Opportunity for Stakeholder Input on EPA's Hydraulic Fracturing Research Study:
Criteria for Selecting Case Studies

Hydraulic fracturing (HF) is a process used to increase the volume of natural gas that can be recovered from sources such as coalbeds, tight sands, and shale formations. HF is also used for other applications like oil recovery. During HF, fracturing fluids are injected into production wells under high pressure to generate fractures in geologic formations. Fracturing fluids consist primarily of water and chemical additives that serve a variety of purposes, such as increasing fluid viscosity, inhibiting corrosion, and limiting bacterial growth. Water used for HF activities may come from surface water and ground water. Proppants (such as sand or ceramic beads) are added to keep the fractures open after the pressure is released. The fracturing fluids (water and chemical additives) are then returned back to the surface, where they are stored, treated, and disposed of or recycled. After fracturing, natural gas will flow from pores and fractures in the rock into the well for subsequent extraction. Over the past few years, several key technical, economic, and energy policy developments have increased the use of HF for gas extraction. HF is now used more extensively and in a wider diversity of geographic regions and geologic formations. Along with this expansion of HF, there have been increasing concerns about its potential impacts on drinking water resources, public health, and the local environment.

EPA is developing a research study to examine the potential relationships between HF and drinking water. A key goal of the EPA study is to generate data and information that can be used to assess risks and ultimately to inform decisions. EPA has proposed four key approaches to obtain data and information to address research questions:

1. Compile and analyze background data and information
2. Characterize chemical constituents relevant to hydraulic fracturing
3. Conduct case studies and computational modeling
4. Identify and evaluate technological solutions for risk mitigation and decision support

The purpose of this document is to provide background information on the role of case studies in EPA's HF study and to introduce a proposed process to identify, nominate, and select case studies. A critical step is to select and prioritize sites for study. EPA is seeking stakeholder input on the proposed criteria for selecting case study locations and appropriate research questions that may be answered using case studies.

Stakeholder Input

EPA requests input on the proposed criteria that may be used to determine case study locations. The Agency asks that stakeholders consider the following questions:

- Are the proposed selection and prioritization criteria appropriate?
- Would you suggest revised or additional criteria to better identify, screen, and prioritize sites for field investigations and case studies?
- Are there other research questions that a case study approach would be uniquely able to address?
- Are you aware of potential candidate sites or case studies that would be useful for this study? If so, what are the characteristics that would make the candidates appropriate for this study on the relationship between HF and drinking water resources? Please provide additional supporting information.

Stakeholders may submit comments to EPA on the proposed case study criteria by providing a verbal or written comment during the public information meetings held during July and August 2010; emailing comments to hydraulic.fracturing@epa.gov; or mailing written comments to Jill Dean, 1200 Pennsylvania Ave. NW, Mail code 4606M, Washington, DC 20460.

Role of Case Studies in the HF Research Study
Case studies are widely used to conduct in-depth investigations of complex issues such as HF. The scope of case studies can range from local or regional data collection and analysis at existing sites to extensive investigations on new or planned HF sites, conducted in collaboration with industry or other partners. Developing a single national perspective on HF is complex due to geographical variations in water resources, geologic formations, and hydrology. In addition, the stressors on water resources vary over the lifecycle of hydraulic fracturing. Ideally, the types of data and information that are collected through case studies should provide enough detail to determine the extent to which conclusions can be generalized at local, regional, and national scales. Case studies, together with other elements of the research program, can be used to help determine:

- if drinking water resources are impacted by HF;
- the extent and possible causes of any impacts; and
- what can be done to avoid or mitigate impacts.

Conducting case studies can provide a forum for stakeholders to interact and exchange date and information. Case studies may also provide data and model inputs on the fate and transport of fluids and contaminants that may vary in different regions and geologic settings. In addition, case studies may inform the development of best management practices for environmental protection.

The starting point for developing case studies is to define specific research questions that they can address. An initial set of research questions proposed by EPA includes:

1. What sampling strategies and analytical methods could be used to identify potential impacts on sources of drinking water, water supply wells, and receiving streams?
2. Are there vulnerable hydrogeologic settings where HF may impact the quality and availability of water supplies?
3. How does the proximity of HF to abandoned and/or poorly constructed wells, faults, and fractures alter expected impacts on drinking water resources and human health?
4. Is there evidence that pressurized methane or other gases, HF fluids, radionuclides, or other HF-associated contaminants can migrate into underground sources of drinking water? Under what conditions do these processes occur?

Data and Information Sought to Inform Design of Field Investigations and Case Studies
For candidate sites, efforts will be made to compile and review available data and identify gaps that need to be addressed during initial site investigations. In addition, EPA may map and classify candidate sites based on variations in geologic settings and infrastructure components to further prioritize the field investigations. Examples of the types of data expected to be useful in characterizing candidate case studies include:

- Depths of all existing well(s)
- Well completion details (production and other nearby wells)
- Well logs (production well and other nearby wells)
- Cumulative production data
- Cumulative injection data, including for stimulation
- Data on the location, design, and operation of surface infrastructure, such as pits, evaporation ponds, lagoons, etc.
- Local geologic information including shallow ground water information
- Ground water monitoring data
- Cement bond logs
- Geologic descriptions, cross sections
- Modeling to estimate HF impacts (microseismic, water flow, chemical fate and transport, etc.)
- Monitoring data (types of samples collected, parameters monitored, etc.)

Potential Criteria for Case Studies

Case studies are likely to fall into the following categories: (a) sites where HF is being planned; (b) sites where HF is in progress; or (c) sites where HF has already been completed. Because of the resource and time constraints associated with EPA's study, it is only feasible to conduct a limited number of case studies. Therefore, criteria to identify and select case studies are important, especially given the inherent complexities associated with the diverse regional, geological, and community settings under which HF takes place.

The success of case studies depends on a clear definition of specific goals coupled with robust criteria for the nomination and selection of cases. Some possible criteria for the selection of case studies include:

- Proximity of other well penetrations
- Proximity to drinking water resources
- Geographic diversity
- Potential to impact drinking water sources
- Magnitude of activity (wells/acre)
- Site history
- Available data
- Site access
- Potential to collaborate with other stakeholders

A list of field-based activities relevant to key components of the HF lifecycle is shown along with potential site selection criteria in Table 1.

Case Study Prioritization and Selection

EPA seeks advice from stakeholders regarding potential case studies. Stakeholders are invited to provide suggestions and refinements to the prioritization of criteria and information listed in Table 1. Once candidates for case studies are evaluated, EPA will select from among the candidates based on the extent to which the selected case studies are expected to contribute answers to the high priority research questions. EPA will also consider geographic and geologic diversity, potential availability of data and access, potential for effective collaboration, and resources required.

Table 1: Overview of field based HF activities, criteria and information needed for selecting case studies.

Hydraulic fracturing stage	Field activities to determine potential impacts on water resources	Potential criteria for selecting sites for case studies	Information needed
Siting of production wells, construction, and well development and completion	Assess production well integrity and monitor quality and quantity of surface and ground water supplies before, during, and after construction Review of geology and hydrology	Proximity of other well penetrations, including drinking water supplies, abandoned wells, other injection activities Proximity to drinking water resources Geographic diversity and population density near site Potential to leverage with other partners (NGOs, industry, states, etc.)	Well logs (geologic strata descriptions), cement bond logs, inventory of nearby wells, including drinking water, production, disposal and abandoned wells Identification of local drinking water supplies Existing studies, investigations Site access
HF of targeted geologic formation	Monitor on-site, up-gradient, and down-gradient before, during, and after HF Microseismic monitoring	Potential for fluid migration beyond HF zone and into underground source(s) of drinking water Potential for biogeochemical mobilization of metals, radionuclides, mineral salts, organic contaminants and gases from gas-bearing formations Potential for surface water withdrawals to affect drinking water and/or impact flow regimes in streams Potential for ground water withdrawals to affect water levels, water quality, and the usability of smaller aquifers for water supplies Intensity and duration of HF activity in a particular geographic location	Chemical baseline data for production well, nearby drinking water wells, other wells Data on geologic and geochemical characteristics of HF zone and overlying zones Historical data on nearby surface water flows Historical data on nearby water well levels \ Identification of current or possible HF pads and /or leases in a particular area
Management of wastewater and residuals	Monitor flowback water, produced water, residuals, storm water, receiving water, wastewater treatment facilities Assess location practices, operating characteristics, capacity, and performance of waste management activities	Potential for release to surface water Potential for infiltration of wastewater to underlying underground source of drinking water from pit storage water Proximity of treatment facilities that accept fracturing wastes	Characteristics of wastewater transport and storage systems Relative location of waste water treatment plants and /or underground injection control (UIC) wells