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2011]

**'SHALE' WE DRILL? THE LEGAL AND ENVIRONMENTAL
IMPACTS OF EXTRACTING NATURAL GAS FROM
MARCELLUS SHALE**

VILLANOVA ENVIRONMENTAL LAW JOURNAL SYMPOSIUM

JANUARY 30, 2010

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EDITORS' SUMMARY: On January 30, 2010, the Villanova Environ-
mental Law Journal hosted its annual symposium, focusing on ex-
tracting natural gas from the Marcellus Shale. This rock formation
under Pennsylvania and neighboring states is believed to hold tril-
lions of cubic feet of natural gas. Natural gas has increasing eco-
nomic value and is environmentally attractive because of its
relatively low carbon content. Thus, the prospect of exploiting the
natural gas in the Marcellus Shale is enticing. While oil and gas
companies have recently developed new methods to extract natural
gas from shale, there is concern that these techniques will release

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harmful chemicals into groundwater and contaminate water supplies. This symposium brought together participants with a variety of perspectives – scientific, legal, government, industry, and non-profit – to discuss the legal and environmental impacts of extracting natural gas from the Marcellus Shale.

TODD AAGAARD: I'd like to welcome you to the Villanova Environmental Law Symposium this year, addressing a very pertinent topic of both regional and national significance: the Marcellus Shale.

This afternoon's symposium is entitled "‘Shale’ We Drill? The Legal and Environment Impacts of Extracting Natural Gas from Marcellus Shale." There are currently trillions of cubic feet of shale underlying large parts of central Pennsylvania, New York and West Virginia. This holds tremendous potential in terms of natural gas extraction. There is debate over two primary areas, however, which we are going to cover in today's symposium. First, does the extraction process actually harm the environment? And if so, to what extent? Secondly, and somewhat related, what regulations exist today at both the state and federal levels to control this extraction process? Moreover, is more regulation needed by either the state or the federal government?

Our first panel today will be addressing the environmental effects issue. This panel includes Terry Engelder, John Baillie, and Phil Bender, with Andrew Mergen moderating. Our second panel will focus on the regulatory issues surrounding shale extraction. This panel will include Hannah Wiseman, Scott Perry, Tom Beauduy, Jack Ubinger, and Phil Bender.

As an introduction, Professor Terry Engelder, Professor of Geosciences at Penn State, is going to provide a general scientific background of the Marcellus Shale to give some context for the later discussions.

I. Scientific Background of Marcellus Shale

TERRY ENGELDER: What a pleasure to be here. I'm not a lawyer. In fact, I am probably the only person in the room who is not a lawyer. I can at least imitate, however, what I think lawyers might be doing, which is imagining a hypothetical lawsuit which could be called *Safe Drinking Water v. Marcellus Gas Shale*. In my portion of the presentation, I hope to fold into this summit the technical understanding of what is involved in extracting natural gas from the Marcellus Shale.

Any time you listen to a professional talk, there always has to be a disclosure. Bear in mind that I am the poster child for gas companies. Every time I talk to a reporter, I have to start out by reminding them that it is my connection with gas companies over the years that has funded my students and maybe even allowed me to get to where I am relative to the Marcellus.

First of all, one has to understand what the salient facts are. Probably the most critical fact, the reason that we are here today, is that America consumes 100 quads of energy a year. One quad is equal to one trillion cubic feet. So it is a very easy measure of energy. That is the first and crucial fact.

Now there are some secondary facts. I think in this business the most important secondary fact regarding petroleum is that the party is over. At one time, America had 220 billion barrels of oil. Present Saudi reserves are somewhere on the order of 250 billion barrels. So America, at one time, had about as much oil as the Saudis have now, but America has used all but about 30 million barrels of its oil. So we are really in a tight spot right now.

There are additional facts which should be discussed. Firstly, two-thirds of America's petroleum is now imported. That is a huge strain on the national treasury, and we really want to stop that bleeding. Secondly, coal puts twice as much greenhouse gas into the atmosphere per BTU produced as natural gas. That is why we might say coal is not a clean fuel as it stands right now. The second panel that will speak today will consist of a number of regulators. They actually are the ones that are charged with keeping energy production safe. People that seek proof that this will be safe, again, have less of an idea of what is going on than they probably should. Industrial processes will never be proved completely safe.

Hydraulic fracturing is the process by which natural gas is extracted from the Marcellus Shale. The primary reason for using hydraulic fracturing is to economically remove gas located in rock that is so impermeable that gas cannot otherwise flow naturally through the matrix of the rock. The thickness of the Marcellus, in some sense, relates to its economic potential. Specifically, the places where the Marcellus is the thickest may be the most valuable. The area we are going to talk about is Dimock. Dimock is located in Susquehanna County, Pennsylvania.

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The thickness is not the only parameter that governs whether gas shale is productive. Again, America uses on the order of 23-25 trillion cubic feet of gas per year. The amount of gas shale that is estimated to exist worldwide is 24,000 trillion cubic feet. Now, let me put that number into perspective.

In terms of international oil consumption right now, worldwide, we are at a point in time called Hubbert's Peak. Hubbert's Peak is that point in time in which half of the world's oil has been used up. America is well ahead of the Hubbert's Peak curve because America has used more than fifty percent of its oil reserves; America has used seventy to eighty percent. This number may be higher than eighty percent if natural gas is also taken into account. The world, in total, has used about fifty percent of its oil right now. So in terms of absolute numbers of barrels, there are about two trillion barrels accessible worldwide, of which one trillion have already been used. Most of that oil is located outside the United States.

The relationship between gas and oil is this: 6,000 cubic feet of gas is equal to one barrel of oil. So you take that number and divide it by 6,000. This leaves a measure that's on the order of 4 billion barrels of oil. In other words, in terms of worldwide natural gas, there is twice as much natural gas available today for use by mankind as there ever was oil. And half the oil is gone. This is why natural gas is so important. Before a company documents its reserves, it is required to prove the reserves to the Securities and Exchange Commission (SEC). Obviously, not all gas deposits have been proven, so there is another term that we use called "technically recoverable." Technically recoverable refers to whether we can drill down and get gas out of the ground.

Just briefly, I am going to review a number of laws that are in place to protect your water. The Safe Drinking Water Act of 1974 is very important, specifically section 1421. It specifies that whatever water is pumped into the ground in the process of fracturing must be identified. I regard this act, which was passed by the Bush administration, as a mistake on the part of the operators. This act mandated that the oil and gas industries do not have to disclose what they put down wells. In fact, this act has really turned the public off to hydraulic fracturing because it makes it appear as if it is a big mystery. In order to rectify this particular problem, the legislature has proposed the FRACK Act. The FRACK Act has not passed yet, but it would essentially mandate transparency regarding the com-

ponents in the liquid that is pumped into the ground during the fracturing process.

One of the misperceptions is that fracturing down in the Marcellus Shale will compromise drinking water. On the contrary, the drinking water table is actually located on top of the Marcellus Shale, closer to the surface. Therefore, contamination of drinking water by fracturing the Marcellus Shale is not going to happen. In June, *The Daily Review* of Towanda printed an article stating that “we already have private wells contaminated by gas and fluids using hydraulic fracturing.” There are two things that I would question about this statement. Firstly, is there any evidence of fluids used by hydraulic fracturing in the so-called contaminated wells, and secondly, what is contamination by gas?

It is very important to appreciate that the Marcellus gas shale is at high fluid pressure and additionally that it is a gas. If anything is going to leak out through a rock column, gas leaks out before water because the viscosity of gas is very low in relationship to the viscosity of water, which is very high. When gas leaks out of the Marcellus, it becomes sort of like a deflating balloon. Like gas coming out of the balloon, the Marcellus would be deflated if the gas came out of the Marcellus. The gas located in the Marcellus has been there on the order of 250 million years at a pressure greater than hydrostatic. That’s the geological evidence that says that hydraulic fracture fluid will not get out of that rock.

QUESTION: How then, in your opinion, could one determine if these wells were contaminated?

SCOTT PERRY: The Department of Environmental Protection has the material safety data sheets for every company that is conducting fracturing in Pennsylvania. This data lists all of the chemicals that are employed in hydraulic fracturing. While this means we have the ingredients as to what chemicals are employed in hydraulic fracturing, what we don’t have is the “recipe,” which is currently protected by trade secrets.

QUESTION: Why don’t we have the percentage of each chemical being used?

SCOTT PERRY: Well, that’s the part that’s protected by trade secrets.

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QUESTION: Why can't Pennsylvania or the federal government find that out?

SCOTT PERRY: Right now I don't think that we have the statutory authority to require disclosure of the proprietary mix; that is currently protected by intellectual property law. What we are concerned about is contamination of underground sources of drinking water, and what we need to know to determine if drinking water is contaminated is what could possibly show up in the water from the fracturing. Even if you have that list of what chemicals to look for, it is not clear exactly how much greater a benefit would be provided by actually knowing the percentages of each chemical used in the fracturing fluid.

II. Environmental Effects of Drilling [Panel 1]

ANDREW C. MERGEN: My name is Andrew Mergen. I am a lawyer with the United States Department of Justice. Over the last few weeks, one hundred percent of my time has been spent dealing with environmental impacts from different energy development strategies; everything from coal bed methane to wind power to LNG [liquefied natural gas] terminals. All of these things are incredibly interesting issues and have significant environmental impacts that really matter to people. For this region, there is really no greater issue on the forefront of energy development than the Marcellus Shale.

Our first speaker is John Baillie with Penn Future, a Pennsylvania environmental group based in Pittsburgh. Our next speaker will be Phil Bender, an attorney in private practice in Pittsburgh. Finally, to balance the lawyers with science, Dr. Engelder.

JOHN BAILLIE: Thanks, Andrew. I work for an environmental conservation organization and have been following the Marcellus Shale developments for the past two years. This issue really came up suddenly. While we like to think that we have our ear to ground about what is going on in Pennsylvania with respect to environmental issues, this issue came out of nowhere in the beginning of 2008, and I think it caught not just environmentalists flat footed, but a lot of other people flat footed as well.

Landowners were selling their property, including drilling rights to their property, for literally pennies on the dollar. For example, people are now getting \$4,500 and \$5,500 an acre in some parts of

the state. Back in 2007, people all across the state were selling the same type of rights for \$50 an acre, just signing the form that the company gave them, and accepting it without reserving any rights for themselves. Subsequently, they experienced a tremendous amount of buyer's remorse.

The Department of Environmental Protection (DEP), which is the regulatory authority in Pennsylvania that is in charge of oil and gas drilling, only had about fifteen enforcement officers in mid-2008 and they were charged with looking after 50,000 operating wells and perhaps as many as 300,000 non-operating wells. So they were, understandably, very busy at that time. There is a lot more water around in Pennsylvania than there is in other regions of the United States. This means that there are also a lot more opportunities for pollution. During this time there was a tremendous amount of misunderstanding and chaos.

One way of looking at the Marcellus Shale is that it is drawing industrial projects to parts of the state that have never seen industry before. This creates a set of issues that would play up even if it wasn't gas drilling. For example, truck traffic and diesel exhaust; fragmentation-the loss of habitats and vegetative cover-which leads to erosion problems; water pollution problems; and noise issues. People are upset because they had a house that was sitting on a hillside and it looked down over a bucolic valley, but now there are five or six drilling rigs there operating twenty-four hours a day.

This is illustrative of the kind of change that people have to face. There are, however, more pressing issues which are unique to the gas drilling rigs. The first issue that I want to talk about today is groundwater contamination from drilling. Specifically, I will address what should happen to the water that comes back out of the gas well after it has been used to frack the well. The second issue I want to talk about is the radioactive materials that come back out of the gas well in some situations. Third, I want to talk about erosion and sedimentation control issues at the gas wells, which have proven controversial here in Pennsylvania. Finally, I want to talk about air pollution issues.

The first and the most important problem, and the one that gets peoples' attention, is groundwater contamination. Groundwater contamination is, and always has been, a risk that is unavoidable with gas drilling. There is a provision in the Oil and Gas Act that

specifically addresses what is to be done when a gas well contaminates groundwater. It happens often enough that the state has prescribed steps that people should follow to prevent contamination.

One thing that can cause groundwater contamination is failed casing and cementing of the wells. When a well is drilled, one is first required to put down iron pipe and then fill the hole between the pipe and the sides of the well with cement. The idea is to prevent migration of drilling fluids and gas from the well into the groundwater that surrounds the well. Once in a while, the cement does not hold up or the pipe fails at the top of the well. That allows the groundwater from down in the lower parts of the well to come up to the top and migrate throughout the drinking water aquifer, causing contamination. It can be contaminated with salt or methane gas from down below.

The second thing that can cause groundwater contamination is a failed frack pit. I have worked on three or four such cases myself in the last year. When they drill down into the Marcellus, a tremendous amount of water is used, which is highly pressurized by the pump. When the pressurized water comes back up to the surface, they put it into an impoundment. By law, they are required to build a pit which must be lined with a thick plastic liner and sealed. Once in a while, however, the lining can rip. When that happens, if there is a drinking water source downstream from the pit, contaminants from the pit will move into the drinking water source and contaminate the well. I had one case where four families were sharing a well in Indiana County and the total dissolved solids (TDS), pre-drill and TDS limit, or level, was forty-five parts-per-million. After the contamination, the registered level was 18,000 parts-per-million. TDS is a measure of sulphates and chloride salts that are dissolved in the water, and 18,000 parts-per-million is roughly half as salty as seawater. I guess the silver lining of this occurring is that the water becomes immediately so salty that no one would drink it. The remedy to fix the well is to call the driller, who is required to establish a replacement water supply. In the long run, the aquifer basically flushes itself clean in six months to a year, and then you can return to drinking it.

This is only true of contamination that occurs at the surface of the well. When contamination comes from a spill or a leak rather than from the fracking process itself, it can be a little more serious because when the fluids are used in the fracking process, there is liter-

ally hundreds of thousands of gallons of water. When the fluids leak out of the tank at the surface, they are in pure form and some of the constituents are very nasty things like benzene, for example. Another cause of groundwater contamination has been linked to seismic testing. Explosives used for seismic testing done in conjunction with the development of a gas well in Johnstown allegedly caused water from a deep aquifer contaminated with salt to move up through the fissures into the drinking water aquifer.

The next concern is how to dispose of the contaminated water that is produced by the drilling operation. When a Marcellus Shale well is fracked, as much as one million gallons of fresh water can be used. Some of the water stays down in the ground; some of it comes back up. The water that comes back up to the surface is heavily contaminated, so the question becomes, what do you do with it? State law prohibits companies from dumping it on the ground or into a stream.

The first option is to recycle it. This is being done on a larger and larger scale throughout the state. To recycle the water, it is purified to some extent and then pumped back down to be used again on another frack job. The second option is to take the water to a treatment plant. There are a small number of industrial treatment plants in Pennsylvania that are able to treat frack water. This is expensive, however, and can cause its own set of pollution problems because the salt that is taken out of the water must be landfilled as a hazardous waste. It takes a lot of energy to treat the water, which creates a set of air pollution issues that would not necessarily have existed before. Additionally, trucks must be used to haul the water around in parts of the state that are not used to a lot of truck traffic. So, you have traffic and air pollution issues caused by this as well. The third option is underground injection, where the polluted water is pumped back underground below the lowest known drinking aquifer. That is done on a very limited basis in Pennsylvania right now. There are only about a half-dozen operating injection wells.

The next thing I would like to talk about is naturally occurring radiation in the shale. New York State did a study on Marcellus Shale and it sampled about a dozen wells in counties in southern New York, just over the border from Pennsylvania. During this study, the state found elevated levels of radioactive materials in frack water from those wells. To give you some idea, the federal safe drinking

water standard for radium in water is five picocuries per liter. The water that was coming out of these wells had 18,000 picocuries per liter. This is disconcerting, as there is no treatment for radioactivity in water. You have to separate it from the water somehow and then treat it as a radioactive waste. The concern is that a large portion of it can end up in the water supply and cause some problems.

The next thing I would like to talk about is erosion and sedimentation controls in gas wells. A gas well is a large construction project that involves moving earth around. Each well pad encompasses a five- to ten-acre area. This is a real concern in parts of the state that have not seen a lot of development before, where the streams are relatively pure and the Marcellus Shale development is threatening those streams. The high quality and exceptional-value streams are in danger, and protecting them from pollution stemming from construction projects is a challenge.

My last topic is air pollution, which I have just begun to look at. Air pollution occurs at nearly every stage of the construction and drilling phase of an oil and gas well. When dirt is moved around at the well site, it creates dust and other fugitive emissions, on top of any diesel exhaust. When the well is drilled and vented, gases are released into the atmosphere in significant quantities, including methane gas and sometimes hydrogen sulfide. After the well is under control, it is flared for a while. That can produce toxins as well as greenhouse gases and sulfur dioxide. Other fugitive emissions are produced from the tanks and the pipes.

From a regional standpoint, there was a study done on the Barnett Shale in Texas, which is a shale formation similar to the Marcellus Shale, and it was found that the aggregate effect of oil and gas construction and resultant air pollution was greater than all vehicular traffic in the Dallas-Fort Worth area. A resulting problem is that these pollution levels threaten to knock the Dallas-Forth Worth area out of the acceptable range for the National Ambient Air Quality Control Standards, which would require the area to add additional controls all across the board. In Pennsylvania, Pittsburgh is facing the same air quality issues as Dallas, so the development of the Marcellus Shale in the counties around Pittsburgh is a concern.

PHILLIP BENDER: When determining the best possible locations for gas development, companies typically engage in a series of surveys and conduct seismic work in the area. Once the surveys determine

a site that is potentially going to produce gas, the company typically conducts a cost-benefit analysis regarding the potential that a particular location will produce enough gas to be, ultimately, economically beneficial to the company.

Drilling this type of gas well costs well over a million dollars, which is quite substantial in comparison to the history of gas well development here in the state. Most shallow gas wells in the state cost around one hundred thousand dollars to drill. There's been a hundred years of that kind of development in Pennsylvania and the surrounding states. So, when you're going to spend that kind of money, particularly on a program where you're going to drill forty, fifty, or sixty wells over the course of several years, companies consider very seriously where they're going to drill, and one thing that plays into that decision is a strategic choice about the potential environmental impacts of a given location. Where a particular well site is positioned in relation to creeks, residences, and groundwater supplies needs to be taken into account when siting a well.

Assuming a suitable location is found and investment made, two additional impacts must be accounted for. One is on the construction side, which tends to be temporary kinds of impacts that occur over the course of about a year to a year and a half. Then there is the longer-term production impact. Construction impacts start with access to the well and the well site. Accord must be given to erosion and sediment controls and spill prevention plans, and the company needs to think about how to develop the well to keep from contaminating the ground by dumping diesel, factory fluids, or anything else that's not allowed to be on the ground. Stormwater management is a big issue for many sites because it must be controlled once it hits the ground and managed so it doesn't end up in local creeks to add to the sediment loading.

Another thing that hasn't been mentioned is pipelines. Once gas comes out of the ground, how is it transported anywhere useful? Gathering lines are a small scale solution, but typically gathering line construction impacts are things like cutting a trench, clearing the area around where the pipeline is going to be, creating a right of way for the pipeline, dropping in the line, and closing it back up. Thus, the same kinds of erosion and storm water impacts tend to come into play. There are also all sorts of general construction impacts just from truck traffic and lots of construction equipment moving on to an off-road site.

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Additionally, there are issues of water use. It takes over a million gallons of water to frack a well, which often is drawn from local streams. Typically, a truck will pull up and fill up with several hundred dozen gallons of water. The water will then be transported to an impoundment near or immediately adjacent to the well site, which will store enough water to complete the frack job.

A frack job starts with about twenty trucks that all pull up to a wellhead. These trucks are semi-truck sized and have giant pressure pumps on them. This is actually another point where you can get air pollution concerns. Those trucks turn on all of their pumps, which force the water and a small proportion of fracking chemicals down into the well. Sand is intended to fill the gaps that the frack job produces. The process uses complex computer driven algorithms for cycling, but it essentially slams a lot of water and sand down 7,000 feet and along a horizontal section of the well to crack the shale rock and let the gas out.

Typically, about one third of the water sent down the well for fracking comes back as frack water waste, or residual waste. This carries potential pollution concerns, which has led a lot of the companies to look into recycling options. Some companies, in fact, have achieved one hundred percent reuse of that water. Whether that's achievable on an industry-wide basis remains questionable. It probably is not. Assuming it's not, the TDS waste disposal issue returns. And even if the TDS is treated, salt disposal issues still remain. There is no easy solution to the problem of the salts pulled out of this water that comes out of the well.

Once drilling is complete and a wellhead is placed on the well, then the issue of site restoration arises. Pennsylvania, like most states that allow oil or gas drilling, has pretty sophisticated site restoration requirements. Typically, the whole well pad must be restored back to a sort of natural terrain through reseeding. Issues at this stage include trying to control for future erosion and storm water issues.

Finally, once a company has reached production, concerns regarding collected produced fluids come into play. These are materials that come up out of the well and are collected, but are not gas. Typically, this is water contaminated with some materials from the subsurface that gets collected, treated as residual waste, and can lead to disposal issues. Finally, there may be maintenance or other

activities that someone has to perform on the wellhead to keep it operating or just to check that it's operating effectively.

TERRY ENGELDER: In the Dimock area, there are two separate issues that have made the news recently in terms of compromising the environment. The first was about a woman who had the top of her cement well blow off, stemming from the ignition of methane. That should be separated completely from another issue that came up, in which a set of fittings were compromised on one particular well pad and some hydraulic fluid with gel spilled out. The Pennsylvania Department of Environmental Protection (DEP) has issued two separate documents to deal with these two incidents, one of which is called a consent assessment of civil penalty. The civil penalty was assessed in the case of the fitting that broke with the hydraulic fluid washing across the land.

This is all public information. You'll find that in one of the cases of fittings, an O-ring failed. The most famous failure of an O-ring was the one that caused the space shuttle Columbia to explode. The nature of this one leak and the nature of the Columbia accident in 1987 are virtually identical.

The message here is that DEP is warning the residents of Pennsylvania that methane creeps up into the water supply commonly, and this occurs throughout much of the Appalachian Plateau area. This has nothing to do with Marcellus drilling. In fact, it happens in great parts of the state, where methane is dissolved in your drinking water. You drink methane every day just like you drink a can of coke and the gas dissolved in it.

I lead a group of researchers called the Appalachian Basin Black Shale group. We are coring the Marcellus where it is very near the surface. We take samples back to analyze and try to determine various things about the Marcellus. During the drilling of a well, when we core the well, normally the water that comes out of the well is translucent.

ANDREW C. MERGEN: One of the things that just became clear to me is the difference between contamination as a result of problems with the casings themselves and with the cement-like leaks, cracks, or poor work practices that might cause a failure. The overall sort of concern I think that is shared by many people in the public who are paying attention to this issue is that it's just not a good idea to

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put all of this water, maybe two thirds of which is left deep in the ground, 6,000 or 7,000 feet down, and just leave it there. It has chemicals in it. And at the end of the day, after we've pumped that water in the ground and that's where it stays, are there environmental issues? I want each panel member to address whether they are troubled by the fact that we are pumping large amounts of water deep into the ground and leaving it there.

PHILLIP BENDER: I agree with the distinction between work practices and the larger concept of what is to be done with the water that goes down into the ground. The short answer I suppose is that there are significant underground injection well programs all over this country that pump contaminated materials and frack water down into deep surfaces like this. The environmental question is, if you're putting 600,000 to 700,000 gallons of water down into the base of these wells, what is the environmental impact of those independent injections? I think the way to evaluate that question is by asking whether any of that water works its way back up. My understanding of the geology as a layperson is that it stays there. It doesn't work its way up because there are many layers of rock in between, preventing it from working its way back to the surface. I just don't think that that's a serious concern in comparison to how to dispose of water on the surface. I'm not troubled.

JOHN BAILLIE: I guess I'm a little troubled. As I understand, there are 5,000 well permits pending right now and considerably more than over the last couple of years. I certainly haven't seen any evidence of what's going on now, which is taking too much water out of the environment, so that streams are affected. I guess what I need to know in order to make a good decision is how does this compare to other uses that are going on in the state? I guess 600,000 or 700,000 gallons sounds like a lot to a home-owner who uses 300 or 400 gallons a week, probably. In terms of industrial usage, it isn't that large. So perhaps it's not all that big a concern. I'm a little troubled, but I guess it's also a secondary concern.

TERRY ENGELDER: I'm not troubled. Again, there are some facts that are very important, one of which is that hydraulic fracturing has been going on for sixty years in the country. There are no known instances where a fluid put 7,000 feet down has made its way back to the surface. The federal government passed the Safe Drinking Water Act in 1974, which regulates what goes into deep wells. There are a lot of deep wells. The depth of the Marcellus is such

that things far more dangerous than the frack fluids going into the Marcellus have stayed there for a long period of time. This is a scientific experiment that has been repeated over and over again for the last fifty or sixty years, not using Marcellus fluid, but using far more dangerous fluids. The federal government has a very good handle on that. There is a geological argument that I want to return to: the Marcellus is like an inflated balloon containing gas, and that inflated balloon has existed for 250 to 275 million years. If gas can't get out of the Marcellus in 275 million years, water's not going to get out of it with this set of chemicals in anthropomorphic time scales.

ANDREW C. MERGEN: I'm going to ask one more question. I'm going to call this the global citizen question. There was recently an article about the Marcellus Shale in the Washington Post last month. One of the people quoted in the course of this article was a gentleman named Bruce Nilles, a very prominent Sierra Club leader. He is primarily known for his work to get America off of coal energy. We're at a critical time in planning our energy future. Technology has advanced. We're looking at all sorts of options: coal bed methane; the Marcellus Shale; the Alberta tar pits; the oil sands; wind power. My question is whether it is worth taking a risk on Marcellus because, in your minds, as people educated in this area, it's better than some of the other options, or is it too risky?

PHILLIP BENDER: My personal view on this as a global citizen, aside from the people that I represent, is that we should make very careful and informed decisions about energy policy, and to the extent that energy policy and environmental policy come together, the decision is even more complicated.

My tendency, personally, is to err on the side of caution and be conservative. I certainly am conservative when I advise my clients about things like regulatory risks and how to deal with potential compliance problems. So, as a global citizen, on a scale of impacts of energy sources, natural gas has been talked about as relatively non-negative. It has obvious benefits over coal and tars. To the extent that it is a current technology that we can use as a bridge to a more renewable future, that makes sense as long as the extraction is done responsibly.

JOHN BAILLIE: I tend to agree. I view coal as perhaps the worst evil out there. Natural gas is a destructive process certainly, but it's

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much, much less destructive than coal. As a bridge to alternative energy sources in the future, it will be useful for us. I am cautiously optimistic about natural gas for the future.

TERRY ENGELDER: Human beings have to learn to become sustainable. That is another reality. That must occur in the next century. Natural gas will buy us some time, perhaps our children's generation and that's it. Once that's gone, we really do have to be energy sustainable.

III. Laws and Regulations Relating to Drilling [Panel 2]

ANDREW C. MERGEN: Our first panel educated us and helped focus us on certain areas of potential concern regarding the environmental effects of extracting the Marcellus Shale. This panel will explore the legal aspects and implications of that discussion for regulatory action, the current state of the law, and where the law should potentially reach. We have five panelists for this panel. First is Hannah Wiseman, who is a visiting assistant professor at the University of Texas. We'll follow that with Scott Perry, assistant counsel at DEP. Then, Tom Beauduy, from the Susquehanna River Basin Commission. Next will be Jack Ubinger from the Pennsylvania Environmental Council and then, finally, a little bit from Phil Bender again. We will start with Professor Wiseman.

HANNAH WISEMAN: As the outsider looking at the regulations as they read on paper, I will discuss the Marcellus Shale in the federal context as related to fracturing. I'm going to attempt to present a broad regulatory overview and I hope that those after me who actually bring suits related to these regulations or apply these regulations on a daily basis can give a much more accurate account.

From a legal perspective, hydraulic fracturing is a relatively unregulated practice at the federal level. This is an overstatement because there are many federal laws that do apply to hydraulic fracturing, yet in 2005, the Energy Policy Act exempted hydraulic fracturing from the definition of underground injection. Moreover, the reason that exemption was important is that the Safe Drinking Water Act requires states to protect underground sources of drinking water through the control of underground injection. That is a federal program. Therefore, although states administer it, they still must meet federal standards and receive approval from federal entities. Although the injection of waste from the fracking process is

regulated, the practice of hydraulic fracturing itself does not currently fall under the Safe Drinking Water Act.

In terms of hazardous waste, many hazardous substances in the United States are regulated under what is called the Resource Conservation and Recovery Act (RCRA) and are listed by the EPA under this act. Congress regulates hazardous waste from inception to disposal under this act, and it tasks the EPA with listing the regulated substances. Congress also instructed the EPA, when it passed the RCRA, to consider whether or not to regulate oil and gas waste for exploration and production—what are often called E and P wastes.

The EPA made this consideration in the 1980s, looking at the many hazardous substances involved in all types of oil and gas production. It eventually made the determination that it would not regulate hazardous wastes involved in oil and gas exploration and production (E&P) under RCRA Subtitle C. This subtitle is the only exemption for oil and gas hazardous waste. Therefore, other portions of the RCRA might potentially apply.

In addition, the reason I mention the listed wastes and the mixture rule is that some of the substances that the EPA has listed as hazardous in its regulations under the RCRA do appear in fracking fluids. Hazardousness, of course, depends on concentration and quantity of the substance. Therefore, it is possible, depending on the concentration and total quantity of these chemicals in fracking fluids, that they would not even normally count as hazardous. My point is that some of these chemicals, if they were not categorized as oil and gas E&P waste, might otherwise possibly be considered hazardous under RCRA Subtitle C, for example toluene and acetic acid.

Another federal statute that is very important to hydraulic fracturing is the Clean Water Act. The National Pollutant Discharge Elimination System (NPDES) prohibits the discharge of pollutants into waters of the United States without a permit. This is why fracking operators cannot put flowback water and other contaminants into waters, or into a pit to the extent that they will flow out of the pit into waters, without a permit.

I think an interesting question is how states are regulating this practice because much of the responsibility has been left to them. I am going to discuss the states that overlay the Marcellus Shale alphabet-

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ically, so as not to favor any one state. Moreover, I included Maryland because even though it is not typically considered one of the major Marcellus states, it has passed some related regulations. The Maryland Department of the Environment is the entity that is passing some of these new regulations, or at least putting up information on its website.

Something to mention upfront when discussing the varied state regulations is that most of the regulations I will talk about were already in place prior to the great increase in fracking. Therefore, what we are seeing is the application of traditional oil and gas regulations to this new practice. In many cases, states have revised their regulations to include mentions of terms like fracking fluid or fracturing. However, in Texas for example, you will see almost no mention of fracking, so you have to guess at where this particular operation falls within the regulation. In addition, this matters for things like disposal of the flowback water. How should flowback water be characterized when it is disposed of? This is important because in places like Texas, pits that have certain types of substances in them do not need a permit at all. So, depending on how one defines flowback water, a permit for a pit might be required or not.

Maryland already has regulations relating to the construction of access roads and well pads, which of course have been required for drilling all along, but will also be important for fracking operations. Moreover, it has an environmental assessment requirement. Any fracking operator submitting an application must attach an individual environmental assessment form and indicate whether the access roads will cross any streams, particularly higher quality tier-two streams. Similar to Pennsylvania and other states, some sort of sediment and erosion control plan must be submitted as well as a spill prevention control and counter measures plan, and a drilling and operating reclamation plan.

Maryland has added some regulations, however, that are specific to the Marcellus. There is a form called the Marcellus Shale Wells Hydrofracturing Addendum that must be attached to the permit to drill. This is where you will often see additions of regulations that specifically address fracking. In this addendum, the applicant must indicate the location of the treatment facility to which it will be sending the flowback water, as well as the contents of the fracking fluids. Therefore, some states are starting to require these types of disclosures. In addition, you will also see regulations relating to in-

formation about the water that will be withdrawn. Most states are concerned with this and, as part of their regulations, are requiring some sort of water withdrawal information in applications. Specifically, in Maryland, the water appropriation and use permit is being used.

New York is engaged in one of the largest regulatory transitions, calling it a Supplemental Generic Environmental Impact Statement (Impact Statement). New York also has a State Environmental Quality Review Act (SEQRA)—like other states that perform some sort of environmental review of impacts that might have an adverse effect on the environment. The Impact Statement is the document that is required under the SEQRA.

New York already completed one generic environmental impact statement for drilling in 1992. However, New York decided it needed to complete this supplemental generic environmental impact statement because of the increase in proposed hydraulic fracturing and, particularly, what New York calls high volume hydraulic fracturing. The state first defines, starting at around 80,000 gallons of water used in the fracking operation through 299,000 gallons of water, what could be a high volume hydraulic fracturing job. This also depends on other things like where the water is being taken from and what types of chemicals are being used.

These high-volume fracturing activities have the potential to be regulated under the New York Supplemental Environmental Impact Statement, and any fracturing job that uses more than, or equal to, 300,000 gallons will have to meet the conditions in the Supplemental Generic Environmental Impact Statement. Therefore, regulation in New York is going to consist of your typical oil and gas regulations within a state code and the existing Generic Environmental Impact Statement completed in 1992. These impact statements contain conditions that oil and gas operators must meet in addition to the code. Even though it's just called an Environmental Impact Statement, once it's finalized, it becomes the conditions that must be met.

Finally, once the Supplemental Generic Environmental Impact Statement is finalized, it will be the final document setting forth other conditions that fracking operators must follow, and that supplemental document will only apply to the high volume frack operators. On the whole, New York has a very complex regulatory

scheme. One of the central documents that will be required for high-volume fracking operators is called the Environmental Assessment Form Addendum (Addendum). This Addendum will be required for the high-volume frackers and is in addition to the environmental assessment form that is already required. On the Addendum, fracking operators will have to provide the composition of the fracking fluid, as well as indicators of toxicity and how much fracking fluid might be used. Overall, New York has proposed a very comprehensive regulation that, if the Supplemental Generic Environmental Impact Statement passes as it is proposed, will become finalized once the agency looks at all the comments and will regulate many aspects of the fracking operation.

Ohio, like other states, requires a permit for an application to drill before any drilling activities occur. In addition, Ohio has added special requirements for those applying to drill in urbanized areas. This has been an interesting issue in Texas, and I think Ohio has similar concerns because fracking may be occurring in relatively populated areas. Ohio has said it is particularly worried about this issue and is therefore going to require some extra elements in urbanized areas. For example, pits must be closed sooner. Some impoundment pits located in urban areas must be closed within thirty days, or sooner, of the completion of drilling if required by the agency chief. Further restrictions are being added for these areas, as well as best management practices for oil and gas well site construction. These best management practices address things like access roads, well pads, and the erosion of soil into water. Ohio already had these best management practices in place for oil and gas operators, but it is requiring them for fracking or drilling in the urbanized areas, making them mandatory where fracking occurs.

Pennsylvania, as mentioned, requires disclosure of the ingredients in the fracking fluid to the Department of Environmental Protection, though several states do not. My understanding is that the disclosure is called the Preparedness Prevention Contingency Plan. Additionally, Material Safety Data Sheets must be provided. Pennsylvania also maintains a special code for fracking fluids. Again, many states have not even managed to recognize that fracking is a new part of oil and gas drilling. Pennsylvania, however, has done so. The state is also at the forefront of active enforcement, conducting a number of inspections which found many violations and led to some fines.

West Virginia is also moving forward quite quickly with its own regulations. There are recent proposed changes to the West Virginia Code of State Rules. There are even more requirements for what is done with a site after the fracking, in terms of reclamation, requirements for pits, and the safety of the storage pits. Examples include maintaining adequate free board (enough space to ensure that pits will not overflow) and a proposal that the pits must be lined, as many states do not currently require a synthetic liner in the pits to prevent the infiltration of water.

West Virginia has also aggressively embarked upon inspections of impoundments. Therefore, both the fracking water stored on the site to be used and the disposal impoundments or containment impoundments are being inspected. This means engineers go out and see whether the sites are safe, essentially whether these impoundments are going to allow discharges that West Virginia wants to avoid. West Virginia is primarily focusing on wells in the Marcellus area because it is finding that these are where very high-volume impoundments are.

This is just a comparison of some of the information that must be provided on various forms submitted to state agencies before drilling and fracking occurs. You will see here that all the states that I have talked about have some sort of requirement to show where the drilling and fracking will occur with respect to other water resources. Pennsylvania requires quite a bit of disclosure in terms of surface water bodies and often will require companies to list water bodies within a particular distance. West Virginia, however, does not have a distance requirement. In addition, there are requirements that fracking operators indicate on the drilling permit application whether there are water wells near the drilling. I have not found that requirement in Ohio. So, right now, only New York and Pennsylvania require that sort of information. Maryland is requiring it on its addendum to the permit; however, it is not yet in any regulations.

Also, there are differing regulations with respect to how to hold on to the flowback water and other wastes before their ultimate disposal. There are only three states so far within the Marcellus that are requiring a synthetic pit liner. Other states view clay or other impervious materials at the bottom of the pit as sufficient to prevent infiltration. In West Virginia, a liner requirement has been proposed, but has not yet passed. Some states also have time limits for

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how long the pit containing flowback water or other fluids can stay on the site. Therefore, there are various time requirements for how quickly the pits must be closed.

SCOTT PERRY: Pennsylvania has a long history of oil and gas well development. We're the birthplace of the North American oil industry. When I first started working in the Pennsylvania Department of Environmental Protection in 2000, the bureau director there told me that we were putting an industry to bed. Well, news of the oil and gas industry's demise in Pennsylvania has been greatly exaggerated. We've been seeing record numbers of permits issued every year, except for the past year, when the economic recession significantly impacted well drilling in Pennsylvania, along with the moratorium put on oil well drilling in the Allegheny National Forest. Right now, Pennsylvania has about 121,000 active well sites. We think 350,000 wells have been drilled in Pennsylvania since 1859. We have information on about 225,000 of them. So the difference between 225 and 121 are plugged or abandoned wells.

In terms of Marcellus Shale activity, there has been a lot of attention paid by the newspapers and obviously people have a great deal of interest in it. Well permitting has grown exponentially, but it still makes up the minority of well permits that we see today. In 2008, when we had 476 well permits, we were projecting 700 and we got almost 2,000 applications. We have been told by the industry that we can expect 5,200 applications. So far those numbers haven't quite matched, but we can expect to see a lot more Marcellus Shale activity, maybe even overtaking our traditional well drillers. Of course, other issues arise, such as the time lag between wells being drilled and when the permits are issued. And some wells are never drilled despite being permitted.

There are three laws administered by the DEP. My focus today will be on the Oil and Gas Act, but I will mention the other two. The Coal and Gas Resource Coordination Act does what it says. It exists to coordinate the activity between the two extraction industries in Pennsylvania. Drilling and mining companies have two very different prerogatives. Given the expense of digging around wells so mining companies can mine the area, the two industries cannot agree on how to space wells and mine the coal. If no private agreement is reached, it is likely that these procedures will be decided legislatively or judicially.

The Oil and Gas Conservation Law (OGC) is a correlative rights statute. It applies to deep wells, and therefore does not apply to Marcellus Shale activities. There are approximately 11,000 wells permitted in the state of Pennsylvania that are deeper than any of those used for Marcellus Shale activities. The Marcellus lies on top of a defining horizon called the Onondaga Horizon. The OGC covers wells drilled below 3,800 feet. If a well does not reach 3,800 feet in depth, it is not subject to the Conservation Law. Conservation laws are prevalent in Wayne County, governed by the Delaware River Basin Commission, despite the fact that there is very little mining activity.

Well permitting is very limited in Pennsylvania. In 2008, only 8,000 well permits were issued. The main consideration for permit approval is location. In addition, there are basic spacing requirements from the wells and springs, included in the Coal and Gas Resource Coordination Act and the Conservation Law.

The function of the permit is to determine where the well will be located. The current regulations cover every aspect of drilling and afford notice to the surface landowner of any activity. The proximity of a well to a water supply is another concern. In order to be approved for a permit, the applicant must prove that it has given adequate notice to the landowner and, in addition, prove that it has resolved any and all threats to endangered species. These requirements make the permit application process difficult on the applicant, rather than the DEP.

Once an applicant company has received a permit, it must then figure out how to drill the well. There are currently draft regulations on the DEP website that would strengthen the casing and cementing requirements. These strict requirements are absolutely critical to protect groundwater resources. In order to do this, the DEP requires pressure-testing for well casings used in high pressure wells. The use of welded casing especially requires this testing. A surface casing may not be used as a production casing in instances where cement is not circulated all the way back to the surface. Gas migration is another concern, and many new provisions are being added to prevent these occurrences. It is likely the industry would agree that no instance of gas migration is acceptable. It can and must be avoided because of the threat to public health and safety. It is entirely unacceptable.

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Another important progression in the new regulations deals with legacy wells. The regulations will require operators to inspect those wells quarterly, making sure the pressures are not too high and that the casings are intact and structurally sound. If they're not, operators have to tell the DEP immediately and begin remediating any aspect not meeting the requirements.

The DEP is still in the process of codifying case law regarding the contamination of a water supply. Water supply impacts have to be permanently restored, and companies are required to provide a permanent source of income to make up for any increased cost. For example, if a landowner has to have treatment equipment put on his well which wasn't there before, the operators are going to have to come up with subsidies to pay, in perpetuity, the increased cost of that supply. The idea is to make the homeowner whole.

As part of these new regulations, operators will have an affirmative duty to investigate stray gas instances if the homeowners complain. Operators are now required to immediately take action upon a homeowner's complaint. In addition, the operators must inform the DEP immediately of the complaint and then affirmatively investigate the situation, rather than wait for the Department to issue an order. These requirements evidence the severity of the situation.

There has been controversy over the use of NPDES permits for storm water control. The Energy Policy Act of 2005 added some additional language to the Clean Water Act to strengthen an existing exemption for the oil and gas industry. As a result of that exemption, the Department moved to a different permitting process. The DEP has a state permit, the Erosion and Sediment Control General Permit. After the state permit was created, the NRDC sued the EPA over the regulations implementing that change. Later, the Ninth Circuit invalidated those regulations, resulting in invalid regulations that were based on a statute that still exists. As a result, the EPA is not requiring NPDES permits for storm water construction, but states may.

There is a permit process in place now for earth disturbance activities. If an operator disturbs five or more acres, it will need a permit. Earlier, it was characterized as a permit-by-rule, although I disagree with this characterization. After a licensed professional certifies that the application meets the Department's requirements and reflects conditions on the ground, the DEP then looks through the

permit application to make sure that it's administratively complete. Completion requires that all the necessary materials are actually there. Then, the Department will go out in the field and inspect the site.

The aforementioned discussion is applicable to all wells. Marcellus Shale activities are largely responsible for bringing to light the issues raised. Marcellus requires large volumes of water, and the Susquehanna River Basin Commission is doing an excellent job of managing that use. The Department has a duty to protect and maintain water quality for surface waters. Quantity and quality have a direct relationship. The DEP makes an effort to prohibit operators from drawing down streams and water bodies in the Commonwealth that will impact and impair water quality. Requiring submission of a water management plan for approval allows the DEP to ensure that designated uses for water are maintained and protected.

Large, centralized fresh water impoundments served to relocate surplus water. These were never addressed by the DEP's regulations. However, large, centralized impoundments of up to 15 million gallons were being used to store wastewater. The DEP now requires a permit for such impoundments. The DEP will issue a permit only when the operator has demonstrated that the pit was constructed soundly using best engineering practices, with a thirty-millimeter liner that is used in landfills. When an impoundment is proposed to be in a location that has the potential to break and jeopardize property or impact wetlands, the operator must get the approval of the DEP's safety staff. So far, none of these impoundments have threatened peoples' health or safety.

The main issue now is what to do with the water. In Pennsylvania, the DEP will inquire as to how much excess water came out, where it was taken from, and who relocated it. In addition, the Department is informed of the contents, by requiring an operator to fully chemically characterize the waste. This information will be submitted to the DEP and must be available to the centralized or publicly owned treatment works to take the wastewater. No wastewater can be moved without first obtaining permission from the DEP.

The constituencies' concern is total dissolved solids (TDS), particularly chlorides. The chlorides in flowback water can range from a couple thousand milligrams per liter to 300,000 or 400,000 milli-

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grams per liter, far saltier than the ocean. The traditional method of dealing with TDS across the nation is dilution. The DEP has developed a strategy to end that practice. The Department has proposed regulations to impose TDS limits on all new or expanded discharges of high volume TDS. Those regulations are being debated by the DEP's Water Resources Advisory Committee and are open for public comment. These regulations will have a significant impact on disposal of wastewaters in Pennsylvania.

One of the best ways of getting rid of high TDS fluids is underground injection. Pennsylvania doesn't have the geology for it, to my knowledge. The best geology available is currently being used by Pennsylvania's sixty-five natural gas storage fields. If we could take a gas storage field out of use, maybe we could use the area to inject the TDS, though this would raise natural gas prices for homeowners. Right now, it doesn't seem like an option.

Of the eight underground injections that are permitted in Pennsylvania, only one is really open for commercial use. It can take 800,000 gallons a month. The underground injection control well simply is not going to be able to accept this volume when a single well can produce a million gallons in flowback. So, other methods of dealing with wastewater are being explored.

Reuse of water is very prevalent now. Operators are approaching one hundred percent recycling levels, but we have to see more of that. And there's still the need to dispose of the salty sludge left over. We have people telling us they've got the wastewater treatment plant that's going to solve the problems, but they do not solve the issue of what to do with the leftovers.

The DEP has recently been concerned over radiation issues, an issue that has been known to the oil and gas industry for decades. The issue of concern here is exposure levels for the truck drivers and the workers to radio nuclei. The 226 and 228 are basically contained within the aqueous solution and do not present an exposure risk, nor does the shale itself. To put this in perspective, granite countertops, common in homes, are more radioactive than the Marcellus Shale. Approximately twenty picocuries per liter is the exposure level of some of the shale, so it doesn't present an exposure risk.

The title of this program is how the Marcellus Shale should be regulated. Instinctively, it should be regulated based on sound science and good policies. The DEP is taking its time and making sure we've got the facts straight before we take any actions, but it is constantly evaluating the situation and taking appropriate actions as needed.

THOMAS W. BEAUDUY: The Susquehanna River Basin Commission (Commission) was formed by the enactment of a federal-interstate compact by Congress and the member states. Under federal law, Congress provided its consent pursuant to the Compact Clause in the Constitution. The regulations of the Susquehanna River Basin Commission are contained in Title 18 of the Code of Federal Regulations, parts 806 through 808. Any decision of the Commission involves the approval of all four of the signatory parties, which include the states of Maryland, Pennsylvania, and New York, as well as the federal government.

The Commission has full water resource management authority, as the states delegated their sovereign jurisdiction over water pursuant to the compact. The Commission does all the water allocation work in the Susquehanna Basin, which begins at Cooperstown, New York and ends at Havre de Grace, Maryland. The Commission is also charged with all of the interstate water allocations. The Supreme Court has original jurisdiction for disputes over water between states, though the Court prefers not to exercise that authority. Instead, in 1963, the Court in *Arizona v. California*¹ reaffirmed that Congress has the lead for either making allocations or statutorily providing for an allocation process, and our compact is consistent with that. A further duty of the Commission is the regulation of diversions of water. Diversions in and out of the Susquehanna Basin require Commission approval in a public hearing process more elaborate than for normal regulatory decisions.

The Susquehanna Basin comprises about fifty percent of the Commonwealth of Pennsylvania. This basin comprises what I call the "sweet spot" of the Marcellus formation. Specifically, the north central region of Pennsylvania is a very attractive location for the Marcellus industry. There has been a lot of development activity in this region which began very quickly. In fact, in early 2008, we didn't even know this was coming—it's been a development tsu-

1. 373 U.S. 546 (1963).

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nami, and we have been going through regulatory triage ever since the industry came to town. This placed a huge burden on our regulatory structure and has since prompted a number of regulatory modifications. This maturation of the regulatory program is being driven both from a policy standpoint and from an industrial standpoint. The goals of these changes are to ensure that the regulations are responsive, cover the uniqueness of the industry, and advance sound public policy as it relates to environmental protection and sustainable water resources.

The Commission generally regulates water withdrawals over a 100,000 gallon-per-day threshold for ground and surface water throughout the basin. For consumptive use, which is water that is taken but not returned to the basin, it is over 20,000 gallons per day. For diversions, the Commission has two different standards. Water that is leaving the basin is generally not regulated if the amounts are de minimus (less than 100,000 gallons per day), but water that comes into the basin is regulated by the gallon due to concerns over the introduction of exotic species and water quality.

The Marcellus industry as a water user is regulated by the same standards applicable to all users in the basin. Surface water withdrawals are subject to a fairly comprehensive review. We look at stream classifications applied by member states and aquatic resource surveys. These are fairly extensive surveys, which we don't do if we have contemporary data. These surveys provide stream profile data, including cataloging of the biota and aquatic habitat, the impact of the withdrawal on the receiving stream, and the cumulative impact of these withdrawals on a large watershed scale, a sub-basin scale, and then on a full basin scale. There are a lot of withdrawals approved every year, and the industry has certainly added a lot to the mix.

The Marcellus Shale drilling industry is a different industry from what we're used to. The Commission's regulations were really designed to deal with facilities such as a manufacturing or power plants located on the bank of a river or stream, which used a dedicated quantity of water withdrawal. There was intake, a dedicated amount of water, or a range of withdrawal quantity, and the Commission knew the fate of that water (i.e. what percentages were discharged and consumptively lost) due to the fairly static conditions.

With the Marcellus industry, the water withdrawals are nomadic. Each company may need 100,000 gallons a day from a stream, may

want as many as forty or fifty locations, and they want operational flexibility. They don't always know where they will be drilling in any given month because of constantly changing conditions. This made for a decentralized use of water, a condition for which the regulatory program was not designed. Therefore, the Commission has since made several modifications to make it work more effectively.

Long-standing rules and methodologies are still used, however, by the Commission, the Pennsylvania Fish and Boat Commissions, and the DEP to evaluate the impact of withdrawals, with a particular emphasis on high-quality streams. These organizations are working toward a major environmental flow analysis that will result in target flows for every sub-basin, as well as the basin overall. This analysis will drive decisions in the regulatory program and provide the analysis performed on each withdrawal.

Pass-by evaluations are done. The Commission is evaluating whether water can be taken at the requested quantity year-round from a particular site. If it cannot, we impose a pass-by condition, meaning certain times during the year when such water intake cannot be utilized because the withdrawal would otherwise have too great an impact on that stream or other users in the vicinity. Certain basins, including the Chemung River Basin in New York State, have a very low natural base flow. Therefore, there is a much greater cumulative impact from withdrawals during low-flow conditions because of that natural condition. Pass-by evaluations are done on every withdrawal and, particularly in these areas, almost any proposed withdrawal will be subject to a pass-by in order to minimize the withdrawal's impact.

The Commission also regulates consumptive water usage on a cumulative basis because increases in consumptive use change the water balance and therefore affect flows. Consumptive water is water that is lost from the basin and not returned through any natural system. This is of particular significance in drilling because one hundred percent of the water that goes down the bore hole is considered lost to the basin. There may be some amount of water that is returned and put back in the system post-treatment, but it is *de minimus* in terms of the overall volume of water.

From a regulatory standpoint, this water use is categorized as consumptive use in the basin so that the Commission can examine the

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industry, analyze its water use, and therefore be able to project its overall impact on the water resources of the basin as a whole. Mitigation on usage is required on a one-to-one gallon basis. Many companies are paying a fee that goes into dedicated funds used to acquire water storage. Most of these storage facilities are at an Army Corps facility and are used to make low-flow augmentation releases during periods of drought in an attempt to balance the system.

The Commission did not have a regulatory program that was designed for the Marcellus industry. The Commission initiated an approval-by-rule process as soon as the industry came to town. It took nearly \$2 million of fines paid by the industry to get its attention. The commission and the industry then began working progressively, positively, and constructively ever since.

The Commission took the stance that the industry had to wait for withdrawal approvals, like everyone else, while aquatic resource surveys were first completed. The industry needed to get in line and plan for water months in advance. They had a lot of infrastructure and hardware that they were paying a lot of money on, but they had to wait on withdrawal approval.

At that time, we had a provision in our regulation that allows companies to go through an approval-by-rule process to take water from public water suppliers. Because environmental reviews had already been conducted on the withdrawals of the public water suppliers, we know what those impacts are. Public water suppliers are approved for a certain quantity of withdrawal. The Commission took the stance that if public water suppliers had any excess and wanted to sell it to the industry, that was fine. The industry ran with this procedure, starting in mid-2008, and almost all of the water used was coming from public water supply systems from that point forward, at least in the Susquehanna Basin.

Problems arose, however, due to the structure of the Commission's rules. The rules dictate that before construction on a project is initiated, Commission approval is required. For example, if a company is going to build a plant and it knows it is going to use a million gallons a day, it needs to get that approval before it initiates construction. For this industry, drilling an exploratory well can lead to uncertain estimates. The problem is that actual gallons are not known until midway through the process. In this case, however,

if the industry has initiated construction, then the Commission's rule has been violated. To clarify the process, the Commission decided to throw out the threshold requirements as they relate to the Marcellus industry and insert a blanket approval requirement. The industry agreed to the requirement that if it was taking any water at all, it needed to have Commission approval to do so.

The Commission modified its approval-by-rule process to add a provision tailored specifically to the Marcellus industry. Approvals are issued on a drilling pad basis, primarily to track water usage. The Commission doesn't set casing standards and isn't trying to regulate the disposal of fluids; the state of Pennsylvania does that. Similarly, the state of New York will be implementing a program consistent with the Supplemental Generic Environmental Impact Statement it is about to issue. The bottom line is that states are best-equipped to regulate water quality activity. The Commission does not profess to know what integrity standards are needed for casings—that's the business of the state agencies. The Commission is interested in water, where it comes from, where it goes, and how it affects the balance of the overall system.

Thus, the Commission revised its approval process in order to issue drilling pad approvals. It is now in a digitized form, which the industry can access electronically. This eases the administrative burden of all the paperwork associated with issuing pad approvals. Moreover, it preserves the Commission's resources to conduct the substantive reviews on withdrawal applications, which is much more important as it relates to managing water resources.

The Commission also tried to incentivize the industry to use lesser-quality water, rather than taking it from pristine trout streams. This, however, led to its own problems in that people did not want to let the industry use acidic mine drainage to frack a well. On the other hand, by doing so, the Commission is keeping the acidic drainage out of the stream and keeping the industry from taking high quality water. Yet, concerns persist. If the frack standards aren't adequate, then that's just more contamination that potentially could wind up in local water groundwater systems, according to some. Thus far, to the extent there have been problems, it has been because of non-compliance with state standards or another problem or accident. This is why we require companies to certify their compliance with all state standards.

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The Commission subsequently conducted another round of rule-making and further progress was made. The industry started to accept the fact that pass-bys are needed on a lot of the headwater streams in order to protect them, but they also need water. Some companies had received less favorable stream access agreements than others, and these companies requested a change to the Commission's regulations to facilitate water sharing amongst the industry participants. The Commission agreed that this arrangement made sense to protect headwater streams, particularly during low-flow conditions and times of drought. The Commission's regulations were modified to provide that kind of flexibility for the companies.

The Commission has been quite active, with 391 pad approvals issued in 2009. As of early 2010, the Commission was on track to be issuing around one hundred pad approvals per month in the Susquehanna Basin. On the surface water withdrawal side, 103 approvals have been issued to this industry. Most of these came in the areas with drilling activity. Additionally, the Commission anticipates many more surface water withdrawal approvals. To date, however, there have been no requests for groundwater withdrawals for this industry. If there have been any landowners letting companies drill wells and take water without Commission approval, they will be subject to discipline unless they're outside the Susquehanna Basin.

The Commission requires a lot of reporting by the industry, specifically to get a clear picture of its use. The Commission requires metering and monitoring plans, as well as a post-hydrofracture report from the industry. The Commission has reviewed the data and determined that water usage is a bit different from what was projected two years ago. It was predicted that, on average, 2.7 million gallons of water would be used for each frack operation. The reality, however, is that the number is closer to 5 million. That includes exploratory activity and some of those fracks are in the 400,000-, 500,000-, or 600,000-gallon range. The reports indicate that the companies are using about a million gallons per thousand feet of horizontal lateral. The Commission is currently considering applications, which propose to go out as far as two miles with those laterals.

The Commission has also measured its rates of return of flowback. The reports indicate about fifteen percent of the fluids that are put down the well come back, which contrasts with earlier projections in the thirty to forty percent range. Of that fifteen percent that

comes back, about half of it is being reused. That figure is an industry-wide average and is extremely good news. Some companies are going for one hundred percent re-use, but the Commission believes even an industry-wide average of fifty percent would be significant and a trend which will continue. The bottom line is that only about five percent of the water going down the hole in the Susquehanna Basin comes out and needs treatment.

The Commission does a lot of monitoring work. It is in the process right now of deploying equipment that can be placed into streams which will monitor water quality parameters remotely, continuously, and in real time. These parameters are then transmitted via cell or satellite to our mainframe. This process will be transparent, with a network of data sondes throughout the Basin, and particularly in the Marcellus area, so anybody can see what the water quality conditions are and where the sign locations are. The Commission's "Phase 1" goal was to have thirty stations up by June of 2010.

Ironically, when a member of the industry heard that the Commission was going to implement this system, he asked how much the equipment cost. The company then wrote out a check for \$750,000 because it had an interest in this process being transparent. The company wanted to convince the public that it was playing by the rules and fully endorsed the Commission's real-time water quality monitoring.

The Commission predicts that when the Marcellus project reaches full development, 28 million gallons of water per day will be used by the industry. By way of comparison, the golf industry uses twice that much per day for irrigation operations. And an individual power plant can use 4 to 5 million gallons per day. So, in the scheme of things, the Marcellus water use is not significant. In the end, the real issue on Marcellus is the timing and the location of withdrawals. The Commission is concerned about protecting the high water streams and that withdrawals are not having an effect on the cumulative impact side. As discussed, there are a lot of initiatives being taken to make sure that isn't an issue moving forward.

JACK UBINGER: The Marcellus Shale play is important for the Commonwealth and for the energy conversation in the country generally. The development of shale gas resources in Pennsylvania

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should move forward, but only if it is conducted in manner that is protective of human health and the environment.

It is important to recognize that Pennsylvania has been down a similar road in the past. In the nineteenth century, it started with the exploitation of natural resources such as timber, coal, oil, and gas. We are still paying to mitigate the adverse environmental consequences that are the legacy of those prior natural resource extraction practices. The Pennsylvania Environmental Council's overarching objective is that when the Marcellus Shale play has run its course, we shouldn't see a repeat of the negative legacy of prior natural resource development in the Commonwealth.

It is fair to say that, prior to 2007 or 2008 when Marcellus Shale well development activity ramped up, Pennsylvania's regulatory framework did not contemplate the complexity, scale, or intensity of the activities associated with the development of unconventional shale gas wells. In addition, the Pennsylvania DEP did not have the administrative capacity to adequately deal with the volume of well development permit applications that have been submitted at an ever-quicken pace or the compliance monitoring demands of the ensuing surge in well development projects. Consequently, Pennsylvania was confronted with the challenge of a tremendous boom in natural gas development activity with insufficient resources to deal with it and an obsolete regulatory structure that requires significant alteration.

The Pennsylvania DEP has taken steps to substantially increase its administrative capacity through a concerted effort to add personnel to the Oil and Gas bureau. The funding for this initiative is provided by additional revenue from an increase in the permit application fee schedule authorized by legislation enacted by the General Assembly in 2009.

The alteration of the regulatory structure involves legislative and rule-making processes which require the reconciliation of diverse interests and, often, a substantial lapse of time. The process is complicated further by the fact that activities associated with oil and gas well development are covered by a multitude of statutes and regulatory programs in addition to the Oil and Gas Act; e.g. the Clean Streams Law, the Solid Waste Management Act, and the Air Pollution Control Act.

I am supposed to say something about potential federal involvement in the regulation of shale gas development. In that regard it should be noted that each of the above-mentioned Pennsylvania statutes has a federal counterpart: the Clean Water Act, the Resource Conservation and Recovery Act, and the Clean Air Act. Another potentially applicable federal statute is the Safe Drinking Water Act, particularly the “underground injection control” permit program for waste disposal wells established by the act. At the present time, Pennsylvania has not sought delegation of authority to administer and enforce the underground injection control program for the disposal drilling wastes so there is no state counterpart. As indicated by other speakers, the hydraulic fracturing of shale gas formations is currently exempted from regulation under the Safe Drinking Water Act. Senator Casey has introduced a bill known as the FRAC Act which would bring hydraulic fracturing within the coverage of the Safe Drinking Water Act.

Pennsylvania has responded to the regulatory challenges on several levels. First it has revised parts of its technical guidance for oil and gas well development and its permit application forms to address the issues raised by Marcellus Shale development. These kinds of revisions don't have the stature of statutes or regulations but can be made more expeditiously than amendments to statutes or regulations. In my view, the DEP deserves credit for taking these interim steps in advance of completing amendments through formal rulemaking processes.

Second, the DEP has formulated amendments to several regulations and has proposed them for promulgation by the Pennsylvania Environmental Quality Board. For example, the DEP has proposed amendments to 25 Pa. Code Chapter 95 (relating to wastewater treatment standards) to establish new treatment standards for total dissolved solids and certain other constituents found in wastewater generated by oil and gas development; amendments to 25 Pa. Code Chapter 102 (relating to erosion and sedimentation control) to add new requirements for the construction of well pads, including post construction operation and maintenance requirements; and, just yesterday, the DEP announced on its web site proposed amendments to 25 Pa. Code Chapter 78 (relating to well development standards) that address such issues as well casing and cementing standards, and well inspection protocols. These proposed regulations will become effective following promulgation by the Environ-

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mental Quality Board and review by the Independent Regulatory Review Commission, a process that could take a year or more.

On the legislative front a number of bills to amend the Oil and Gas Act have been introduced by legislators. One bill of particular note as far as I am concerned is Representative George's bill to substantially increase the dollar amount of bonds required to assure that wells will be properly decommissioned at the end of their productive life. We believe that it is very important to take the long view as we address Marcellus Shale development today. It is hard to predict which if any of the pending bills will be enacted in this legislative session.

Pennsylvania has begun to amend the legislative and regulatory structure governing the development of unconventional shale gas wells. However, much remains to be done and it is important that the General Assembly and DEP complete this work as expeditiously as possible.

Returning to the question of federal involvement, as indicated earlier, there is the potential for federal involvement. It seems to me that federal involvement needs to be considered carefully. If you look at the shale plays around the country, you will note that there are considerable differences in the facts and circumstances surrounding the development of oil and gas resources from region to region in terms of geology, topography, and climate. The question will be: are there areas with enough commonality to be effectively regulated by nationally applicable standards? It may very well be that effective state regulation, tailored to the characteristics of the region, will prove to be more protective. However, federal involvement may be required in the event of a default at the state level.