

Water 21

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**Underground
resistance:
focus on
'fracking'**



**Water Safety Plans
for groundwater
Baltic Sea project
targets phosphorus**

accepted safety procedures, which include the integrity of the steel well casings and the concrete lining.

'These wells are going to depths of up to 18,000 feet (5400m),' he explains, 'far below the aquifer. And great care is taken going through the aquifer.' He also notes that hydraulic fracturing has already been used successfully in drilling for water, geothermal energy development, and in the clean-up of EPA 'Superfund' sites polluted with toxic materials.

'The argument (for fracking) should begin and end with groundwater,' he says. 'If groundwater is being threatened, then steps need to be taken to stop it. Fortunately, hydraulic fracturing has never in its history been proven to have any relationship to groundwater contamination.'

EID also has no issue with public disclosure of fracking fluids. Tucker says that all chemicals require what are known as Material Safety Disclosure Sheets in any case, and that many drillers already make the chemical composition of their fracking fluids available to the public. 'Besides, all companies currently meet EPA compliance requirements for chemicals,' he says.

Mike Nickolaus, special projects director with the Ground Water Protection Council (GWPC), says the organization is in the process of developing and implementing a voluntary chemical registry website called 'FracFocus' which will allow people to find out what chemicals are being used to fracture wells — location by location, state by state.

GWPC represents groundwater regulatory agencies in the various states of the US. The Council has been active in working with states on regulatory issues, providing testimony to the US Congress, studying systems

A sustainable approach

Among those advocating a slower approach to natural gas development is Mark Olishoorn, a faculty research assistant at the University of Maryland's Center for Integrative Environmental Research.

While others debate safety and the chemical composition of fracking fluids, Olishoorn believes the discussion should also address how the natural gas can help advance a low-carbon, sustainable energy system and lasting employment.

He advocates that politicians, the natural gas industry and environmental organizations 'get together around the table and deal with the larger issue of developing our shale resources, not just putting extra gas into the market but how society (as a whole) can benefit from the gas for a sustainable, post-gas economy, energy supply and jobs. 'We need a framework for responsible extraction,' he says. It would be wasteful to simply put more gas on the market and burn it to heat badly insulated buildings or fuel inefficient cars, he believes. 'That would increase energy consumption and actually increase greenhouse gas emissions.'

He is encouraged by the actions of the Environmental Defense Fund and Southwest Energy to work with others to develop best management practices, and thinks the recent moratoriums on drilling in place in some states — although inelegant — could slow down the process and lead to a more sustainable approach with broader support.

'Eventually, the resource will probably be developed,' he says, 'but it should be done in a way that the community, the economy and the environment benefit together.'

in various states to investigate complaints and document cases, reviewing all phases of drilling, including site preparation, hydraulic fracturing, and chemical handling, and developing overall risk-based management models.

Another organization in favour of full disclosure of the chemicals used in hydraulic fracturing is the Environmental Defense Fund (EDF). Scott Anderson, Senior Policy Advisor with EDF's Energy Programme, comments: 'The gas industry has no hope of improving its public image until it discloses the identity of these chemicals on a well by well basis. It doesn't just look like the industry is hiding something, the industry is hiding something.' EDF has praised disclosure requirements recently adopted in Arkansas and is encouraging other states to take similar action.

In addition, EDF is working to strengthen regulations and enforcement — especially regarding well construction and operation. 'Although in some circumstances hydraulic fracturing can threaten groundwater, a bigger risk is shoddy well construction,' Anderson says.

'Natural gas almost certainly has a role to play in reducing greenhouse gases,' adds Anderson. 'But only if it's produced in a manner that's good for the environment and public health.'

Surface concerns

Hydrogeologist John Conrad feels that concern about the content of injected fracking fluids may be overblown. His firm — Conrad Geoscience of Poughkeepsie, NY — provides clients with shale gas, carbon storage, and other environmental services, including public outreach.

He suggests that there is actually more risk of environmental damage at the surface of wells because flowback and production water need to be properly contained, transported, treated and disposed of. This is especially true in the Northeastern region of the US underlain by

Marcellus shale where there are very few wells for the disposal of brine.

The concern over the composition of the chemicals and their potential hazard beneath the surface 'is a bit disingenuous', Conrad says. 'It's not an argument for disallowing horizontal drilling and hydraulic fracturing.' He maintains that in a properly constructed and operated well any exposure to the fluids would be from spills at the surface, and would not differ from other chemical handling situations. He says: 'The emphasis should be on preventing surface spills and on minimizing the impact when they do occur.'

Conrad, who has over 20 years of experience in energy and environmental applications, believes most of the fears about horizontal drilling and hydraulic fracturing for natural gas are unfounded, and have been somewhat influenced by the BP Deepwater drilling disaster in the Gulf of Mexico last year.

'We have no known cases where groundwater aquifers have been contaminated by natural gas fracking,' he says, 'yet people have developed the impression that [the practice] is hazardous. Deep water drilling [for oil] is much riskier.'

Flowback questions

Flowback is an issue getting much attention, particularly in areas where deep well injection of the water and fluids is not feasible. Salinity of the flowback fluids can be problematical, requiring special treatment. 'Off-site disposal (of these fluids) is expensive,' EID's Tucker points out, and the water is not always readily treatable.'

For these reasons, many operators are pursuing recycle and reuse of the fluids in a closed loop system. Conrad points out that recycling of the water is becoming a more popular option since the technique reduces the overall need for water and minimizes or eliminates the disposal issue. 'The water must be treated to remove solids and turbidity



Patterson drilling rig in southwestern Pennsylvania. Credit: Energy In Depth

Underground resistance: focus on 'fracking' for shale gas extraction

● Hydraulic fracturing, or 'fracking', where fluid is pumped deep into rock to create cracks to release natural gas from shale formations, is becoming increasingly popular in the US as alternative fuel sources to oil and natural gas are sought. However, debate is also increasing regarding its potential impacts on the quality of groundwater. **JIM FORCE** reports.

The promise of abundant domestic fuel supplies is driving increased efforts in the United States to drill for natural gas in shale formations using the practice of hydraulic fracturing – creating cracks in dense rock structures deep underground in order to release the gas.

At the same time, environmentalists and some public entities remain concerned that the fluids used in hydraulic fracturing could lead to contamination of groundwater supplies.

But the US Environmental Protection Agency (EPA), energy organizations, and industry groups alike are promoting an approach that emphasizes good science and peer review in evaluating the potential hazards. They agree that proper safety procedures must be in place in order to prevent fracturing from contaminating drinking water sources.

Natural gas could be the key to breaking the United States' dependence on foreign oil as its main source of energy, many believe. By some estimates, there is enough natural gas trapped in deep shale deposits in the US to power the country for 100 years. EPA says that as much as 20 percent of the US supply of natural gas could come from these shale deposits by 2020.

'Shale is a great new source of natural gas', explains Chris Tucker of Energy In Depth (EID), an organization of independent companies engaged in natural gas drilling. 'The amounts are staggering – billions of cubic feet per day of potential.'

Natural gas is also attractive since it produces only about half as much carbon dioxide as coal and about one-third less than oil.

To capture the natural gas contained in shale formations, however, producers must use horizontal drilling techniques and hydraulic fracturing (or 'fracking' as it is popularly known). Engineered fluids are pumped at pressures of up to 15,000 psi into rock

formations, between 1500 and 6000 metres deep, opening cracks through which the gas can be withdrawn. These fluids contain 99 percent water and sand, and a small amount of chemicals like biocides to protect pipes and kill bacteria. Particles in the fluids – usually sieved round sand or man-made ceramics – keep the cracks open as a permeable pathway for the gas to move to the borehole where it is brought to the surface. About 15,000 cubic metres of water are used per well for fracturing.

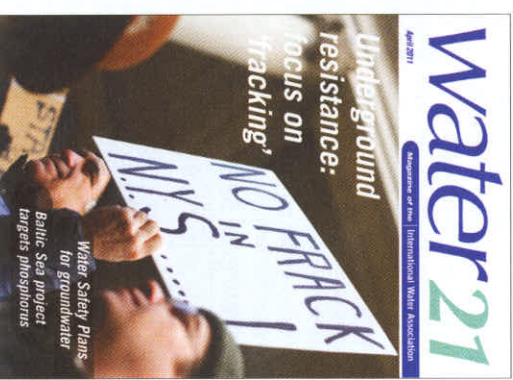
The picture, as far as water is concerned, also includes 'flowback', which is the return flow of fluid from the fracking process, and production water, which is the highly saline water produced while the well is in operation.

Critics fear the fluids can contaminate aquifers, and point to a few cases where they suspect drilling may have caused pollution of drinking water supplies (see box). They also have concerns about potential seismic activity caused by fracturing.

Advocates claim that hydraulic fracturing technology has been used for over 60 years to stimulate oil and gas recovery in tens of thousands of wells in the US and around the world.

In 2004, the EPA studied the effects of drilling for natural gas, but the investigation was focused on producing gas from coal bed methane, not shale. Furthermore, the study did not investigate the potential for fracking fluids to cause pollution at the surface. One result of the 2004 study was that drilling companies voluntarily agreed to stop using diesel in drilling fluids in coal bed methane zones that were underground sources of drinking water.

Now, at the request of the US Congress, EPA is engaged in a new study aimed at determining the potential impact on groundwater when natural gas wells are drilled deep into the shale formations using the horizontal drilling and fracking methods. The scope of the proposed research includes the full lifespan of



Cover image shows people gathered on the steps of New York City Hall in January 2010 protesting at the state's plan for shale oil drilling in the city's watershed. (Credit: REUTERS / Shannon Stapleton)

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 production water and its ultimate treatment and disposal.

EPA submitted the draft study plan to its Science Advisory Board for peer review on 8 February of this year. The board plans to accept public and stakeholder comment and review the plan in early March, then launch the study. Interim research results are expected in 2012, and a final report in 2014.

Drilling companies have been asked to convey information about the composition of drilling fluids to EPA for review, and most have complied, according to the EPA website (www.epa.gov). One company, Range Resources, voluntarily discloses on its website the composition of each of the hydraulic fracturing components for all wells it operates in the Marcellus Shale.

Industry position

Tucker says EID is on board with EPA's current study as long as the work is based on 'good science and peer review'. Tucker says fracking can be safe and successful when drillers follow

Research into the possible impacts of hydraulic fracturing on groundwater is being undertaken by the US EPA. Credit: Energy In Depth.



Concerns around hydraulic fracturing

Hydraulic fracturing for natural gas is meeting with resistance in some parts of the US, and detractors point to a few specific instances they say are evidence that the practice is not safe.

One of the most widely publicized incidents occurred in September 2009, near Dimock, Pennsylvania, when 8000 gallons (30,400 litres) of drilling fluids leaked from a well site and seeped into a nearby stream, resulting in a fish kill. In that same area, metals and methane gas were detected in drinking water in some area homes earlier in that same year. Ultimately, the state fined the drilling company and ordered it to shut several of its wells, according to press reports.

In January of this year, city councils in both Pittsburgh and Philadelphia, Pennsylvania, issued bans on fracking in their areas of jurisdiction. The Pittsburgh council invited other communities in that state to do the same. The Philadelphia council endorsed a ban on shale gas development along the Delaware River Basin, and instructed the Philadelphia Gas Works not to purchase natural gas obtained from the Marcellus Shale Coalition, stated: 'The

In response, Kathryn Klaber, president and executive director of the Marcellus Shale Coalition, stated: 'The development of this clean-burning resource is tightly regulated and subject to a host of stringent environmental laws and regulations. Our industry has a long-standing working relationship with state regulators to ensure that Marcellus development is done safely, environmentally responsibly and in a way that protects groundwater.'

The Coalition's press release continued: 'From enhanced well casing standards to recycling water to increased permitting fees allowing DEP (Department of Environmental Protection) to hire additional inspectors without adding a financial burden to state taxpayers, the natural gas industry remains supportive of effective, smart regulations and is committed to working with regulators as this responsible development expands.'

and adjust pH, but it can be recycled. It's a good development.'

As for the highly saline production brine, Conrad notes that several private water treatment companies are developing technologies for crystallizing and recovering salt and metals that can be reused. Other 'pre-treatment' technologies are being used to make the wastewater suitable for treatment at conventional wastewater treatment facilities. Conrad's firm is also develop-

ing injection wells to dispose of gas well brine.

Nickolans adds that GWPC supports strong safety procedures, including use of casing and cementing for borehole isolation. Where possible, the organization feels that injection wells are 'good safe isolation technique' for spent fracking fluids, and supports closed loop fluid management systems because they lower the risk of contamination. 'We want to

keep everything out of the groundwater,' he says.

In the end

'Shale gas will be produced both here in the US and around the world,' Conrad concludes. The rate and volume of that production will be somewhat dependent upon the price of oil and gas, but he notes that the vast Marcellus shale deposits are near population centres and pipeline networks are already available.

'New York State and New York City are already among the major users of natural gas in this country,' he observes, suggesting that tapping the gas in the shale deposits beneath that area is just a matter of time.

'Natural gas is critical to reducing greenhouse gases,' says energy specialist Scott Anderson, on the Environmental Defense Fund's website. 'But only if it's produced in a manner that's good for the environment and public health.'

Adds Nickolans: 'Industry has been using 'fracking' for over 60 years – one million wells – and to our knowledge no one has been seriously injured or killed by groundwater contaminated by fracturing fluid. Actually, we [in the groundwater profession] are more concerned about contamination from nutrients, septic systems, and stormwater. ●

PUBLICATIONS

Benchmarking Water Services

Guiding water utilities to excellence
Authors: Enrique Cabrera Jr., Peter Dane, Scott Hashins, Helmo Theuretzbacher-Fitz

Benchmarking has become a key tool in the water industry to promote and achieve performance targets for utilities. The use of this tool for performance improvement through systematic search and adaptation of leading practices, has expanded globally during the past decade. Many ongoing projects worldwide aim to address different needs and objectives, in varying contexts, with outstanding results and impact.

Benchmarking Water Services provides valuable information to everyone interested in benchmarking in the water industry. The document is presented with a clear practice oriented approach and can be used as a how-to-benchmark guide presented from different perspectives. Readers will gain practical insight on real life benchmarking practices and will benefit from the experiences gained in some of the leading benchmarking projects of the water industry.

This Manual of Best Practice is edited by the IWA Specialist Group on Benchmarking and Performance Assessment.
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Corporate Water Strategies

William Sami
In the past, businesses have viewed water as a minimal operational cost and not a strategic issue. However, water has now emerged as a critical issue for both corporations and the public sector in response to increased water demand, climatic risks and potentially negative impacts on brand value.

This book provides up-to-date information on global water issues and describes how companies can not only address these challenges but also implement high value global

water strategies.

It shows why water is a critical business issue for companies, which now face water risk to their operations and brands; how new concepts such as embedded water and virtual water are forcing companies to think differently about how they use water; that companies need to develop a corporate water strategy; and how companies can develop partnerships with non-governmental organizations to implement water strategies.

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Decision Support for Water Framework Directive Implementation

Editor: Peter A Vannollegghem
This book is a concrete outcome from the Harmoni-CA concerted action as part of a four-volume series of Guidance Reports that guide water professionals through the implementation process of the

Water Framework Directive, with a focus on the use of ICT-tools (and in particular modelling). They are complementary to the Guidance Documents produced by the EU Directorate General for Environment.

Water resources planning and management and the development of appropriate policies require methodologies and tools that are able to support systematic, integrative and multidisciplinary assessments at various scales. It also requires the quantification of various uncertainties in both data and models, and the incorporation of stakeholders participation and institutional mechanisms into the various tools and risk assessment methodologies, to help decision makers understand and evaluate alternative measures and decisions.
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