FY10 Appropriation Conference Committee Directive for EPA

"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."

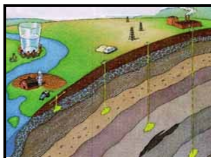
United States Environmental Protection Agency

Hydraulic Fracturing

Applicability of the Safe Drinking Water Act
and
Clean Water Act

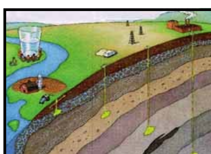
Science Advisory Board Discussion
April 7, 2010

Cynthia Dougherty, Director
Office of Ground Water and Drinking Water



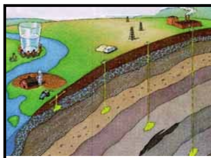
Outline

- Statutory Framework to Protect Water
  - The Safe Drinking Water Act
  - The Clean Water Act
- 2004 Underground Injection Control Program Study of Coalbed Methane



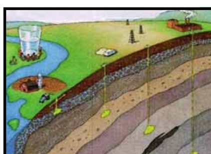
Safe Drinking Water Act

- EPA's central authority to protect drinking water is drawn from the Safe Drinking Water Act (SDWA)
- The SDWA requires EPA to set legal limits on the levels of certain contaminants in drinking water
- The SDWA also requires EPA to protect underground sources of drinking water (USDWs) from contamination caused by underground injection
  - §1421 provides minimum standards for underground injection
  - §1422 provides for state primary enforcement authority
  - §1425 provides for alternative showing of effectiveness of program by state Underground Injection Control (UIC) Programs (Oil and Gas wells only)
- SDWA §1431 contains provisions to address imminent and substantial endangerment



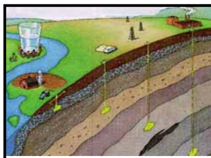
Safe Drinking Water Act: Underground Injection Control Program

- Activities not regulated under Safe Drinking Water Act Provisions for UIC (Sections 1421, 1422, and 1425)
  - Oil and gas *production* activities
  - Hydraulic fracturing (except use of diesel) per 2005 Energy Policy Act
  - Natural gas storage
- States may choose to regulate these activities
- Surface water discharges are regulated under the Clean Water Act (CWA)



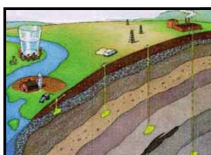
Safe Drinking Water Act: Underground Injection Control Program (cont'd)

- Currently, EPA regulates five classes of UIC well (Classes I – V)
- Class II wells inject fluids associated with oil and natural gas production including:
  - **Enhanced recovery** wells which inject fluid or gas to recover residual oil and gas after primary production has occurred
  - **Disposal** wells which inject fluids associated with oil and gas production or gas storage operations (including wells used to dispose of flowback from hydraulic fracturing)
  - **Hydrocarbon storage** wells which inject liquid hydrocarbons for storage, usually as part of the US Strategic Petroleum Reserve
  - **Hydraulic fracturing** activities where diesel is used to fracture formations



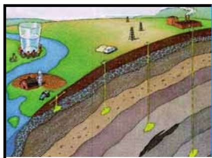
Clean Water Act

- National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States
- Water quality based limits for regulated entities (established in NPDES permits) are often required to ensure compliance with state water quality standards for protection of waters of the U.S.
- Effluent limitation guidelines regulations establish a national, technology-based discharge requirement and are implemented through NPDES permits
  - Effluent guidelines for Oil &Gas extraction facilities apply to facilities engaged in exploration, drilling and production in offshore, coastal, and onshore areas.



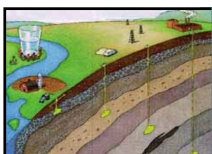
NPDES Permits & Flowback Waters

- If flowback is not injected into Class II wells, it must, in most cases, be sent to Publicly Owned Treatment Works (POTWs).
- In states where POTWs accept these flowback waters, dischargers must notify the permitting authority of this.
  - Note that chlorides in flowback water are not well treated by POTW treatment systems; in fact, additional treatment by the discharger to remove chlorides from these waters is needed prior to disposal at a POTW.
- For water users downstream, note that neither the CWA nor NPDES regulations require notification of downstream users by POTWs that treat and discharge these flowback waters



CWA Effluent Guideline Study on Coalbed Methane

- EPA is presently conducting a study of the impacts of flowback and produced waters on waters of the U.S. from surface water discharges of natural gas production in coalbed methane (CBM) reservoirs
- The study is planned for completion late calendar year 2010
- After completion of the study, the agency will decide whether to develop CWA Effluent Limitation Guidelines for the coalbed methane subcategory of the oil & gas category



EPA UIC Coalbed Methane Study (2004)

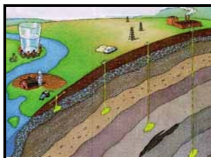
Title: *Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs*

Focus: Impacts to underground sources of drinking water (USDWs) directly related to hydraulic fracturing of CBM reservoirs

Objectives:

- Review existing literature and information on incidents of ground water contamination in the vicinity of CBM fracturing activities
- Evaluate theoretical potential for contamination of USDWs due to injection of hydraulic fracturing fluids into coalbed methane wells
- Determine whether further study is needed

- Study focused on CBM because CBM gas reservoirs are typically closer to the surface and have a higher potential to impact USDWs than conventional oil and gas reservoirs
- Over the last several years, the study has been selectively used by individuals and groups to both support and oppose HF in a variety of oil and gas production applications



UIC Coalbed Methane Study Conclusions

- EPA determined injection of hydraulic fracturing fluids into CBM wells posed little or no direct threat to USDWs
  - Direct threat = hydraulic fracturing fluids in USDWs
- Study details
  - Focused on direct threats to USDWs from HF fluid
  - Limited to CBM plays, not all unconventional formations
  - Limited to existing data
- Potential indirect impacts from HF may exist beyond the scope of SDWA and the 2004 study
  - Surface discharge of waste waters
  - Depletion of drinking water supplies
  - Methane migration

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Potential Relationships Between Hydraulic Fracturing and Drinking Water Resources

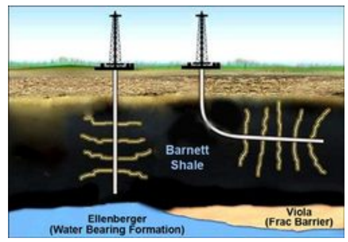
Initial Approach For Study Design

Office of Research and Development

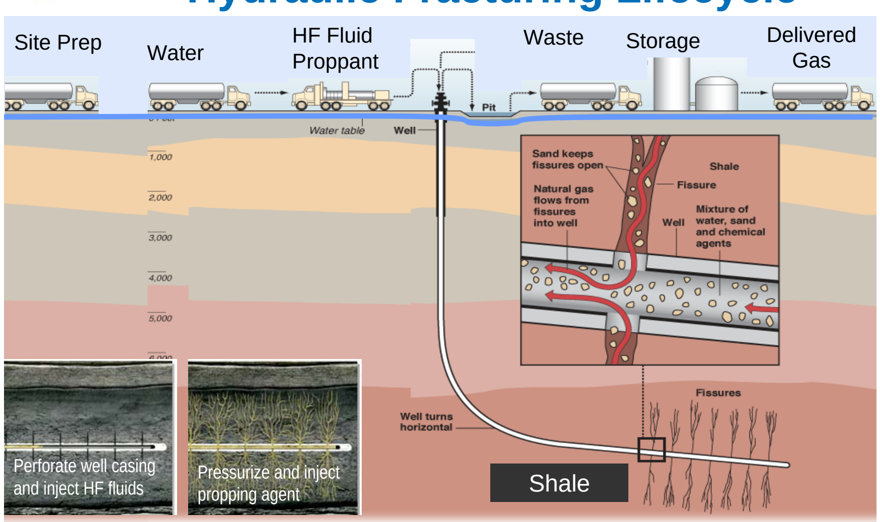
Science Advisory Board Discussion
April 7-8, 2010
Washington, DC

Objectives

- Provide approach for defining the lifecycle of hydraulic fracturing as it relates to energy resource extraction and drinking water
- Discuss approach for developing study design
- Discuss charge questions
  - Scope of Study
  - Research Questions
  - Research Prioritization
  - Stakeholder Process

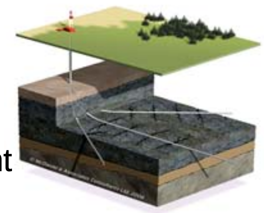


Definition of Hydraulic Fracturing Lifecycle



Adapted from Graphic by Al Granberg

Why is This a Concern Now?

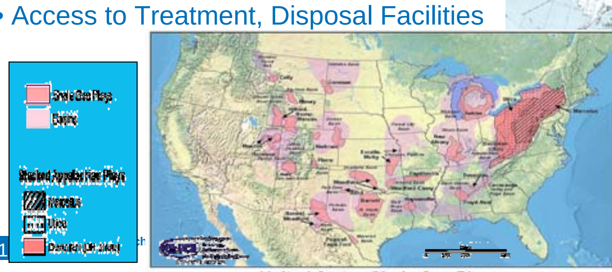


- Extraction of energy resources from shale is becoming more prevalent due to:
  - Advances in horizontal drilling technologies
  - Shale gas is perceived to represent a significant domestic "clean" energy source for the future
- Concerns about potential endangerment of water supplies
  - New geographic and geologic settings
  - Potential risks to public health, water resources, and the environment

Comparison of U.S. Shale Gas Reservoirs and Major Aquifers

Regional/local variations:

- Basin Geology and Hydrology
- Public or Private Land
- Proximity to Population
- Mineral and Water Rights
- Availability of Water
- Relationship to underground sources of drinking water (USDWs)
- Access to Treatment, Disposal Facilities

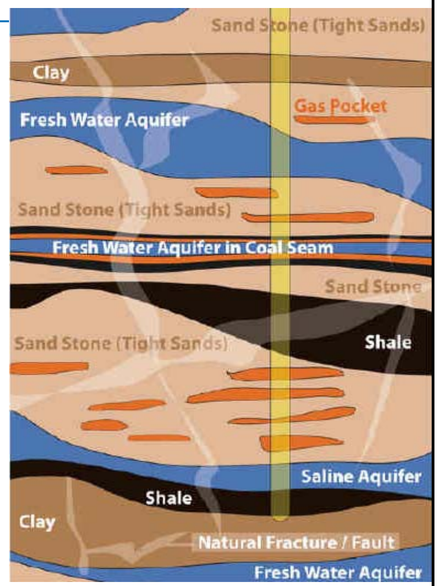


United States Shale Gas Plays

Source: Energy Information Administration

Geological Context

- Hydraulic fracturing targets depths ranging from less than 1000’ to more than 8000’ below the surface :
  - Shale
  - Coal-beds
  - Tight sands
- Adjacent formations may contain metals, radionuclides, or other formation fluids



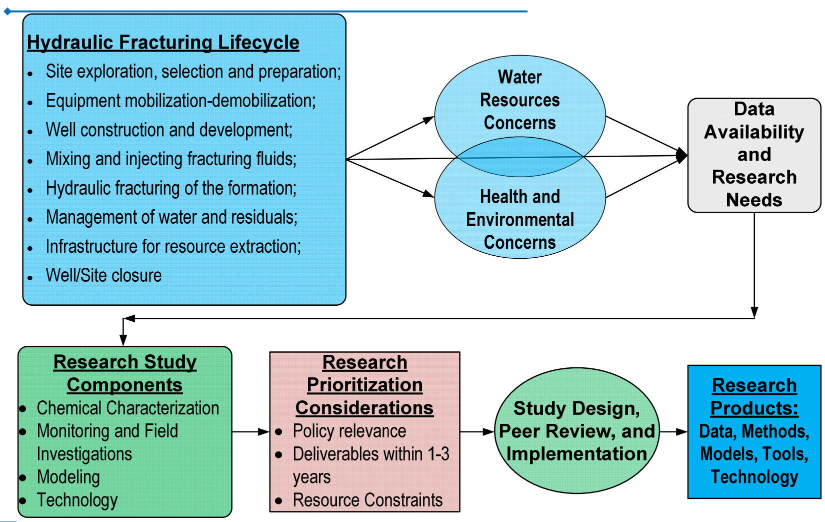
Role of Water in Hydraulic Fracturing

- Water associated with hydraulic fracturing is derived from local underground or surface sources and 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 lifecycle include:
  - Make-up water for mixing hydraulic fracturing fluids and proppants
  - Fluids that flowback or are brought to the surface during the course of energy resource extraction
  - Stormwater
- Contaminants associated with flowback fluids and produced water may include:
  - Hydraulic fracturing fluids, sand, and propping agents
  - Materials in the subsurface that are mobilized by the injected fluids and brought to the surface during energy resource extraction

Steps in Study Design

- Define scope of study
- Identify key research questions
- Evaluate background information, literature and data relevant to research questions to identify research and information needs (develop topical papers)
- Develop initial framework for study and criteria for prioritization
- Prioritize research and develop initial study design
- Peer review of initial study design and revise as needed
- Implement study
- Monitor and report progress
- Develop research products: data, models, methods, tools, technologies

Overview of approach for developing EPA Study



Scope of Study

Congress urged EPA to carry out a study on "the relationship between hydraulic fracturing and drinking water."

- Hydraulic fracturing has potential to impose short-term and long-term impacts on:
  - **Underground and surface drinking water resources**
  - Land-use, erosion, and storm water runoff
  - Local air quality
  - Community health
  - Ecosystem services
- To develop the study design it is important to define the overall scope of the study:
  - What types of policy-relevant decisions should be considered in developing the study design?
  - What types of field investigations are needed?
  - What are the priority environmental & human health issues?

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

Proposed Research Categories

- The initial identification of research questions has been organized around three categories:
  - ***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 the research questions identified?

Hydraulic Fracturing Lifecycle

- Site preparation
- Equipment mobilization-demobilization
- Well construction & development
- Transport, storage, mixing fracturing fluids
- Hydraulic fracturing of the formation
- Management of water, chemicals, and residuals
- Infrastructure associated with energy resource extraction
- Well/Site closure

Hydraulic Fracturing Lifecycle

Land Use Changes and Infrastructure Access roads

- Well pads
- Transport vehicles
- Compression stations
- Cleaning stations
- Pipelines
- Site closure and future land use

Vehicular traffic:

Water: 5,000,000 gal @3000 gal/truck= 1667 truckloads of water

Proppant: 1,500,000 lbs @2000 lbs/truck= 750 truckloads of proppant

Hydraulic Fracturing Lifecycle

Potential Impacts on Local Air Quality

- Sources of potential emissions
  - Construction and vehicular traffic
  - Drilling rigs, generators, and compressors
  - Vapor emissions during HF operations
  - Gas production/distribution
  - Fugitive emissions
- Air quality concerns
  - Ozone and precursors
  - Particulate matter
  - Methane, hydrogen sulfide
  - VOCs, radon, and other air toxics

Potential Relationships to Drinking Water Resources

- Water Quality Concerns
  - Leakage of fracturing fluids and mobilization of other formation fluids and methane
  - Surface infiltration of waste, production fluids to near-surface aquifers and recharge zones
  - Stormwater runoff or overflow
  - Discharges to surface water supplies (on-site systems, wastewater treatment facilities)
  - Spills or accidental releases
- Water Resource Concerns
  - Reduced supply to public and private wells due to competing demand
  - Maintenance of in-stream flows
  - Cumulative impacts from multiple drilling operations within an individual groundwater basin or watershed

Potential Sources of Contamination

- On-site water storage and treatment
  - Potential leakage and overflows
  - Water quality changes associated with on-site treatment (e.g. evaporation, aeration): TDS, volatization (VOCs, radon), residuals
- Treatment facility discharges
  - Total dissolved solids (TDS), metals, toxics, residuals
  - Technically enhanced naturally occurring radioactive material (TENORM)
- Water, waste, and chemical transport
  - Spill Prevention
  - Erosion and stormwater
- Well infrastructure
  - Inadequate mechanical well integrity
  - Abandoned wells in proximity to fracturing operations

Potential Health Concerns

- Risks associated with potential exposure to contaminants through:
  - Water
  - Ingestion, inhalation, or dermal contact
  - Indoor air related to vapor intrusion
  - Air emissions (ozone precursors, air toxics, radon, GHGs) from site activities
- Cumulative risk due to multiple pathways\multiple contaminants
- Potential disproportionate risks to disadvantaged communities

Potential Environmental Concerns

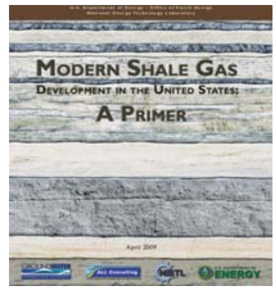
- Impacts of water availability and quality on resiliency of ecosystem resources and services
- Spread of non-native or invasive species
  - Golden algae
  - Habitat for fish and wildlife
- Agricultural activities (livestock, crops)
- Water quality to support macroinvertebrates, mussels, plankton, etc.

Potential Elements of the Study

- Collection of background data and information
- Chemical characterization
- Potential field studies
- Technology assessment, development

Data and Information Needs

- Hydraulic fracturing lifecycle data needs
  - 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
  - Regional and geographic variations
- Important to compile, evaluate and consider relevant data
  - Numerous reports have been published by EPA, DOE, USGS, GWPC, Industry, State Associations, Environmental Groups, Universities
  - Develop approach to identify data gaps



Chemical Characterization

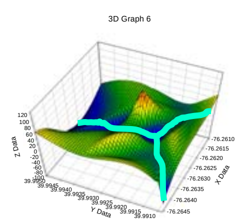
- Develop analytical methods that can overcome potential matrix effects
- Analyze degradation properties of fracturing fluids
- Chemically characterize pre-injection, flowback, and produced water
- Identify indicator/surrogate parameters that can be used to indicate exposure
- Determine the potential for metals, radionuclides, organic contaminants or gases to be mobilized from geologic formations
- Evaluate key biogeochemical processes that might impact the quality of drinking water supplies

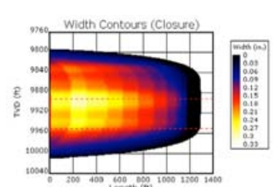
Potential Field Study Components

- Well Sampling and Analysis
  - New nested monitoring wells
  - Existing drinking water wells
  - Abandoned wells (gases)
- Air Quality Sampling before, during, and after hydraulic fracturing activities
- Develop sampling program to analyze pre-injection, flowback fluids, produced water, wastewater discharges, and surface water supplies

Potential Modeling Study Components

- Fate and Transport studies of HF fluids
- Develop models or techniques to predict the likelihood of drinking water impacts based upon the available geologic, geochemical, and geophysical data
- Identify tools to determine the zone of influence of HF fluids and area of review in the subsurface
- Develop watershed based models to evaluate impacts of water withdrawals and wastewater discharges on water quality





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Technology Components of Study

- Evaluate opportunities for sustainable green chemical usage
- Optimize treatment technologies for flowback fluids, residuals, and other waste materials generated through HF
- Employ a geographic information system (GIS) approach to overlay HF activities with the locations of gas resources, drinking water resources, and other relevant site information

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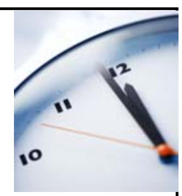
Potential Near-term Activities



- Development and dissemination of Best Management Practices (BMPs)
  - Site management
  - Well integrity procedures
- Guidance and potential solutions for water, wastes, and residuals management, including BMPs
- Analytical methods for characterization of hydraulic fracturing fluids
  - Compilation and critical review of current procedures
  - Method development and validation

Potential Prioritization Criteria

- Congressional intent
- Scientific support for EPA's mission to protect public health and the environment
- Policy relevance
- Useful and relevant deliverables within 1-3 years

- **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?

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?

Stakeholder Process: Key Considerations

- What is the goal of stakeholder involvement?
  - Transparency?
  - Consultation?
  - Scientific Peer Review ?
  - Balance?

Stakeholder Process: Key Considerations (cont'd)

- At what stage is stakeholder involvement critical?
  - In study design?
  - In study implementation?
  - In final phases?
  - Others?

Stakeholder Process: Key Considerations (cont'd)

- What is the best approach for involving stakeholders at each stage?
  - Website/Email Updates?
  - Webinars?
  - Federal Register Notices?
  - Listening Sessions?
  - Technical Workshops?
  - Scientific Peer Review Panels?
  - Outreach through Regional Offices?
  - Other?

Stakeholder Process: Key Considerations (cont'd)

- Other considerations
  - What key stakeholder groups should be involved?
  - Where should face to face meetings be held?
  - What are the resource implications?

Summary
Charge Questions

1. Scope

What recommendations does the SAB EEC have regarding the scope of the study?

2. Research questions and prioritization

a. What recommendations does the SAB EEC have regarding the research questions identified?

b. 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?