The HydroDynamics Group
studies in mass & energy transport in the earth

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Joan Harrigan-Farrelly—Chief
Underground Injection Control, Prevention Program
Office of Ground Water and Drinking Water
Environmental Protection Agency—Mail Code 4101
1200 Pennsylvania Avenue, NW
Washington, DC 20460
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RE: EPA draft study report—***Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs: Subject:*** Federal Register August 28, 2002, Volume 67, Number 10, Pages 55249-55251 (water Docket Id no. w-01-09-11)

Dear Ms. Harrigan-Farrelly:

I am writing on behalf of the Oil and Gas Accountability Project to provide an impartial analysis of the adequacy of the actions proposed in the subject report. I am a practicing hydrogeologist; I spent 32 years at the U.S. Geological Survey in both management and research positions. I left the USGS in 1995 to become a consultant. I have published more than 100 papers in the refereed scientific literature on various groundwater problems. My resume is attached to this comment.

Introduction

Methane is adsorbed on coal. The methane can be released (desorbed) by reducing the fluid pressure associated with the coal environment. Reducing the fluid pressure is accomplished by pumping out the groundwater contained in the coal. As the groundwater is removed the fluid pressure is reduced and the methane is released from the coal. The objective of coal bed methane (CBM) production is to maximize the groundwater drawdown (maximize the pressure drop) in order to release the maximum quantity of gas. Coal beds that once were water saturated become partially saturated by methane. The methane moves freely. It can migrate toward the land surface through natural fractures in the rock and through old drill holes that were poorly plugged when abandoned. Wells that once were good water wells now become water and gas wells. In some cases good water wells become better gas wells than water wells.

Coal-bed methane is an energy source that in many places in the United States is associated with underground sources of drinking water (USDW). In some places the coal beds are the best aquifers in the area. In these places the development of CBM is incompatible with the continued use of the coal beds as an aquifer. There is a direct conflict between national/state energy policy and the preservation of USDW. For example, in the Powder River Basin of Wyoming and Montana the Bureau of Land Management predicts, in their Final Environmental Impact Statement for CBM, that the development will lower the water levels in the coal measures by 600 to 800 feet over much of the basin. This will make unusable several thousand private water wells that are completed in the coal beds. The law favors the development of the methane over the continued use of the coal beds as aquifers—in this case the best aquifers in the area.

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CBM is Associated with USDW

EPA was aggressive in defining potential USDW; they defined groundwater with less than 10,000 mg/l of total dissolved solids as a potential USDW. Groundwater with more than 2,000 mg/l of dissolved solids is almost never used directly as a source of drinking water; water beyond 2,000 mg/l needs treatment to remove salts before it can be used as drinking water.

Nevertheless, using its definition of USDW, EPA found that of the 13 geologic basins identified that contained CBM, 11 contained an USDW associated with the coal beds. Only the Piceance Basin, and the Forest City portion and the Oklahoma portion of the Western Interior Coal Basin were found unlikely to have an USDW associated with the coal. EPA concluded that many of the coal beds associated with CBM are also USDW.

Table 1. CBM production in the year 2000 (taken from the EPA draft report—Table ES-2).

Basin	*Number of Producing Wells (Year 2000)	*Production of CBM in Billions of Cubic Feet (Year 2000)	Does Hydraulic Fracturing Occur?
San Juan	3,051	925	Yes
Black Warrior	3,086	112	Yes
Piceance	50	1.2	Yes
Uinta	494	75.7	Yes
Powder River	4,200	147	Yes (in the past)
Central Appalachian	1,924	52.9	Yes
Northern Appalachian	134	1.41	Yes
Western Interior	420	6.5	Yes
Raton Basin	614	30.8	Yes
Sand Wash	0	0	Yes (in the past)
Pacific Central	0	0	Yes (in the past)

*Data provided by GTI and EPA Region Offices

Of the 11 coal basins listed in Table 1 EPA stated that only the San Juan, Black Warrior, Powder River, and the Central Appalachian currently have really active CBM development. Hydraulic fracturing is widely used to stimulate well production in all the basins. However, currently it is rarely used in the Powder River Basin. It is not uncommon that some wells during their productive life are hydrofraced more than once. The use of hydraulic fracturing for CBM production will increase as development proceeds in the six or seven other basins that are not currently most active.

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Problems Fluids—Groundwater Contamination

EPA examined the fluids used in creating hydraulics fractures.

Table 2. Problem Fluids Used in Hydraulic Fracturing Fluids—Fluids that Exceed the Drinking Water Standards (ug/l) (Table 2 is derived from Table 4.4 in the EPA draft report).

Product		Drinking Water Standard Maximum Concentration	EPA Estimate Hydrofrac Injection Fluid	MCL Exceed Factor	30x Dilution	MCL Exceed Factor
Diesel	benzene	5	313	62.6	10.4	2.1
	naphthalene	20	14,094	704	470	23.5
	1-methylnapthalene	20	71340	3567	2378	119
	2-methylnapthalene	122	34974	287	1166	9.6
	aromatics	200	574200	2871	19240	95.7
Acid	methanol	18250	236070000	12935	7869000	431

EPA calculated the 30 times dilution factor based upon an analysis of the estimated volume of fluid in typical hydraulic fractures. Even with the calculated 30 times dilution a number of constituents exceed the drinking water standard. A small volume of these constituents contaminates large quantities of groundwater. Typically a single hydraulic fracture ranges in size from 50,000 to 350,000 gallons of fluid. If one uses 100,000 gallons as a typical volume of a hydraulic fracture, Table 2 indicates that even at 30 times dilution one contaminants 3,000,000 gallons of groundwater at levels several times higher the drinking water standard—indicated in the last column of the table. For example, in order for benzene to reach levels acceptable in drinking water the benzene would have to be uniformly distributed in more than 6,000,000 gallons of water. In the case of 1-methylnapthene it would need to be dissolved uniformly in more than 300,000,000 gallons to reach the drinking level standard. Methanol needs to be uniformly dissolved in more than 1.2 billion gallons of water to reach the drinking water standard.

The hydraulic fracturing fluids are not fully recovered by subsequent gas development. Where fluid recovery has been investigated only 25% to 61% of the injected fluid is recovered. Undoubtedly, some injected fluid remains in the formation. Under undisturbed conditions groundwater moves slowly, typically from several feet to several tens of feet per year. As a consequence contaminants will remain in an aquifer for long periods of time.

The problem fluids that create aquifer contamination are associated with 1) the use of diesel fuel in the fracing gel, and 2) the use of methanol as an acid treatment. EPA noted the problems associated with injecting diesel into USDW; they urge the states to eliminate its use. However,

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EPA does not regulate against the use of diesel fuel; nor do they regulate the use of other chemicals in CBM related hydraulic fractures.

The problems associated with the injection of hydraulic fracturing fluids are likely to show up where groundwater is produced from the places where the coal beds themselves are the best aquifers or where the aquifers are intimately associated with the coal beds. For example, the coal beds are currently good aquifers, with potable water in the Black Warrior Basin, the Powder River Basin, and the Central Appalachian Basin of Virginia—three of the Basins where CBM is actively being developed. Hydrofracing will produce latent problems; there will undoubtedly be instances where the coal beds are contaminated by hydraulic fracturing fluids. As suggested above groundwater typically moves slowly. Contaminants will remain in the aquifer for many years, decades or longer in many instances, and can be subsequently pumped out by future generations seeking drinking water. It seems prudent for EPA to eliminate fluids that can potentially contaminate groundwater.

State Response

Currently only Alabama regulates hydraulic fracturing associated with CBM; Alabama was forced by a court decision to regulate. The rules in Alabama require that water be used as the fracing fluid. Furthermore, no fluids can be introduced during hydraulic fracturing that exceed the drinking water standards.

In Virginia the coal seams are the most permeable layers in many parts of the subsurface. Many water wells are completed in the coal beds—similar to the Powder River Basin. Virginia restricts the depth of hydraulic fractures in CBM development areas in an effort to protect water wells. The Virginia regulations require an operator to determine the lowest topographic elevation and the elevation of the deepest water well within 1500-foot radius from a proposed CBM extraction well. Hydraulic fractures must be 500 feet deeper than the lowest of the two elevations.

In other states where CBM is developed the respective state oil and gas regulatory body supervises the production, including hydraulic fracturing. In general these regulatory bodies do not distinguish between CBM and other oil and gas reservoirs. The oil and gas regulators are inclined to favor CBM development over the protection of USDW. This is especially true where the state receives revenues from CBM production. There is a need for EPA to step in to protect potential USDW.

The EPA Survey of Problems

EPA tried to find clear evidence from citizen reports that hydraulic fractures associated with CBM development posed problems. EPA utilized the citizen reports of problems; they relied heavily upon reports to state agencies. EPA did no independent study of problems, no independent field investigations, or other sampling. There were a number of instances where problems were identified that could be associated with CBM production. The majority of the problems fell into two broad categories:

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1. Water level declines in producing water wells in areas of CBM production; the declines impacted the productivity of wells in the area.
2. The occurrence of gas in water wells.

Even so, there were some instances where substances were found in the groundwater that could have been derived from hydraulic fracturing fluids.

Summary

Based on the EPA report, one concludes that contaminants are potentially emplaced in drinking water by hydraulic fracturing for CBM development in the 11 basins that have coal associated with USDW. These facts alone suggest that EPA should exercise some administrative control on hydraulic fractures associated with CBM in areas where an USDW exists. EPA went on to suggest that using water based fracing fluids can eliminate many of the contaminants used in hydraulic fracturing. Alabama successfully regulates the composition of hydraulic fracturing fluids associated with CBM; Alabama does not allow any chemicals that exceed the drinking water standards.

At greatest risk of contamination are the coal-bed aquifers currently used as sources of drinking water. For example in the Powder River Basin the coal beds are the best aquifers; there are several thousand water wells in the basin completed in the coal beds. CBM production in the Powder River Basin will destroy most of these water wells; BLM in their FEIS predicts drawdowns in the coal measures that range from 600 to 800 feet over most of the basin. This will render the water wells in the coal unusable because the water levels will drop 600 to 800 feet. The CBM production in the Powder River Basin is predicted to be largely over by the year 2020. By the year 2060 water levels in the coal beds are predicted to have recovered to within 95% of their current levels; the coal beds will again become useful aquifers. However, contamination associated with hydrofracing in the basin could threaten the usefulness of these aquifers for future use. At the present time hydraulic fracturing for CBM in the Powder River Basin is uneconomic; however, this could change if natural gas prices were to rise significantly.

EPA discounted problems associated with hydraulic fractures based upon a limited sample of identified problems. They relied upon citizen reports almost exclusively. There were no independent surveys, no independent field investigation or other well sampling. The EPA exercise is incomplete at best.

Conclusions

The EPA Report concludes:

1. That CBM development is associated with USDW in 11 of 13 basins in the United States where CBM occurs.
2. In some basins the coal beds are the best aquifers.
3. Hydraulic fracturing is used as a well stimulant in CBM development almost everywhere.

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4. Diesel fuel is commonly used as a hydraulic fracturing fluid; this practice emplaces contaminants in USDW. The hydraulic fracturing fluids are not fully recovered by the subsequent CBM production.
5. Changes in the hydraulic fracturing fluids that eliminate diesel fuel and methanol would eliminate many of the potential groundwater contaminants. Alabama already regulates CBM fracing fluids eliminating the use of chemicals that exceed the drinking water standards.

Having made these points EPA then proceeds to dismiss the potential problem based upon scanty evidence from a canvas of state reports of water well problems associated with CBM development. It would seem that having reached the conclusion that common hydraulic fracturing methods emplaces contaminants in USDW EPA would move aggressively to protect drinking water by regulating hydraulic fractures associated with CBM production. An easy solution that eliminates most of the problems is to regulate the composition of the hydraulic fracturing fluid as is done in Alabama.

EPA's solution is to suggest to the states that they regulate hydraulic fracturing in places with potential USDW; EPA suggests using only water based hydraulic fracturing fluids as is done in the Black Warrior Basin of Alabama. This seems like a weak effort on the part of EPA to address what their study identifies as a potential problem.

EPA seems caught up in the conflict between the National Energy Policy of the Bush Administration and the EPA mandate to protect USDW.

Sincerely,

John D. Bredehoeft

Attachment—Resume of John D, Bredehoeft, Ph.D.

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