environmental Protection Agency. http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_hydrowhat.cfm. Accessed May 4, 2011.
[24] http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/HFStudyPlanDraft_SAB_020711.pdf
[25] Ibid.
[26] http://yosemite.epa.gov/sab/sabproduct.nsf/55EAFA25D3F322AA8525788000697B34/$File/SAB%20Report-Review%20of%20EPA%E2%80%99s%20Draft%20Hydraulic%20Fracturing%20Study%20Plan-4-28-11%20draft.pdf

consider revisions to its study plan and then immediately begin the study. EPA plans to release preliminary results of this study by late 2012 with a final report completed by 2014.

Department of Energy Working Group on Hydraulic Fracturing

On March 30, 2011, President Obama released “Blueprint for a Secure Energy Future,” outlining a number of energy policy activities by his administration. Included among these was a directive to the Secretary of Energy to establish an advisory committee to “identify, within 90 days, any immediate steps that can be taken to improve the safety and environmental performance of fracking and to develop, within six months, consensus-recommended advice to the agencies on practices for shale extraction to ensure the protection of public health and the environment.” The Members of this advisory group were named on May 5, 2011.