

# DRILLING FOR TREASURE

BY PAM HUNTER  
WITH JONATHAN BARNES

Depth of gas reserves yet to be plumbed, but concerns persist

**A**s drivers travel down Route 6 through Mansfield, Pa., they quickly realize something has changed about the rural town. Trailers for energy companies are popping up like mushrooms, and traffic has become increasingly snarled as trucks carrying material to and from natural-gas drilling sites share the road with local cars.

It's not quite a boomtown, but it is certainly changing, and the transformative agent over the past two years has been the discovery of an estimated 500 trillion cubic feet of recoverable natural gas locked in the Marcellus Shale Formation some 5,000 to 8,000 feet below the earth's surface.

The Marcellus Shale Formation spans 600 miles of the Appalachian Basin, from West Virginia and Ohio to the Northeast through Pennsylvania and New York. In terms of potential recoverable gas, it is considered one of the largest unconventional sources in the world, according to Travis

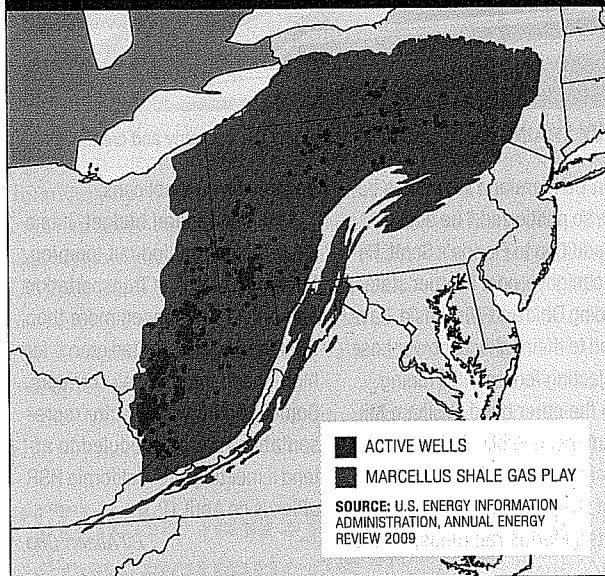
Windle, spokesman for the Marcellus Shale Coalition, a group of firms involved in the Marcellus shale business.

Many experts agree that the Marcellus shale region's potential for natural-gas production is vast. But at what price?

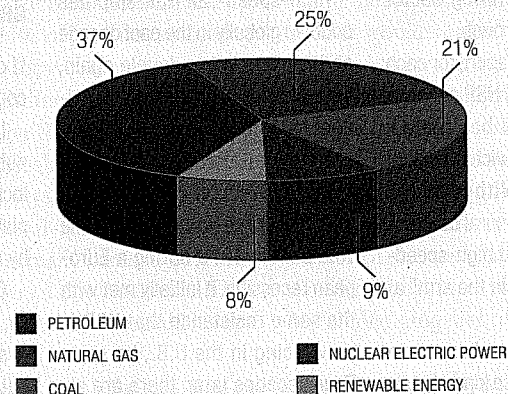
The only economical way to extract the gas is through a controversial technique called hydraulic fracturing, or hydrofracking. The technique involves blasting millions of gallons of water mixed with sand and a small amount of chemicals deep into the ground to create in the rock fissures that then release the natural gas. The process is extremely resource-intensive: A single well can require more than three millions gallons of water as part of its development process.

Environmental groups believe hydrofracking, as well as the entire process of drilling for natural gas near community drinking-water supplies, is slowly poisoning the land and creating a living nightmare for some residents who live near the gas pro-

TO BE LESS DEPENDENT ON FOREIGN ENERGY, NATURAL GAS WILL HAVE TO BE PART OF THE U.S. SOLUTION



U.S. PRIMARY ENERGY USE BY SOURCE



duction wells and compressor stations.

While industry sources claim the process is safe, the issue has generated an enormous amount of controversy, fueled largely by lawsuits, media reports and a 2010 award-winning documentary, "Gasland," which documented health and environmental problems that the film associates with hydrofracking.

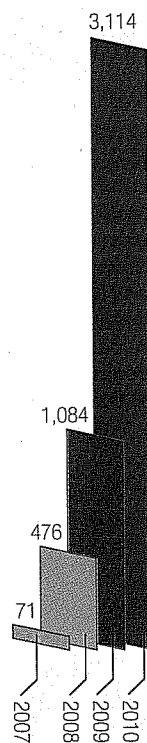
Meanwhile, engineering and construction firms are finding plentiful work in the burgeoning oil-and-gas exploration and production industry throughout the Marcellus shale region as well as at shale plays in other parts of the U.S. and the world. Further, enterprising firms are trying to find solutions to some of the thorniest problems the gas sector faces. Engineering firms may well find themselves at the heart of determining whether this gas sector continues to develop or public pressure brings future drilling to a standstill.

### Part of the Equation

Obama administration officials have made it clear that they consider natural gas an important part of the nation's energy mix for the foreseeable future. At a March 30, 2011, White House briefing for reporters, Energy Secretary Steven Chu said, "The [natural gas] reserves, because of the ability to frack shale rock, have been increasing. We believe that it is possible to safely and responsibly extract natural gas, and the U.S. government remains committed to that."

But some lawmakers question the wisdom of relying too heavily on a technology that many say is harmful to the environment and public health. In its fiscal 2010 budget report, Congress appropriated funds for a fed-

NATURAL-GAS DRILLING PERMITS IN PENNSYLVANIA



SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY REVIEW 2009

eral study to evaluate whether the process can indeed be performed safely and cause no long-term threat to the environment.

The Environmental Protection Agency is in the middle of conducting that study now, and it plans to release a preliminary report late in 2012.

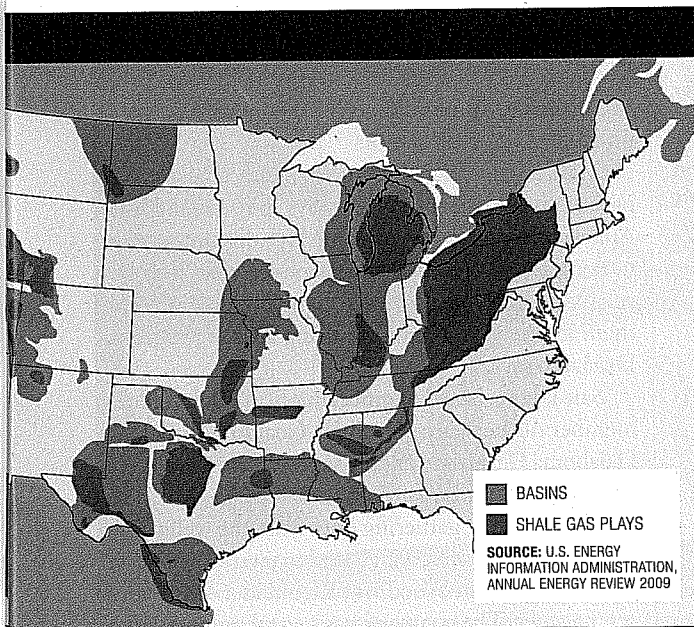
Environmental groups say they are pleased the EPA is taking a hard look at hydrofracking. Dusty Horwitt, senior counsel for the Environmental Working Group, an environmental and public health advocacy organization, says, "What we really need is some rigorous scientific investigation." He claims a 2004 EPA study conducted during the George W. Bush administration that ultimately concluded hydrofracking posed no lasting harm to the environment was "deeply flawed in large part because EPA conducted no on-the-ground testing—it was basically just a literature review."

### Environmental Minefield?

Those findings emboldened energy services and supporting firms to press forward. "It's like a gold rush out there," says Vince Rice, president and CEO of Aaron Enterprises, York, Pa., referring to the development of the Marcellus shale region. Aaron Enterprises specializes in "trenchless" pipeline technologies, such as boring and directional drilling used by utilities and a variety of other industries.

However, environmental concerns have grabbed the attention of the media and the public. The Pennsylvania Land Trust reports that, between Jan. 1, 2008, and August 20, 2010, more than 1,600 violations by 45

BOTTOM RIGHT PHOTO BY GETTY IMAGES/BLOOMBERG



Pennsylvania Marcellus shale drillers were identified by the Pennsylvania Dept. of Environmental Protection, including 1,056 with the potential to cause environmental harm. Violations included improper well casing, improper construction of wastewater impoundments and non-compliance with permitting requirements. The most serious violation was inadequate blowout prevention at a Clearfield County site, where, on June 3, 2010, one million gallons of gas and water shot 75 feet into the air for 16 hours.

The problems are not specific to Pennsylvania. Similar incidents have occurred at shale plays in Ohio and Colorado in recent years, and residents near compressor stations close to the Barnett Shale Formation in Texas have complained of air quality, says Horwitt.

Moreover, the contamination of water wells and drinking-water supplies has spawned several lawsuits, including one filed against Houston-based Cabot Oil in 2009 by several families from the small town of Dimmock, Pa., who are now drinking bottled water after methane and metals allegedly leaked into local water wells and streams, poisoning the water supply.

Environmentalists say it is difficult to determine whether it is the hydrofracking or other mistakes in the drilling process that are causing spills, leaks and other hazards, but it is clear problems are occurring.

Jeff Schmidt, director of the Pennsylvania chapter of the Sierra Club, which has about 17,000 members throughout the commonwealth, says, "There are a lot of examples of problems that have occurred because of drilling [that took place] where, if they didn't have the fracking process, they wouldn't be drilling in those locations. ... So, clearly, if we weren't fracking, we wouldn't have a lot of the environmental problems that we're seeing in the gas drilling of the Marcellus shale."

EWG's Horwitt adds, "We're concerned about the entire drilling process. ... What we've said is that natural gas and drilling and drinking water do not mix."

One of the chief concerns many have in Pennsylvania has been enforcement of existing regulations. "We're concerned that there is still inadequate staff on the ground to enforce the law," Schmidt says.

Nels Taber, director for Pennsylvania DEP's north-central region as well as its East Oil and Gas program, acknowledges, "It became obvious pretty quickly that there was an inadequate number of people" initially to conduct inspections. But the Dept. of Environmental Protection hired more staff since launching its oil-and-gas program in the north-central region in 2009. "[Our] inspections increased substantially between 2009 and 2010," he said. "I would anticipate that inspections in 2011 are going to increase even beyond



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[2010's figure] simply because we have more people."

Gas-sector experts say hydrofracking is safe. "There is a lot of misinformation out there about the process, about the environmental safeguards and regulations and policies in place that not only ensure that groundwater resources are protected, but that the environment at large is protected," says the Marcellus Shale Coalition's Windle. Operators are careful to separate the natural-gas wells from sources of freshwater using several layers of cement and steel casing, he says.

### Engineering Opportunities

"There is a lot of emotional debate going on about the relationship between hydrofracking and groundwater," adds David Breitmayer, senior business consultant with Atlanta-based engineering and environmental services firm Golder Associates. "The reality is, it's an entirely safe and environmentally sound process. Having said that, if there are issues with well design and construction, there is the possibility for impact on surface water. But it has no relation to the hydrofracking which is going on 5,000 feet deep."

Breitmayer is leading Golder's shale gas business development efforts in the Appalachian Basin and manages the firm's new office in Pittsburgh, opened in 2011 specifically to capitalize on the Marcellus shale market. Golder already has 16 offices throughout the Appalachian Basin, as well as offices at nine of nearly 30 active shale gas basins in North America. Firms say the opportunities for engineering firms in the Marcellus shale region, as well as at other shale plays around the nation, are growing. The type of services firms provide run the gamut of typical environmental engineering consulting work: regulatory compliance, safety audits, environmental permitting, preparation of water management plans, design and construction of water-supply intakes, groundwater wells, water transmission pipelines and pump stations.

Matthew DeMarco, principal with Chester, Pa.-based Advanced Geoservices, says the ramping up of Appalachian Basin projects quickly adds up for engineering firms. "It may be that one well pad may be a relatively small design, but when you look at 100 of them in one year, it ends up being a large program," DeMarco says.

San Diego-based engineering firm Kleinfelder, a member of the Marcellus Shale Coalition, is helping Oklahoma City-based energy services firm Chesapeake mostly in the "midstream" of the natural-gas extraction process, building gathering lines from the wells to the compression systems, which lead to interstate pipeline systems, says Tom Woodrow, Kleinfelder senior project manager. The company has several million dollars

in ongoing work helping Chesapeake to set up operations in the northeastern part of the state.

The two companies have been working together for about 18 months, and right now Chesapeake is one of Kleinfelder's top clients, Woodrow says. The companies have been collaborating on development in the counties of Bradford, Sullivan and Susquehanna.

Usually the sites the firms have been working on are very rural, with little infrastructure. Water and sewer systems often are nonexistent, and many of the sites have only gravel or dirt roads as access. The lack of infrastructure presents its own set of problems.

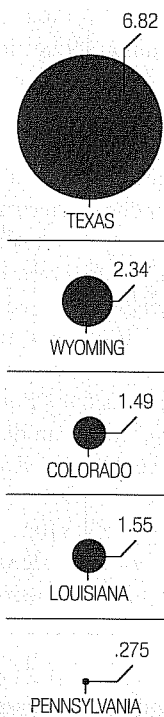
In one case—on a project in Towanda Township, Pa., which Woodrow calls “the least rural [Pennsylvania] project we’ve worked on yet”—Kleinfelder had to build a 4,500-ft road and get approval for it from Bradford County’s Planning Commission. The project also required approval of erosion and sediment control plans by the Bradford County Conservation District.

At its point of entrance, the topography of the site was a very steep hill, into which Kleinfelder had to make a large cut of dirt and rock. “The biggest challenge we had was to do the construction in the winter,” Woodrow says. “We needed to get earthwork done to meet the project deadline.”

### Part of the Solution

According to DeMarco, engineering firms can be part of the answer to the industry’s environmental questions. “Our background is in environmental remediation, so we’re tied a lot to the environmentalists’ position. We try to harmonize that [set of concerns] with

### NATURAL-GAS PRODUCTION BY STATE, 2009



(million cubic feet)  
SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY REVIEW 2009

what the industry needs,” DeMarco states.

One aspect of that balance is finding ways to increase the amount of water generated during fracking that can be recycled. After fracking, most of the fracking fluid returns to the surface—this is called “flow-back” water. As the well begins to produce natural gas, some of the water from the rock also returns to the surface—this is called “produced” water.

In some shale plays, like the Barnett Shale Formation in Texas, most of the water generated is treated, then injected back into the ground. But the geology of Pennsylvania makes that difficult, says the Marcellus Shale Coalition’s Windle. As a result, energy companies typically try to recycle at least a portion of the generated water and transport most of the rest to storage sites in West Virginia and Ohio, although some water does go back into the rivers and streams of Pennsylvania after it is treated.

According to the Pennsylvania DEP, operators in the state recycled about 70% of the water generated from fracking and drilling in 2010.

Marty Muggelton, principal with Williamsport, Pa.-based Larson Design Group (LDG), says, for energy clients in 2010, a LDG subsidiary treated and returned about 17.5 million gallons of generated water, which translates to about 7.5% of the total amount recycled in Pennsylvania last year. The subsidiary, TerrAqua Resource Management, designed and managed construction of a facility to treat water generated from hydrofracking and drilling (see story, p. 24).

Other firms, including Pittsburgh-based Chester Engineers, are working to develop mobile treatment

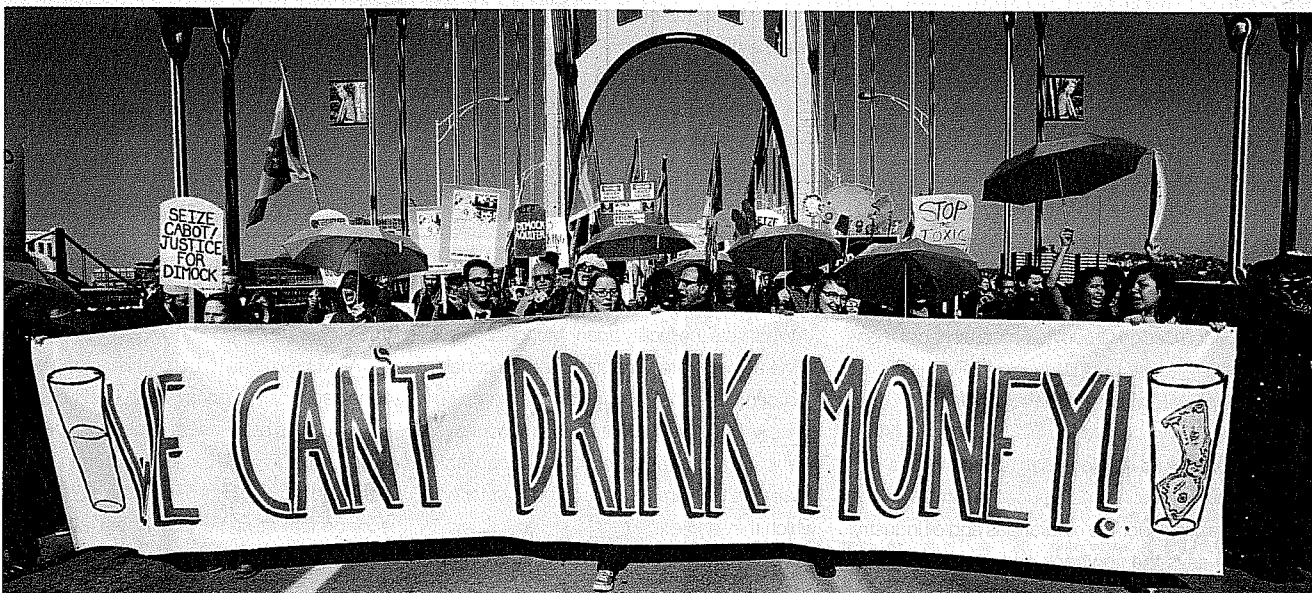


PHOTO BY AP/WIDEWORLD

Pennsylvania residents protest shale gas development because of problems with well contamination in rural areas such as Dimock, Pa.



facilities that can treat and recycle water at well sites. In April, Canonsburg, Pa.-based Aquatech, a global provider of water purification technology, unveiled its mobile shale gas wastewater distillation unit that the firm claims can treat the flowback and produced waters at the well pad to meet compliance levels associated with stationary water treatment facilities.

Chester Engineers also is evaluating an alternative drilling method for combined fracking and drilling using a high-pressure cutting head rather than the head typically used, says Chester's president and CEO, Robert Agbede. He says, if successful, the technology will be able to recycle and reuse the water for cutting and other operations and therefore lower the overall consumption of water while reducing energy consumption.

Golder offers a modeling program, called Fracman, that analyzes the natural fracture system in the shale and simulates what is occurring during hydrofracking, says Cliff Reitter, principal with Golder Associates. "[The model] optimizes orientation of the well, the fracking pressure and the fluid. And it looks at what actually gets stimulated during a hydraulic fracture," he says. It presents a "clearer picture of what's there," which could ultimately reduce unnecessary hydrofracking, he adds.

While engineering and energy companies continue to move forward, considerable uncertainty lies ahead. Those on both sides of the issue are eagerly awaiting the outcome of the EPA

study, with both camps seeming confident that it will confirm their arguments. Meanwhile, the controversy continues.

Matt Armstrong, an attorney in the Washington, D.C., office of Bracewell & Giuliani, which has several energy-related clients, believes best management practices already exist to mitigate the risks in the oil and gas exploration and production process. "The question is, are enough participants in the industry following the best management practices and complying with the regulations in a manner that is sufficiently protective of the communities in which they operate?" he says. "I think what you're seeing is that it's going to be necessary for the industry itself and the government, through increased inspections and enforcement, to make sure that smaller companies with less tolerance for increased costs" measure up to what big independents and integrated oil-and-gas producers are doing: spending the money up front to make sure things are constructed properly and that they following the law.

But for Dimock, Pa., resident Victoria Switzer, the problems run deeper. In testimony before the Pennsylvania Legislature last April, she said, "The gas company is not going to leave this area until it has extracted the last isotope of gas. In this frenzy, safety and caution have been abandoned. I fear there will be little we can do to correct or restore something as huge as this massive industrialization of rural Pennsylvania." ■

## SOLUTIONS

## POST-DRILLING WATER TREATMENT

TerrAqua Resource Management's (TARM) new treatment facility in Williamsport, Pa., for wastewater generated from hydrofracking, well development and production was the first of its kind in Pennsylvania and required the firm, a subsidiary of Williamsport, Pa.-based Larson Design Group, to obtain a special "beneficial re-use permit" from the Pennsylvania Dept. of Environmental Protection.

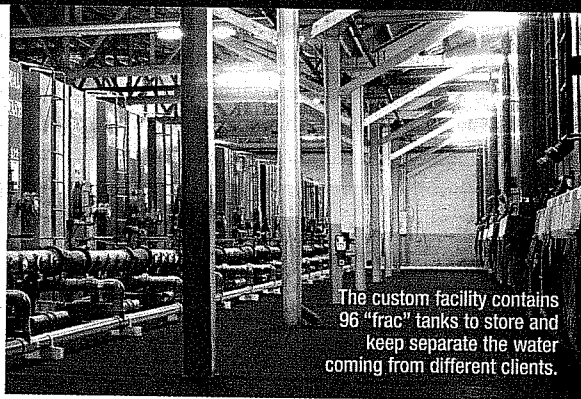
LDG principal Marty Muggleton says TARM saw a need that local sanitary authorities had trouble meeting and stepped in with a solution specifically for the natural-gas and oil industry. He says the flowback and produced water from Marcellus shale development has a higher salt content that is "disruptive" to the biological

treatment systems at most local facilities to treat industrial wastewater.

As a result, TARM built an 80,000-sq-ft facility to treat flowback and produced water using chemical processes and by adjusting pH levels, which typically are more successful in treating the water from fracking, Muggleton says. "It is very straightforward. Nothing we have is proprietary," he says.

What sets the facility apart, Muggleton says, is the 96 separate "frac" tanks, each capable of storing up to 21,500 gallons of water. The tanks keep different clients' water separate, so the water is never commingled; the trucks leave with the same—but treated—water with which they arrived.

Muggleton says the TARM process benefits not only Marcellus shale development but also mitigates environmental impacts through reuse



The custom facility contains 96 "frac" tanks to store and keep separate the water coming from different clients.

of water resources, reducing the carbon footprint and impacts on local roadways with fewer truck trips.

TARM has plans to build at least two additional facilities in Pennsylvania and is eyeing opportunities at other shale plays across the nation, including the Eagle Ford play in Texas. Although a facility like TARM's would not be economical at shale plays near abundant sources of water, it could be useful where recycling of the generated water becomes optimal, Muggleton says. ■