David Schizer: Thanks everyone. I'm David Schizer. I'm Dean of the Law School and it is my great pleasure to welcome all of you to this conference on hydraulic fracturing. Fracturing or fracking as I think you all know is a method of extracting oil and natural gas and it's become the lynchpin of the recent energy boom here in the United States. I think everyone here knows that it has very important implications for our economy, our security and for our environment.

I'm pleased to say that there are quite a number of faculty members throughout the university doing research on this issue and today this conference includes colleagues from the Business School, the Law School, SIPA and the Earth Institute. One of the privileges of being at a place like Columbia is we have the kind of depth and resources to field interdisciplinary expertise on a complicated issue like this and I really think that's crucially important.

So as a result it is a great topic for our new Richmond Center. The Richmond Center is a partnership between Law and Business that was launched last year to promote joint teaching and joint research. It was created thanks to my friend Rich Richmond who is a graduate of both schools and is with us here today. So I particularly want to thank Jesse Green, Kathleen Rithisorn and Josh Safier all of the Richmond Center for doing invaluable work in preparing this conference today and I also want to thank my colleague Travis Bradford, Mike Gerard, Jeff Heel and Tom Merrill who were really the faculty planning committee for this and are all serving on panels.

We're also really privileged to have very distinguished guests with us for the panels today including experts from the academy, from industry and from environmental organizations and we're expecting a pretty full house in the room. We're also streaming this live. So we have a lot of ground to cover and I had a quick housekeeping matter to mention. We have found that we get through more questions when people write them out. So when the question period comes, what we'd ask you to do is take the note cards that you should have, write down your question. There'll be colleagues in the aisle who will walk them up. Colleagues holding that little question mark, exactly, and then they'll walk them up to the moderator who will then get through as many of them as possible.

So now let's begin. Ordinarily at this point what I would do is introduce the first speaker, but this is slightly complicated because I am the first speaker. So I'm trying to figure out whether I should ask you all to welcome me, but I think I won't do that. I will simply say that I know the speaker pretty well and I agree with everything that he's going to say.

So Tom Merrill, my colleague and I, have written an article which was included as a link in the invitation, so many of you may have read it. It is mostly focused on the question of how to regulate the risk of water contamination, but it at least raises a number of issues and you'll see those issues addressed in much more detail in the various panels. So in a sense the paper is a bit of an appetizer for the day and this session is really a summary of the paper and then the opportunity for all of you to ask questions.

So let's begin. As I said, the goal of the paper is to talk about a regulatory strategy to address the risks of water contamination from hydraulic fracturing and so I'm going to do three things in the next few minutes. The first is to talk about the potential advantages of fracturing for our economy, for our security and also for the environment, then to talk about the risks that the practice poses environmental risks, and then finally to outline a regulatory strategy particularly for water contamination.

So let's start with the benefits. Last November I'm sure many of you noticed, the International Energy Agency in Paris, the world's most respected energy forecaster, predicted that the United States would become the leading producer of oil by 2020 overtaking Saudi Arabia and the world's largest producer of natural gas by 2015 surpassing Russia.

This predictions would have seemed widely improbable six or seven years ago and they assume that will continue to tap the really sizeable reserves of oils and natural gas that are in shale and other tight rock formations. I'm just going to say shale for the rest of the day, but obviously shale includes some other things. Now geologists have known about these deposits for a long time, but it just wasn't economically viable to get them and the reason is that traditionally it was easier to drill in permeable rock because then the oil and gas flows out more easily and it was very difficult to drill in a very tighter impermeable rock like shale, but that has changed over the last ten years and it's changed by uniting two different technologies: hydraulic fracturing and horizontal drilling and the truth is neither is new.

Hydraulic fracturing was first used in the 1940s, but combined the two and using them to access these energy resources in shale is new and it's about ten years old. I bet you know, but in case you don't, fracturing basically involves pumping fluids at very high pressure into rock in order to crack the rock and then the gas and the oil can come up. The fluid is mostly water. It also includes a propent usually sand to try to keep the cracks open and then it includes a number of chemicals which are meant to keep the propent in place or sometimes to kill bacteria so that it won't degrade the oil or gas and a lot of these chemicals or at least some of these

chemicals are toxic, which is one of the reasons why fracking has become controversial.

So the ability to use these technologies has lead to a huge energy boom. It used to be in 2000, not that long ago, that only 2 percent of this country natural gas was produced from shale. As recently as 2007 as conventional natural gas reserves were dwindling it was expected that we would become a major natural gas importer, but boy did things change. Since 2008 domestic natural gas production has increased by 25 percent and now 50 percent of that gas comes from shale with 80 percent expected by 2035.

Pennsylvania has the second largest natural gas field in the world. New York has a pretty large one, Texas, Louisiana, Ohio, there are a number of places in the country that have them. There are questions, and we'll discuss them later, about the staying power of these reserves. So estimates vary, but President Obama quoted one in his 2012 State of the Union which others refer to as well which suggested there could be a hundred years of natural gas supply in the United States.

Oil has also been transformed in the United States. So there used to be only 100,000 barrels a day produced from shale as recently as ten years ago and we're up to two million in 2012 and the level is expected to raise possibly as high as 4.5 million barrels per day or more in the next few years. We've had a declining supply of oil in the United States for decades, but since 2008 the production has increased by 1.2 million barrels per day and although North Dakota at one point produced less than a percent of the country's oil, now as of 2012 because of the Bakken shale, which is a 25,000 square miles sheet of embedded oil, North Dakota is now second after Texas, ahead of California and Alaska.

So the economic benefits here as you can imagine are quite substantial. The drilling is said to contribute about 237 billion to US GDP about 1.5 percent as of 2012. This is according to a study by IHS. IHS also attributes 1.7 million jobs to the shale oil and gas boom and that's a pretty significant number considering that the country lost five million jobs in 2008 and has being straining to replace them.

The shale boom has also really strengthened consumer purchasing power causing natural gas prices to plummet. They're a third of what they were back in 2008 and by contrast natural gas is three to five times more expensive in Europe and Asia. I think three to four dollars here, seventeen dollars in China. Per American that amounts to just under a thousand dollars a person and since the median income in the United States is less than $50,000, that´s over 2 percent of the median income just right there.

It also affects the purchasing power and the bottom line of businesses, hopefully allowing them to hire more people to be more profitable. This has been particularly true the petrochemicals industry, but it's been true in a number of industries. So the economics here are very important and potentially very useful to the United States. The geopolitical advantages are significant as well. So every president in recent memory has talked about energy independence, but it hasn't seemed like it could be real for years and perhaps now it may be.

The reality is many of the countries that export oil and also natural gas are either unstable or hostile to the Unites States or frankly both. Exporting – the leading exporting nations top aid oil producing countries are Saudi Arabia, Russia, Iran, the United Arab Emirates, Norway, Iraq, Kuwait and Nigeria. That's not an ideal list. 70 percent of the world's conventional natural gas can be found in either Iran, Qatar, or Russia. Also not an ideal list.

Some of these regimes are consistently trying to undermine U.S. interests and the more oil and gas revenue they have perhaps the more successful they can be. Recent events in the world, sobering events, the attack at the Algerian natural gas facility, the nuclear program in Iran, the attack on US Embassy in Libya, all these things suggest that if anything the world and these countries could be coming more unstable and more hostile. So it's quite fortunate in a way that US is importing less oil that it did. 60 percent of our oil in 2005, down to 42 percent in 2012 and over the years that number should come down further. The IEA projected that the US would be 97 percent energy self-sufficient in net terms by 2035. Well, you can debate that number, but the trend is encouraging.

So. there are economic advantages, there are national security advantages, but we should talk about the environment and I will turn to the risks in a moment, but it is worth mentioning actual potential benefits as well. One potential benefit which you might have noticed this morning in the Wall Street Journal concerns the substitution of natural gas for coal. It used to be that about half of the electricity generated in this country was generated from coal. We're down to 36 percent in 2012 and the main difference is natural gas. So natural gas produces much less sulfur dioxide, much less particulate matter and less carbon monoxide than coal. That's a massive difference so air is cleaner and I think that's a pretty clear benefit that's not really disputed.

There's a second benefit which is more contested and that concerns CO2. I think it's well understood that the burning of coal produces twice as much CO2 as the burning of natural gas. So that is a significant benefit and it

perhaps contributes, it no doubt does contribute at least to a degree, to the decline in greenhouse gas emissions in the US at 760 million metric tons in the past seven years.

That's the largest decline anywhere in the world. It's actually a better record than Europe, but it's more complicated because of the possibility of pipeline leaks and leaks in the drilling for natural gas and the reason is that although burning methane produces less CO2, methane itself is a very potent greenhouse gas and as it gets up to the atmosphere, it can contribute significantly to global warming.

So that brings us then to risks and I'll just start by mentioning that there are also risks of global warming associated with fracking particularly if the leakage issues with pipelines and drilling are not addressed. Robert Howarth at Cornell wrote a very widely followed study where he suggested that maybe natural gas was worse than coal once you considered it on a lifetime basis. We'll have panelists discussing this issue. There are a number of other studies that criticize his study. So my guess, though I'm not an expert, my guess is that his numbers probably overstated, but it is a very important issue.

Now there are other environmental risks associated with fracking, which are also familiar. This kind of activity produces traffic and congestion, uses a great deal of water and it also may trigger minor earthquakes. There's a study on that as well. The truth is I don´t think fracturing is in any way alone on these issues. There are a number of other activities, conventional gas drilling and things that have nothing to do with energy production, that can cause some or all of these issues. So our paper doesn't focus on them as much, but I know our panels will later.

Another issue that I think is important is the relationship between fracturing on one hand and renewable energy on the other. One potential concern is we might want renewable energy for any number of reasons, but perhaps it will be harder for it to become economically viable if there's more low cost carbon fuel available and fracturing certainly contributes to that, but I think that´s oversimplified and I think it's oversimplified partly because a number of renewable sources, solar and wind among them, are intermittent, you can't rely on them all the time, they generally need a backup source of energy, that backup source usually is natural gas for a range of reasons. So there is in a way a synergy between using natural gas and promoting renewable energy over the long term. This is why people speak of natural gas as a bridge fuel.

Another point is that a number of states, maybe even all states, certainly most states, have mandates that require utilities to use a certain amount of

renewable energy. So in that segment of the market there's no competition between solar and wind on one hand and natural gas and the other. On the other hand you could say that maybe over time cheap natural gas could undercut the political will to have those mandates. So I don't mean to say there isn't a potential tension there.

My view though is that even if you are an enthusiastic proponent of alternative sources of fuel, it doesn't make sense to target only natural gas or only fracking because the truth is if there is success in making it harder to drill in those ways, my prediction is there would just be more coal burned. It's not that there would be more solar or wind. There would just be more coal and that doesn't seem to advance the agenda one would be trying to advance there.

So the main issue that I see and the main issue that is the focus of our paper is water contamination. Water is obviously an incredibly important resource and so it's really essential to understand what the risks are and to think of what kind of regulatory system can get us comfortable so that ideally we can have the benefits that I've talked about and also feel as if our water resources are safe. So I'll just mention three types of risks of water contamination because they really do come in categories and they present somewhat different issues.

My sense is the one that attracts a lot of popular attention is that the fracking fluid itself could leak into wells or aquifers and as I said, fracking fluids has toxic chemicals in it. We certainly do not want it to leak into the water, but the theory that you sometimes see discussed is that maybe when the rock has cracked, maybe the crack down there will extend up to a well and the fluid will migrate or maybe there are existing cracks and the fluid will migrate and the truth is that I don't think that that's the most important risk. A number of studies have suggested that that risk is really quite remote and the reason is that at least in most cases fracking is taken place five to ten thousand feet down. The water table is more like 500 feet down and the geology of having a crack that extends all the way up is apparently very, very improbable.

So the Department of Energy in 2011 in their study concluded and I quote, that they share the prevailing view that the risk of fracturing fluid leakage into the groundwater sources through fractures made in deep shale reservoirs is remote and they go on to say quote, there are few, if any, documented in cases of such migration.

The – it is also relatively unlikely that fracking fluid would leak into the water table as it's either going down or coming back up and I say relatively unlikely because the key there is for the well to be constructed

properly and the essential safeguard is called the well casing. It's a very thick layer of concrete and steel which encloses the inside of the well and is meant to prevent leaks of anything inside the well whether it's gas, oil, or the fracking fluid itself and so there was a report in 2011 from MIT. One of the coauthor is Ernest Moniz who is President Obama's nominee to become the next Secretary of Energy and what he wrote about that is quote, it is noteworthy that no incidents of direct invasion of shallow waters evidenced by fracture fluids during the fracturing process have been recorded.

So I don't think that's the key risk, others may disagree with me. Let me turn to another that I think is a lot more significant and that's surface spills. If you spill toxic fluid on the surface, it can seep down into the water table. That's a real problem. It is actually though not a problem that's particularly unique in this setting, there's a lot of industrial activities that involve toxic chemicals. It's really vital that we deal with that in the appropriate way. My hope is that we will.

There are a number of federal and state regulation that already deal with that. So it may be that that's not such a new issue with the following caveat. There's obviously a lot more toxic fluid around than there used to be just because there's a lot of fracking and so maybe the magnitude of the problem is a bit different, but it's not a new problem otherwise.

So then let me turn to a third issue which is about contamination from the methane itself. When methane gets into water, that's not good. The water is contaminated, it's not healthy to drink. So we certainly don't want that and we wouldn't want this drilling to contribute to contamination of wells with methane and one thing that's interesting, and I certainly didn't know before a year or so ago when I really started looking into this, is that quite a number of rural wells already have methane in them. This is a fairly common thing. In the paper we cite a study in Oklahoma, where they found that in 131 of 170 rural wells that they studied before any drilling took place, there was methane contamination.

There's a 2011 study from Pennsylvania which found methane in 40 percent of rural wells, again, before any drilling took place and then that Pennsylvania study did a further look after the drilling began and found no statistically significant difference. So there's not a lot of evidence that fracking is contributing significantly to methane contamination in water, but that is a significant issue. We certainly don't want it to happen and more research needs to be done, but that brings us then to the key topic which is how to regulate this. What kind of regulation do you need? There's no question that if you either build or operate a well improperly,

you could contribute to water contamination and so what do we do about that?

So our proposal is really essentially a two-pronged effort and the first prong is best practices regulation and the second is liability. So I'll spend a few moments on each of those before we turn it open to questions. So best practices regulations obviously these are sort of command and control rules where regulators choose a practice that they think is state of the art and require all the industry participants to use that as opposed to something else.

There are some very old rules in this area which address problems in oil and gas drilling that have existed for 100 years and still are presented in these – in hydraulic fracturing and then there are sme new rules and some updated rules because fracking does present some new issues as well. So I mentioned well casing. That for me is perhaps that most important, certainly one of the most important. You have to be sure the casing is thick enough, that it goes deep enough to protect the water, that it is set properly and that really is vital and if done well gives you a very important measure of comfort.

Another high priority is to think about minimum distances between this kind of activity and bodies of water. We also need measures to deal with surface spills as I mentioned. There has to be reporting, reporting requirements for leaks. We need mechanisms to dispose of fracturing waste and I also think it's a good idea for companies to disclose the content of their fracking fluid which was at one point a controversial issue, but I think industry now is moving in the direction of doing it and a number of states have required it.

So there are really two advantages that I see in relying on these sort of best practices regulations. One is it should give a fair measure of certainty to industry and there's an argument that even if it's not a perfect rule, just having a rule and having people know what it is is awfully valuable so that when companies make millions and billions of dollars of investment they know what to expect and the second point is I think it should be, and probably is, reassuring to the public to know that there's a regulator on the case who's trying to require the state of the art control measures, but there are also challenges.

It's not a perfect regulatory mechanism. One issue is that although there are aspects of fracturing that are quite old, there are also problems that are new and with new problems it's harder to figure out what the best practice is because it's new and people are still figuring it out.

So for example, there's an effort now to produce non-toxic versions of fracking fluid. It's become – they're coming into wider use. It might be that at some point regulators would want to simply require their use, but again you'd need more information and more experience before doing that.

The second issue has to do with enforcement. You can have the best rules on the books in the world, but if they're not enforced and everyone knows that they're not enforced they're not doing what you want them to do. So the bottom line for us is that best practices regulations are quite essential, they're really an anchor of the regime, but you need something else and that brings us to the second prong we recommend which is liability because liability can fill in the gaps for issues that haven't been fully vetted or understood yet and they can also reinforce enforcement because there's a private mechanism, lawsuits, that cause industry to take these rules even more seriously.

There's another advantage of liability which is really about the fact that there's a huge dispute going on here. Energy companies will say, this is safe, this is really safe. Well, if they're right then, and if the liability system works correctly, then their exposure should be minor and of course if they're wrong, then they'll be responsible for cleaning up the damage that they cause and so there's a way in which you don't have to take that position on who is right there. You just have to make someone responsible for it, give them the incentives to be careful and to innovate.

So we think a liability system is important and in my remaining time I want to focus on two different aspects of it. One is the liability standard, what the standard should be and in particular what relationship it might have to the best practices rules and then the second very difficult and important issue has to do with causation.

So let's start with the liability standard. I think ideally what you'd really like is some coordination. You would like liability rule to be at least somewhat related to the best practices regulations because if you do that then you are ensuring that companies have a particular incentive both to comply with those regulations and also to help the regulators make the regulations better. So what we would do is we would make that liability determination related to whether companies are complying with the best practices rule and that brings me to three scenarios to explain it better.

So first let's assume that there is water contamination and that it is caused by a problem that is in fact governed by a best practices regulation. So an example would be your well casing is supposed to be six inches thick. It's only four inches thick. What we would do is just have what lawyers call

negligence per se. We would say the violation of the rule itself establishes liability and by doing that, you make – you create a real incentive for energy companies to comply with the rules.

Now second, and it's the mirror image, let's say they have complied. Let's say that there is – that the well casing really was the six inches that it was supposed to be. So if there's been compliance with the rule, we would view that as a presumptive defense. It doesn't mean they automatically win. There could be some other violation that you could point to. The plaintiff could win by saying, yeah, it was six inches, but you didn't set it the right way or you didn't maintain it the right way, but it would not be okay for the plaintiff to say, well, the rule required six, but it should have been eight. We would not do that and basically we would say no liability in that circumstance and also no punitive damages.

So it's called a regulatory compliance defense and we favor it for three related reasons. First is we think it's not great for courts to try to second guess regulators because our sense is that regulator will have more expertise than common law judges would about these difficult technological issues. Second, it's costly for courts to be creating kind of their own parallel set of rules and standards. If the regulators have looked at it, it's just much more efficient to have one set of rules than two and third, we think that having this rule creates an incentive not only for industry to comply with the rules, but also to work with the regulators to actually create rules. Industry would have something to gain from the creation of a rule because then there would be certainty on that issue and that's something that industry would certainly want.

But let's move to a third scenario and the third scenario is there's contamination and it's caused by a problem that is not addressed, not addressed by any rule. So you're sort of out of the zone of negligence per se or regulatory compliance defense. What we would do there is basically ask the energy companies – we'd shift the burden. We'd put the burden on the energy companies to show that it wasn't their fault, that they couldn't have avoided the problem, couldn't have avoided the problem with reasonable precautions and so for the torts junkies in the room, you probably recognize we're using res ipsa loquitor and basically you give the fact finder to just infer, to make an inference that the energy company's negligence caused the contamination unless they can show otherwise.

So the defendant can still rebut this. They can show that it was an act of god or that there was nothing they could have done, but otherwise, they would be responsible and so this does function a lot like strict liability in this narrow setting where there are no rules and we think that's important. We think it's important to create incentives for industry to be careful when there are issues that aren't yet well understood and we also think that it gives industry the incentive to become a partner of the regulators and promulgate rules for issues. I think that this would create the right incentives there.

And the last point I'll make about that is you'll probably see a pattern and the pattern will be that for issues that are well understood, those will already be the subject of rules, best practices rules and so you'll either have negligence per se or the regulatory compliance defense. This is pretty straightforward and then in the settings where there are no rules and these are unfamiliar issues, issues we may not even know about yet, well, there you'll have strict liability, but that has the advantages that I described earlier.

So the truth is in any of these settings, causation is really quite crucial. You have to try to figure out whether it was the energy company that caused the problem and that's not at all simple because there's lots of – there are lots of natural pollutants out there. There might be more than one company drilling in a particular area and how do we know who it was and the incentives aren't right if the causation determinations are off. If people are getting blamed for things they didn't do, that's a problem. If they're not being held responsible for things they did do, that's a real problem.

So we think causation is a really crucial issue and it's not simple, but what we would recommend is mandatory testing of water quality within a geographic area before the drilling begins because that establishes a baseline and then if there's testing later, if the drilling has begun and someone makes an allegation of water contamination and there's testing and the water quality is not worse than it was before, well then I think that should end the matter. On the other hand, if the water quality is worse than that creates a reason to believe that there is a problem and there would still have to be fact finding about what caused the problem, but it's a much narrower question to resolve.

So I think the issues of causation can be handled pretty well there especially for property damage. Property damage is a part of what we worry about, but admittedly we also worry about health effects. Causation for health effects strikes me as infinitely harder. It's one thing to say that this water is dirtier than it used to be and still another thing to say when someone gets sick years later that it had anything to do with this. So that's a much harder issue and what we would do is create presumptions favoring the plaintiff here because otherwise making – getting proof on this is going to be very difficult and that may seem unfair, but there's a reason and the reason is that through self-help I think industry can protect itself and that is through periodic testing of the water.

So if you keep testing the water and the water is not any worse than it used to, test it every year, every couple of years, that ought to create the kind of record to show that you should never be responsible for health effects. So that's what we envision there.

There's a lot more in the paper and there's obviously a lot more you have to do in order to design a liability regime here. We talk about fee shifting in order to get lawyers to take the cases. We talk about the need for insurance so that companies are not insolvent. We also talked about some very narrow prohibitions in environmentally sensitive areas, but the bottom line is we think that through a combination of best practices, regulations and liability rules we really ought to be able to have reasonable and effective regulation here and the result should be that we can protect the water and get comfortable about water contamination while at the same time deriving these benefits that we talked about for the economy, for our security and for the environment.

So thank you all and we'd love to have your questions. So we have a card over there.

Tom Merrill: I haven't really had a chance to digest these, but here's a short one that's easy to read. Should the New York City watershed be fracked and if not why not?

David Schizer: So I would be inclined to say no and to be clear it's not because I drink the water. It's because I think what you want to think about is in settings

where the potential costs, even if it's a remote risk, the potential costs are huge, it's probably prudent not to put us in the position where we'd have to deal with that because replacing the water supply to millions of people would just be astronomically expensive on short notice. So we talked a bit about this in the paper. We think prohibition should be really rare, very, very rare, but they should focus on that kind of sensitive situation where the costs of dealing with a problem would be extremely high.

Tom Merrill: Okay. A couple of people have asked about exports. Would we allow exports or not? We don't address that question, don't have a position on that. I'll answer on that one. Who should be responsible for establishing best practices regulations? Is it just the local oil and gas commission? Is it the industry? How should industry and the oil and gas regulators and other interested parties interact in setting these best practices regulations?

David Schizer: So the focus of our paper is really more about what the merits of these rules should be and less about which part of the government should create them, but we certainly do discuss the issue towards the end of the paper and I'll tell you what we say. We see tradeoffs and let's talk first about the idea of what level of government it could be. Well, actually, no, let's talk first about which part of the government whichever it would be. You could rely on common law courts. You could rely on regulators and truthfully my preference would be some sort of regulatory system, but in order to do that, in order to invest in that, you have to confident that there would be enough cases to justify some sort of regulatory adjudicator and it's not clear that there would be.

So that may be something for the longer term. The role of the regulator here probably is more about best practices regulations and then maybe we have to leave it to the courts in order to decide these cases and one of the great advantages of courts truthfully is they're kind of an off the rack decision maker for all sorts of things. New technologies are created, not just in this setting, but in any setting and then what you can do is you can look to courts to decide disputes that haven't really come up before.

We also have views about states versus the federal government and Tom, maybe you'd like to talk a bit about that. States and the feds.

Tom Merrill: Right. Well, we have a whole panel on that later this afternoon which is going to discuss the question of who ought to regulate the water – the risks of fracking in general. Focusing just on water contamination, our paper argues that at least for the time being, we should probably rely on the states to take the leading role in regulating these risks rather than attempting to create a new federal regime from scratch. Part of the problem is just a question of who is already up and running in doing this regulation.

Every state that has significant oil and gas production has some regulatory body that is attending to these issues in some fashion. Most states have oil and gas commissions that have regulations designed to protect the public. Some states have departments of natural resources that do that. So the states have a kind of advantage in terms of lead time. The federal government does not current regulate water contamination risks on private land. There is some federal regulation on federal land, but it generally is derivative of state regulation in those areas.

So shifting to a federal regime would create a long lag time for the federal government to get organized and get this regime up and running, but it's also a quite – quite a bit of variability in terms of the safety issues from one state and one sort of location to another. The circumstances of the shale deposits are different. Populations are different. Conventions of disposing of waste are different and so forth. So there's quite a bit of variability which suggests that some type of tailoring to local circumstances makes sense.

I think we're also somewhat optimistic that competition between states or emulation from one state to another might be worthwhile in this area given the great uncertainties about fracturing and about the best way to regulate the water contamination risks. There would be some risks that if we raced with federal regime, we would lock regulations that might prove to be difficult to displace over time. There's more of a dynamism if you leave it at the state level.

Obviously people raise the question of capture. Are the state commissions captured by oil and gas interests to the extent that they are not capable of adopting regulations that are truly in the public interest? I'm sure the oil and gas industry has significant influence with some of these state

regulatory commissions, although in other states, New York would be a good example, obviously they don't have huge interest – influence with the local regulators.

I think the public is greatly concerned about this. People don't like the idea of having their groundwater contaminated to put it mildly and I think it's too simplistic to suggest that industry will always dominate the regulatory process. The politicians that appoint these commissions are very sensitive to public opinion, very sensitive to the fact that property owners are extremely nervous when they're told that maybe their groundwater is going to be damaged and so I don't – I think it's overly simplistic to picture state regulation as simply being in the – captured by oil and gas interests.

So I think that probably the competing interests here and safety will work themselves out and if one state is perceived as lagging behind the others or people point that their neighboring state is doing something much more effectively I think there'll be a lot of pressure for states to catch up to the leaders so to speak. So we at least for the time being would recommend keeping these at the state level, keeping the liability system in the state court system. There are obviously that need to be – that ideally would be made to make the liability system work more effectively which we discuss in our paper, but on balance we think we would go with the state rather than the federal route.

David Schizer: Just to add one more thought about that, the diversity of conditions in the country is a very good argument for state regulation. Another point which is not quite the same is about the sort of the scope of the risks and costs if they arise and I actually see a bit of a difference on one hand between, say, greenhouse gas emissions and water contamination. Greenhouse gas emissions tends to be more of a national, even a global problem. So it seems like there's a better argument for EPA to play a role there and they did actually finalize some regs a year ago dealing with flaring and some other issues and that seems appropriate.

My sense of water contamination – it will be interesting to hear from others today, is that in many circumstances, probably most circumstances, it's a fairly local issues in terms of geography. I don't think that aquifers are connected underground in a way that what happens in North Dakota

could affect Pennsylvania and that sort of thing and so that sort of reinforces the idea that if they impact on that dimension is local, it could make more sense than to have state, the smaller governments as opposed to the national government focusing on it.

Tom Merrill: Here's an interesting question about earthquakes. Somebody points out that earthquakes have long been held to be acts of god and yet there are reports of seismic disruptions of previously stable areas caused by fracking or where fracking has occurred. So how do you – would you advocate burden shifting or leave it to the courts with respect to earthquake damages?

We don't really talk too much about earthquakes in the paper. The most recent research report that's come out from the National Research Council very comprehensively addresses what is known about this and there are a couple of documented cases where fracturing activities seems to have triggered a seismic response, low level on the Richter scale, nothing that caused any surface damage, but nevertheless it does seem that there's some possibility of risk there. Probably the greater risk is from injection of waste materials into deep injection wells. If you do that in an area that's close to a fault line, it's also possible to trigger a seismic response.

I guess my off the top of the head response would be that if an earthquake were caused by either deep injection of waste or by fracturing activity, it would not be an act of god. It'd be an act caused by man and therefore it would not fall within the act of god exception to liability. Ideally I think you'd probably run that through the same type of liability system that we're talking about for water contamination risks and I think a somewhat similar analysis would be appropriate to start with liability – a liability system augmented by best practices regulations if and when we can develop best practices regulations for minimizing earthquake risks, but the Research Council's bottom line was that probably the earthquake risks, the induced earthquake risks from fracturing itself are fairly low.

There are more significant risks from deep injection of waste materials and at least a couple of states – I believe Arkansas is one, maybe Ohio is another – have already started developing some regulations to try and govern the way in which waste materials are injected so that people don't put them in a place that's likely to induce earthquake damage. Just as

people are very apprehensive about water contamination, I think induced earthquakes are also something that make people very uncomfortable. So again, this is an area where proceeding to adopt a regulatory structure to handle the problem makes sense.

Thank you for all your questions. Some of you write more clearly than others. David, why don't you take this one? Water is becoming a scarce resource globally. Can we afford to take millions of gallons of water out of the water table permanently because a large percent must be deposed of with the contaminated frack fluid that comes up in the fracking process?

David Schizer: This is a very good question and I'm glad you asked it because the focus of the discussion has been water contamination, but water use in and of itself is an important issue. It takes between two and four million gallons to frack a single well according to the research that I've seen and so in the aggregate this can be an awful lot of water if you have 35,000 wells at a given time or more.

There are two pieces of good news on this, though. One is that increasingly the fracturing fluid is being recycled. It's used once. Then it's treated to a limited degree and used again and so the total amount of water that is used is less overall as you begin recycling more of it. This is an increasingly common practice which diminishes the scope of that issue.

The second bit of good news is that at least in most places where fracking takes place, water resources are abundant and they're replenishing. Fracking is using 0.1 percent or less of the water in Pennsylvania. There's an awful lot of fracturing going on in Pennsylvania, but Pennsylvania gets – is fortunate to get an awful lot of water. It's also true even in a lot of Texas which is not usually thought of, at least thought of me, as a state with a lot of water, but they do have a lot of water in some parts of the state, but it is also true that in other parts of Texas and in Colorado for example, just the amount of water is an issue because they don't get nearly as much rain.

You can pipe it in. You can truck it in. That creates congestion issues. It raises the costs. So there are some issues in particular localities, but it's also interesting. There's no state – where fracturing takes place, there's no state where they use more for fracturing than they do for cattle and

livestock. So relatively small portion of the overall water in the country that's dedicated to this and in most places it's not an issue, but in some it is.

Tom Merrill: A couple of interesting questions here about water quality testing, baseline testing before the drilling starts. A couple people ask who's going to pay for this water quality testing? How extensive should the testing be and what do you recommend to land owners who face the possibility of nearby fracking regarding water testing?

So I don't think we addressed this in the paper, but my thought would be that probably the production company that's proposing to engage in extraction activity using fracking would as part of the process of getting permission to drill, which every state requires before this activity begins, would have to demonstrate to the regulators that they've done appropriate baseline testing and the production company would pay for that testing. There's obviously tons of issues about how extensive the testing should be.

If – obviously the larger the field that's being fractured, the more potential exposure you have so there should be some relationship between the size of the field and the amount of testing that takes place. If you're extremely worried about water contamination, you'd want to have testing taking place further away from where the field is. If you're less concerned, you might be satisfied with testing relatively close to the drilling activity.

Questions about whether every well has to be tested or only some sampling of wells have to be tested. There are interesting questions about what happens in areas where there aren't any water wells. Are you actually going to make the production company drill a well in order to test the water when no one's using the water in that particular area? We don't really have any answers to these questions. I think is a first approximation, the local regulatory authorities that are in charge of best practices regulations in issuing these permits would have to come up with guidance regulations about how much testing takes place.

One question is what happens if the landowner refuses to allow their water well to be tested. There are cantankerous people out there who don't like somebody coming and messing around with their water or testing their

water wells. We think in that sort of circumstance that some kind of burden shifting at the very least, perhaps an absolute bar to filing a lawsuit would be appropriate. So it's important that – I don't think you could coerce people to allowing their water to be tested necessarily, but there should be some incentive in place to induce landowners to cooperate in testing – in order to make sure that adequate testing is done and people shouldn't be able to file a lawsuit or at least file a lawsuit that relies on a presumption of liability if they haven't cooperated in the testing.

Obviously wouldn't be any rule against landowners doing testing on their own if they thought that more testing was appropriate. I think we have a footnote based on some information that Mike Girard provided us about exactly what this testing might cost. It's probably in the magnitude of hundreds of dollars rather than thousands of dollars and certainly landowners that were concerned could do their own testing, but I think probably the production company would be responsible for paying for the testing and the extent of the testing would have to be determined by the local regulators.

David Schizer: I'll just add that the tax lawyer in me can't resist saying that who writes the check isn't always the same as who bears the cost and perhaps in the initial test, that really would be a cost born by the energy company, but there would be, at least with many of these people, a lease involving the allocation of royalties from any hydrocarbons that you get and could imagine an adjustment in those terms. For example, if someone says I'm really concerned about water. I'd like you to do more tests. That could be arranged, but in return maybe the royalty is adjusted so that the landowner is bearing a portion of this. It's obviously more complicated if the person with the land is not the same person who's going to benefit from the mineral rights and that does exist and so the point I just made doesn't apply there.

Tom Merrill: Here's a hard question, so it's for you David. What would your position be regarding fracking if the intermittency and storage problems with respect to solar and wind energy had been solved?

David Schizer: So I think the very easiest way to deal with that, and I say easy conceptually, but not in any other way, is to have all the costs of different source of energy actually reflected in their price. Tom and I in a different

project wrote a paper recommending a version of a gas tax because we think that that is a very good way to try to get people to internalize the real costs whether they're environmental costs or national security costs or other types of costs.

I think we all know politically this an incredibly difficult thing and so although the effort we made a few years ago was to create a politically viable form of this, you haven't heard about it which suggests that maybe we didn't really solve that problem, but in any event my view is if you have all of the true costs, including externalities of various types of fuels reflected then just pure competition and market mechanisms are a very good way to do it because then we know what is the most efficient way to get power.

I will say putting that answer aside, I think over the long term if we are able to have – to solve intermittency and to bring costs down further, these sources of energy are very promising and certainly come a ways with wind so far even more than with solar, but some progress with solar, too. I don't think in the very near term they're going to be a comprehensive solution. I think it's years from now that we could think about that and so I think the next couple of decades are really important and I don't personally see something viable that doesn't include natural gas or oil of some form.

Tom Merrill: There's an interesting question here. I guess I'll take this one even though it's hard so maybe I should give it to David. How does your proposal differ from the current regulatory and liability regime?

I think actually it doesn't differ in a huge amount from the current regime. Although we discuss various possible alternatives, the bottom line I think is that we would rely on best practice regulations which are already out there and presumably will become more elaborated as time goes on and we rely on the common law liability system which does already have these doctrines that David described, the regulatory compliance defense, negligence per se and res ipsa loquitur. These are already well recognized doctrines that every state has in its common law tort.

I think the way we present the integration of these is perhaps an innovation which would not necessarily be readily found in the existing literature and hopefully would provide some guidance to judges if they

actually get cases which require them to resolve controversies about a regulation.

We do have a number of places in our paper where we are recommending changes to the existing liability system, however. David described these various presumptions about causation which are not currently in the liability system and we would mandate baseline testing, mandate disclosure of chemicals, perhaps in the future mandate tracer chemicals and all these things would require legislation probably which – or at least for the courts to create new presumptions which would go beyond what the current regulatory and liability regime requires.

We're a little bit concerned about whether or not cases that involve only property damage as opposed to adverse health effects would generate enough of a potential liability to attract plaintiffs' lawyers to take these cases. Obviously the causation questions, even with our presumptions, are going to be difficult. This looks like expensive litigation.

If our supposition is correct, that most of the contamination damage would relatively localized and would not affect huge numbers of property owners, there aren't a lot of plaintiff that can be gathered together for a class action perhaps and so we have some concern that actually the liability regime will not have a lot of bite simply because the tort lawyers would flock to bring these cases. There's just not enough money on the table and there's a sort of paradox here which is the more effective the best practices regulations are in preventing large damages from occurring, the less likelihood there will be that significant numbers of law suits will in fact be brought.

So we have a suggestion that perhaps some kind of fee shifting proposal might be adopted by the states that would give successful plaintiffs the right to recover attorneys' fees in these cases. We use this in the environmental area with citizen suits. We use it in the civil rights area and in those areas it appears that these fee shifting statutes are one way only the fees get shifted from the defendant who loses to the plaintiff who wins, not the other way around, that these do generate some significant positive level of litigation even in areas where there's relatively small amounts of damages. So that's an innovation that we throw out there.

We also think that some proposals for dealing with insolvency might be appropriate. Most of the well operators that do fracturing are big companies like Halliburton and Schlumberger and they obviously have a lot of resources. We don't have to worry about them becoming insolvent in the next few years, but conceivably injuries could manifest themselves many years down the road, 10, 20 years from now, even longer perhaps some of these companies might not be around.

Conceivably there might be a very large liability caused by fracturing related activity which would bankrupt production companies or operators in which case the injured people would be left holding the bag. So there is – we have some proposals for dealing with insolvency risk. Perhaps bonding requirements or some kind of government-sponsored insurance regime could be devised where companies would pay into a fund that would create an insurance regime that would provide backstop the system in the case of insolvency leaving plaintiffs without any recourse.

So it's a fair point that in the end our regime is sort of – our recommendation is sort of an elaborated version that looks somewhat similar to what we have now, but I think there are some significant modifications along the way which are designed to make what we have now work better.

David Schizer: Did you mention mandatory testing also?

Tom Merrill: In the causation. I may have not mentioned it.

David Schizer: Okay cause I think that's – sort of exists in Pennsylvania in a way, but it's – I think it's a bit different from the way most systems look and that would be my number one item truthfully.

Tom Merrill: Maybe one more question here. I'll give this one to you, David. Is waste deposal a factor which affects water contamination more or is fracking a bigger threat to water contamination?

David Schizer: So waste deposal is very important and the truth is if you look at some of what's happened in the last few years, my own sense is some of the most regrettable things that have happened have involved waste deposal. There's a concept called land application which basically means you take

the used fracking fluid and you put it on the ground. This is a terrible idea because it can just seep right down into the water table and I think it's not legal probably anywhere anymore, but there were early instances when people didn't focus on it and they did that.

Also in Pennsylvania early on there was some fracking fluid that was put in sort of standard sewage treatment plants. They weren't set up to deal with it and so that fluid then made its way into rivers and various other places I believe and that's a really unfortunate thing. Again, that's not permitted anymore in Pennsylvania. People became much more sophisticated very quickly about that problem, but if by fracturing we mean we mean the actual cracking of the rock, it doesn't seem as if that is as significant a risk to water as what you do with the fluid when you're done with it and so, again, waste deposal is an awfully important part of the picture and there are absolutely responsible ways to deal with it, but it's quite crucial that that's the way we do it.

Tom Merrill: So we're out of time and I really apologize for – you have a terrific pile of questions here, but rest assured that they will not go to waste because David and I are still revising our paper. So I will read these questions with care and try to respond to them as best we can in the final version of our paper so we appreciate your efforts. Thanks.

[End of Audio]

Duration: 60 minutes