HYDRAULIC FRACTURING: Review charts potential paths to water contamination (Monday, March 24, 2014)

Gayathri Vaidyanathan, E&E reporter

Risks to water resources from hydraulic fracturing can occur through four major routes, according to a new review released by scientists at Duke University.

Stray methane gas from formations could leak from improperly constructed gas wells into shallow aquifers. Wastewater from shale gas drilling could spill at the surface or could be improperly disposed of in streams and rivers. Metals or radioactive elements could collect in rivers and streams where partially treated wastewater effluent is released. And freshwater withdrawals for fracking could stress groundwater availability in drought-prone regions, the study found.

It was published in the journal *Environmental Science & Technology* last month and is a review of existing research by Avner Vengosh, Robert Jackson and colleagues at Duke University.

Fracking, a process in which oil and gas companies inject water, chemicals and sand at high pressures to fracture shale rock and release oil and gas, has been a major concern for residents who worry that the process may contaminate supplies. Most studies so far have found that fracking itself, narrowly defined, does not pose a risk.

However, there is evidence that improper drilling techniques, especially faulty surface casing and cementing, can contaminate aquifers.

Scientists have found elevated levels of hydrocarbon gases in some groundwater supplies, likely from leaks in well casings, the review states. Gas could also escape through abandoned oil and gas wells or through pre-existing fractures and faults that are adjacent to the formations being fracked.

In most cases, it is a combination of both well integrity and local geology that leads to methane migration, the review states.

Contamination in Pa.

Methane in water does not always mean it originated from drilling, especially since the gas is naturally present in some aquifers. But studies have found that drilling could be causing gas migration in some cases.

A study by the Duke scientists in northeastern Pennsylvania found that shallow drinking water wells within a kilometer of gas drilling sites contained methane, ethane and propane. The gases were found in proportions that suggested they originated either in the Marcellus Shale, where much shale gas extraction is happening, or from the layer above, called the Upper Devonian formation (*EnergyWire*, July 10, 2012).

Given the distinctive signature of the gas mix, the scientists concluded that gas wells were the origin of methane in groundwater. The companies had probably improperly installed casings that allowed the Marcellus Shale gas to escape into aquifers, the review states. And gas from the Upper Devonian formation likely flowed outside the casings and into the aquifers.

Other studies challenged the Duke findings, saying the migration might have been naturally occurring if the topography of the region allowed it. But the Duke scientists showed statistically that topography could not be the only reason to have contamination in northeastern Pennsylvania.

Studies from Canada have also conclusively shown that both conventional and hydraulically fractured wells in the Montney and Horn River areas of the country leak methane from the surface casings.

"Combined, these studies suggest that stray gas contamination can result from either natural gas leaking up through the well annulus, typically from shallower [intermediate] formations, or through poorly constructed or failing well casings from the shale target formations," the study states.

In contrast, the Fayetteville Shale of Arkansas has not had any documented cases of methane migration, which suggests that local geology -- the network of pre-existing fractures -- has a role to play in contamination, the review states (*EnergyWire*, May 17, 2013).

Conventional research

Laws vary as to how much methane can be present in groundwater before it poses an explosion threat. The U.S. Department of the Interior recommends 10 milligrams per liter as a good threshold, while Pennsylvania has a 7 mg/L threshold.

The review states that methane migration could, in the long term, signal migration of fracking fluids or saline water from deeper formations into aquifers.

"Given the buoyancy of gas, the flow rate of denser saline water would be substantially slower than the flow of natural gas," the review states.

The review drew upon research into conventional oil and gas drilling, which has been around for a lot longer, to show the mechanism is possible. In Garfield County, Colo., for example, an increase in conventional drilling was associated with methane contamination as well as greater salinity of groundwater between 2000 and 2007. Scientists could not figure out if the salinity was due to leaky wells or leaky impoundments that hold oil and gas watewater.

"Thus, evidence of stray gas contamination could be indicative of future water quality degradation, similar to that observed in some conventional oil and gas fields," the review states.

If methane contamination does happen, the question then is how often well casings fail. The review suggests that casing failure is common in the petroleum industry.

In the Gulf of Mexico, about 43 percent of 15,000 conventional production wells tested had cement damage. About 30 percent of the wells reported damage five years after drilling, and half the wells had cement damage 20 years after first drilling.

Surface water contamination

Studies have shown that spills and leaks near gas drilling sites are more frequent in places of denser drilling. In northeastern and western Pennsylvania, the number of violations was higher in areas with more drilling, and the frequency of violations doubled in these places.

Improper disposal of wastewater from drilling has contaminated supplies, such as in Kentucky, where a spill caused a massive fish kill last year (*EnergyWire*, Aug. 29, 2013).

Sometimes, identifying trace contamination can be a challenge, since the exact composition of fracking fluids used in Pennsylvania and elsewhere is not known. The scientists analyzed data on the industry-backed FracFocus site and found that sodium hydroxide, 4,4-dimethyl, oxazolidine and hydrochloric acid can be indicators of contamination.