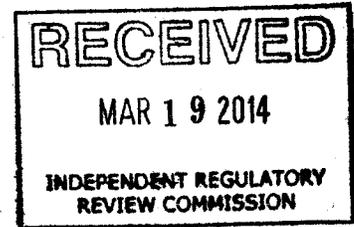


3042

Charles Evans Hunnell  
2248 Oak Forest Road  
P.O. Box 548  
Waynesburg, PA 15370-0548

[ceh65471@windstream.net](mailto:ceh65471@windstream.net)

22 January 2014



Good evening, my name is Charles Hunnell. I am a retired high school teacher of US History and Economics. My home is in Greene County. I own 136 acres of land, the property our family moved to when I was 12 years old. The property was long-wall mined during the decade of the 1980's. I have my own water system consisting of a spring and a well.

We are in trouble in our state and our local region of Washington, Greene, and Fayette Counties. Our leaders and regulators have welcomed in unconventional slick-water drilling and have permitted them to proceed with outdated regulations and with less than strenuous oversight. Citizens in each of our counties have suffered from this rush to new jobs such as: a) exposure to carcinogenic and other gases from well sites, condensate tank vents, and venting associated with the increased number of compressor stations just starting to be constructed. Family members have become sick due to exposure. b) Home potable water, both private and public, has been tainted by flow-back and produced water. Water authorities have to face the problem of increased bromide and trihalomethane. Home water systems have been contaminated. Farmers have lost livestock and families have lost pets when farm ponds and streams have been tainted with flow-back and produced water. We are just at the beginning of this process and many of our citizens have suffered because of an apparent lack of concern for the SAFETY and HEALTH of the people of Pennsylvania by our government and by the involved industries.

I have read DEP lab reports that verify that four sites on Greene County streams have been polluted through mine discharges of Alpha Resources' Emerald Mine and Cumberland Mine not with typical mine discharges but with excessive levels of bromides, strontium, and chlorides which are bi products of unconventional slick-water drilling. DEP's Clyde Mine discharges the same excessive levels of the same chemicals. Greene County's Smith Creek, Whitely Creek, Frosty Run, and Ten Mile Creek continue to receive the same unregulated discharges with no apparent concern for the HEALTH and SAFETY of the citizens. How are unconventional slick-water drilling flow-back and produced water chemicals coming out of mine discharges? Why is no one in our government or the industries concerned with this? These discharges have already affected water quality of local water authorities. Citizens have had to boil water and authorities have been out of compliance because of the high levels of bromides and the increase in trihalomethanes. We have no knowledge of what the long run problems for our citizens may be with continued exposure to these chemicals in our water.

# CHEMICALS TO TEST FOR

Chemicals to test for  
in water wells and or springs:

**Bromides**

**Toluene**

**Benzene**

**Salt Levels**

**Arsenic**

**Methane**

**Bacteria**

**Styrene**

**Strontium**

**Barium**

**Glycol**

**Phenol**

**Cadmium**

January 6, 2014

Berks Gas Truth \* Clean Water Action \* Delaware Riverkeeper Network \* Earthworks \* Clean Air Council \*  
Damascus Citizens for Sustainability, Inc. \* Sierra Club, Pennsylvania Chapter

## **Proposed changes to Pennsylvania's oil and gas regulations** *Key concerns and talking points*

In mid-December, the Department of Environmental Protection (DEP) issued proposed changes to the state's oil and gas regulations, known as Chapter 78 of the Pennsylvania Code. Act 13, the oil and gas law passed in 2012, requires DEP to make these changes. They are also necessary because regulations for conventional drilling are outdated and inadequate given the large amount of land and water used and waste and pollution produced in shale gas development.

*Public participation is essential to making regulations stronger and more protective of air, water, and health! You have until February 12 to submit written comments or testify at hearings. You can use the analysis and talking points below (which cover key parts of the regulations) to prepare your comments. The regulations and public comment information are at:*

[www.portal.state.pa.us/portal/server.pt/community/public\\_resources/20303/surface\\_regulations/1587188](http://www.portal.state.pa.us/portal/server.pt/community/public_resources/20303/surface_regulations/1587188)

**FIRST please state that the public comment period should be expanded to 120 days minimum and more hearings should be set in affected counties.** This is an important and far-reaching rulemaking and more time is needed for people to participate in a meaningful way. 59 Pennsylvania organizations and thousands of people have signed a petition calling for more time.

**1. Pre-drill water testing and the restoration and replacement of contaminated water supplies (Sections 78.51 and 78.52).** We learned through DEP's determination letters that natural gas drilling operations have impacted at least 161 water supplies statewide. The natural gas industry has fought to have water restored to only pre-contamination conditions—even if it is not safe to drink. In addition, DEP leaves it up to the driller to decide when, where, and how to conduct water quality tests before drilling starts. DEP should require:

**Operators to restore contaminated drinking water to a quality that meets Safe Drinking Water Act standards**, no matter what the quality of the water prior to drilling. If the quality of a water supply prior to drilling was above these standards, the operator must restore the water to that higher standard; otherwise, good water supplies will be degraded.

**All drillers to use a consistent list of parameters for pre-drill water testing, which DEP must establish before the proposed regulatory changes are adopted.** The parameters should be as comprehensive as possible, but at a minimum match what DEP uses when it conducts full contamination investigations and to ensure that complete baseline data is available.

**All drillers make pre-drill data available to the public**, while protecting individual homeowners' privacy, through an online platform, which DEP must establish before the proposed regulatory changes are adopted.

**2. Standards for frack pits and impoundments (Sections 78.56, 78.57, 78.58, and 78.59).** Mounting violations and the potential for water and air pollution have already led some companies to transition away from pits and standardize the use of closed loop systems which utilize tanks to store wastewater. DEP should:

**Prohibit operators from using open pits for storage of regulated substances**, including wastewater, drill cuttings, and substances (like gels and cement) that return to the surface after fracking. Many spills, leaks, and other problems involving pits have occurred statewide that contaminate water, soil and air. Waste should be stored only in closed systems.



Monday, January 6, 2014

## Speak now: Public hearings on new oil and gas regulations

The Pennsylvania Environmental Quality Board (EQB) has scheduled seven public hearings in January throughout the state on new regulations around oil and gas development, and is encouraging public comment during the rulemaking process.

At issue are the protection of streams and waterways from drilling operations; storage of freshwater and other fluids related to fracking; and the proper collection, analysis and disposal of waste materials at well sites, among many other concerns.

The first hearing is scheduled on Tuesday, January 7, in northeastern Pennsylvania. A complete listing of hearing dates and locations, as well as registration information, can be found here.

Listed below are a series of concerns we have with the proposed regulations. We encourage you to use these talking points to guide your testimony. If you do testify, keep in mind that you are only allotted five minutes so you will want to speak to the issues that resonate with you the most.

\*\*\*\*\*

### All fluids related to oil and gas development should be contained in engineered facilities, not "natural depressions." (Section 78.1, definition of "freshwater impoundment" and "pit," Section 78.56)

Our streams and groundwater should be secure from pollution caused by the storage of wastes and fluids associated with oil and gas production operations. The definitions of "pit" and "freshwater impoundment" raise questions about that objective because they continue to incorporate the concept of "natural topographic depressions" within the definitions. We should not even suggest that Pennsylvania will allow fluids related to oil and gas operations to be managed in "natural depressions." All facilities used to hold fluids that may contain potential water pollutants should be specifically engineered for the task.

### The definition of "seasonal high groundwater table" should be retained in the proposed regulations, because the term continues to play a key role in regulating oil and gas activities. (Section 78.1)

Proposed section 78.1 deletes the definition of "seasonal high groundwater table" even though that term is still used throughout the regulations, including in sections 78.56(a) (11), 78.59b(e). This definition should be maintained to ensure clarity and consistent enforcement.

### The permit applicant, not the Department of Environmental Protection (DEP), should be responsible for determining whether proposed oil and gas operations would affect threatened or endangered species. (Section 78.15(d))

Protecting the habitat and physical safety of vulnerable species is a critical part of ensuring biodiversity and the quality of our environment. The federal Endangered

## PennFuture Twitter Feed

## PennFuture Blogs

- **PennFuture Facts**  
*brief, interesting looks at topical environmental issues*
- **Session Daze**  
*quick looks at public policy*
- **Re: Energy**  
*championing the transition to a clean energy economy*
- **A Climate for Change**  
*climate news from around the state, country, and world*
- **Flows Downstream**  
*a blog about water*
- **A Bear in the Woods**  
*environmental law blog*

## Blog Archive

- ▼ 2014 (5)
- ▼ January (5)
  - What's in your air?
  - Land (bank) and Water (department): A Philly update...
  - A tale of caution for a precious resource
  - HYOH: Hike Your Own Hike
  - Speak now: Public hearings on new oil and gas regu...
- 2013 (34)

## Search posts

Search

## Labels

acid mine drainage Act  
13 air toxics Allegheny  
County Appalachian  
Trail Arkansas  
Ashland Oil asthma  
bald eagles begos  
benchmarking Bob  
Murray Breathe Project  
building code building  
codes building owners  
buildings cancer  
Carnegie Mellon caspr  
CHEC chemical spill  
Chesapeake  
Chesapeake Bay  
Foundation Choose  
Clean Water Coalition  
City Council  
climate action plan  
Climate change  
coal community  
complete streets  
conservative  
contamination  
Corbett cracker  
cross-slate air pollution

Species Act was designed to achieve these goals by making it unlawful for any person to harass or take a listed species, including adversely affecting the habitat of a listed species in a manner that effects a take. Similarly, state law currently imposes the obligation on operators to ensure that their activities will not adversely affect listed species or their habitat.

The proposed regulations change that obligation by only requiring gas operators to mitigate the impact of their operations on threatened or endangered species if the DEP determines that the well site location will adversely impact species or "critical habitat."

Because an operator proposing an oil or gas project stands to gain financially from the project, and is in the best position to understand the scope and potential impact of its proposal, the operator (and not the DEP) should have the burden of determining whether its project would affect listed species and their habitat.

**The DEP should respond to comments received about a permit that may affect an important public resource. (Section 78.15(d))**

The proposed regulations allow for a public resource agency to receive notice of, and submit comments about, a proposed well permit that would affect its resources. The regulations, however, do not require the DEP to respond to those comments. To ensure that comments are adequately considered and that public resources are fully protected, the regulations should require the DEP to respond to comments submitted by public resource agencies.

**The DEP should not compromise its obligation to protect the environment by balancing the citizens' constitutionally guaranteed right against private interests in oil and gas. (Section 78.15(g))**

The DEP is required by the Pennsylvania Constitution to protect the public's right to a clean environment. The proposed regulations provide that even though the DEP determines that a proposed well will have a probable adverse impact on a public resource, the DEP still cannot impose conditions that will prevent or mitigate that harm without first considering the impact of the condition on the individual mineral right owner's ability to "optimally" develop his or her oil and gas rights. This regulation inappropriately places the DEP, whose mission is supposed to be to protect and conserve Pennsylvania's environment, in the position of balancing protection of important public resources against individual property rights. Furthermore, it inappropriately, and potentially illegally, elevates the "optimal" development of oil and gas over the protection of important public resources against likely adverse impacts. These draft regulations do not give proper weight to the DEP's constitutional obligation to protect the environment. So long as the DEP's actions do not affect a taking of private property, the DEP should be obligated to take whatever actions are necessary to condition permits in a manner that protects important public resources.

**The DEP's duty to investigate water pollution should extend to the all oil and gas activities. (Section 78.51(c)).**

The Chapter 78 regulations require the DEP to investigate instances of water pollution that occur near oil and gas wells. As part of its investigation, the DEP may determine that water pollution was caused by the "well site construction, drilling, alteration or operation activities." This set of activities is much more limited than the list of activities defined as "oil and gas activities" in Act 13. To ensure maximum protection of water resources, the DEP's investigation should extend to all oil and gas activities.

**The prohibition on construction of fluid storage areas within 100 feet of certain water bodies should be extended to all water bodies. (Section 78.59c)**

The current draft regulations prohibit well operators from building "centralized impoundments" for wastewaters within 100 feet of any "solid blue line stream" identified by the United States Geological Survey. Solid blue line streams flow consistently year round. This 100 foot buffer is important, but it should be extended to other streams that do not flow continuously. Although we recognize that Act 13 unwisely referred to "solid blue line streams," intermittent and ephemeral streams need to be protected as well. Some of our most vulnerable waters are intermittent portions of high quality streams. Those waters would not be adequately protected by these regulations. Furthermore, the DEP has an obligation to protect intermittent streams under the Clean Streams Law. Rather than attempt to make that decision on a case by case analysis, the DEP should extend this buffer to all Pennsylvania streams.

oil OGD DEP  
 gasline chemical wells  
 DOE another  
 drinking water blue  
 carbonates effluent  
 ammonia source  
 energy source  
 concentrating energy  
 efficiency energy  
 performance  
 environment  
 environmental  
 protection EPA EOC  
 event flat energy nat.  
 and heat compression  
 flat and water force  
 fragmentation fossil fuel  
 fracking  
 transportation infrastructure  
 industries bank and  
 water gas  
 construction gas panel  
 warning Governor  
 Capitol grants  
 Greenbelt  
 groundwater  
 financing habitat  
 key plays water PB  
 TSC health costs high  
 quality blue line Your  
 Own Risk industry  
 HYDR industry  
 infrastructure priority  
 sector transportation  
 River land bank  
 title Longline Little Run  
 longwall mining  
 Lyonsack State Forest  
 agency Maple Creek  
 Marcellus  
 Margaret Bingham  
 Mayor Michael Neme  
 Mayor's Office of  
 Sustainability MOHS  
 member membership  
 regulatory laws mining  
 permits methane power  
 Monongahela River  
 roads National  
 Academy of Science  
 natural gas NHTI  
 New York Times Next  
 Great City Change oil  
 and gas Oil and Gas  
 Act ozone mercury  
 particulate matter  
 parties PBA Penn State  
 PennFuture  
 Pennsylvania phil  
 grants  
 Philadelphia  
 Philadelphia Land  
 Bank Philadelphia  
 Water Department  
 Philly pipeline  
 Pittsburgh Pension  
 industry PRFA  
 property public health  
 public hearings public  
 lands RAC radon rare  
 red acid Reilly  
 renewable energy  
 renewables rivers  
 Ruckelshaus  
 scumination Sen.  
 Charles McInnis

**The DEP should stop promoting the disposal of residual waste at well sites. (Section 78.62)**

The draft regulations would allow well operators to dispose of residual waste in pits on well sites as long as they comply with certain minimal requirements. Because waste generated at oil and gas sites is exempt from the hazardous waste regulations, the result is that hazardous waste can be managed as residual waste and disposed at well sites with a single synthetic liner and no long-term groundwater monitoring. These minimal protections are inadequate.

As the DEP knows, many well-site disposal pits have leaked in recent years, contaminating surface and groundwater and dotting the Pennsylvania countryside with brownfield sites. Given the high risks of these mini-landfills, and the fact that their one and only advantage is fewer truck trips to landfills (and reduced cost for operators), the DEP should prohibit well site disposal of residual waste entirely. To the extent that the DEP continues to allow this method of waste disposal it should, at a minimum, require long-term groundwater monitoring and public notice of existing and future disposal sites.

**The DEP should strengthen its regulatory mechanisms for ensuring that pits and impoundments are constructed in a structurally sound manner and according to regulation. (Section 78.59c(m))**

The rulemaking proposes to allow engineer certifications that pits and impoundments have been correctly constructed in lieu of DEP inspections. If the DEP is not itself capable of ensuring proper construction of facilities such as centralized impoundments, these certifications should be submitted under penalty of law for unsworn falsification to authorities (18 P.S. § 4904) so that any intentional falsification can be prosecuted criminally. The DEP should also mandate better self-monitoring by requiring that photographs or video be taken of the finished construction so that there is evidence of the site construction that can be reviewed after the fact.

**Any disposal of waste materials at well sites should require that representative samples of the material be taken and analyzed and submitted to the agency to demonstrate that, for example, the drill cuttings are not contaminated, or that residual waste meets the regulatory standards. (Sections 78.61 and 78.62)**

If waste is disposed at well sites, a sample of the material should be taken and analyzed. This sample should be sent to the agency to demonstrate that drill cuttings are not contaminated, and that any residual waste does not exceed legal limits. The regulations do not currently require that the operator use any scientific methodology to demonstrate compliance.

**The collection and analysis of chemical samples of waste that the operator intends to dispose on site should not be discretionary; the regulations should be clear that is a mandatory obligation. This is particularly of concern where the disposal site does not need to be inspected by the agency prior to closure, and there is no long-term groundwater monitoring. (Section 78.63(19))**

Collection and analysis of chemical waste samples that are intended to be disposed of onsite needs to be a mandatory requirement. The draft regulations leave this to the discretion of the operator, which should not be permitted. This is particularly important where a disposal site does not need to be inspected by the agency prior to closure, and there is no provision for long term monitoring of ground water.

**The DEP's proposed regulations for the road-spreading of brine pose unacceptable threats to the Commonwealth's water resources – and would be unlawful. (Section 78.70a)**

Section 78.70 of the DEP's proposed oil and gas regulations would authorize the road-spreading of brine from conventional wells for dust control on dirt and gravel roads. Proposed section 78.70a would authorize the road-spreading of brine for de-icing purposes. Both sections would deem any operator that spreads brine on roads to have a "permit-by-rule" for the beneficial use of residual waste as long as the operator complies with the proposed Chapter 78 regulatory scheme.

DEP's approach is troublesome for two reasons. First, because the proposed regulations do not ensure compliance with the DEP's anti-degradation program or contain adequate chain-of-custody requirements, the risks of spreading brine on roads outweigh the benefits, which are largely confined to disposal-cost savings for the industry.

shale shale  
gas Shippensburg  
University soot  
standards state forests  
stormwater streams  
study subsidence  
subsidies support  
supreme court  
Susquehanna River  
sustainable talking  
points tank collapse  
Thomas UMCO Energy  
united church of Christ  
vacant properties  
vacant property vacant  
spaces wastewater  
water West Virginia  
wet gas Whitman  
Wilkes-Barre  
Williamsport wind  
power Yeats you

**PennFuture has staff throughout Pennsylvania.**

The Philadelphia Inquirer called PennFuture the "state's leading environmental advocacy organization;" the Pittsburgh Post-Gazette named the organization "one of the 10 most influential groups on the issue of natural gas drilling;" and StateImpact Pennsylvania, an online collaboration of NPR stations across the state, called PennFuture "the commonwealth's main environmental advocate."

The second problem with sections 78.70 and 78.70a is a legal one. All wastewaters from oil and gas operations, including brine, are residual waste under the Pennsylvania Solid Waste Management Act ("SWMA"). It follows that any beneficial use of brine, including dust suppression and de-icing, is subject to regulation under the DEP's SWMA regulations at 25 Pa. Code Chapter 287. These regulations do not currently allow permits-by-rule for road-spreading or any other beneficial use of brine. Beneficial uses of brine may be approved only under the general permit scheme set forth in Subchapter H of Chapter 287. Thus, the permit-by-rule scheme proposed in sections 78.70 and 78.70a is not only imprudent; it would also be illegal.

**The DEP's revisions to Chapter 78 should establish meaningful standards for the restoration of well sites and impoundment sites. (Sections 78.65, 78.59b, and 78.59c)**

Act 13 requires two stages of restoration for well sites. On the one hand, section 3216 (c) requires partial restoration after the conclusion of drilling and fracturing operations. On the other hand, section 3216(d) requires final restoration after the last well on the site has been plugged. The DEP is proposing to implement these sections in proposed regulation 78.65, which provides that a well site will be considered restored if it is returned to its "approximate original conditions, including preconstruction contours," and if it "can support the original land uses to the extent practicable." Similar language appears in the DEP's proposed regulations for freshwater impoundments (78.59b) and centralized wastewater impoundments (78.59c), which also contain restoration requirements.

A return to original conditions, contours, and uses is a laudable goal for the restoration of well sites (both post-drilling and post-plugging) and impoundment sites. Currently, though, the DEP's general restoration standards are practically unenforceable because the DEP's regulations (i) fail to require environmental baseline site assessments, (ii) fail to require site-specific standards and criteria for restoration, (iii) fail to require environmental professionals to sign off on site restorations, and (iv) establish no process whereby the DEP can finally approve or disapprove restoration. The DEP should require site-specific baseline assessments and restoration plans for all well sites and impoundment sites, require professional certification that restoration goals have been met, and require DEP approval before a site can be considered to be restored.

**The DEP's proposed regulations regarding bonding are inadequate, because they fail to ensure that well sites and impoundment sites will be finally restored before they are released from operators' bonds. (Subchapter G)**

Under Act 13, an operator can obtain one blanket bond in the amount of \$600,000 that covers all of an operator's well sites in the Commonwealth. Despite the extremely low amount of this bonding requirement (and of all of Act 13's bonding requirements), the bond is supposed to secure all of the operator's legal duties regarding water supply replacement, restoration and well-plugging.

The DEP may not have the power to require higher amounts for bonds than the Act 13 amounts, but it can and should establish a process to ensure that operators are not released from liability for particular well sites until those sites are properly restored. The DEP's proposed revised bonding regulations (set forth in Subchapter G of Chapter 78) fail to do this. They condition release from liability only on the filing of a certificate of plugging. Release from liability should also be conditioned on the adequate final restoration of the well site after the last well on the site has been plugged.

*Andrew Sharp is PennFuture's Director of Outreach and works out of our Philadelphia office.*

Posted by Andrew Sharp at 12:17 PM

 +1 Recommend this on Google

Labels: DEP, EQB, fracking, oil and gas, public hearings, talking points

**1 comment:**



Jack Wolf January 8, 2014 at 4:07 PM

I would also like to point out that those "natural depressions" would include vernal ponds, a seasonal wetland used for spring spawning.

Reply

Enter your comment...

Comment as: [Select profile...](#)

[Preview](#)

[Newer Post](#)

[Home](#)

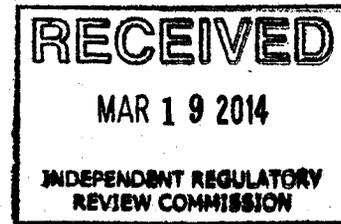
[Older Post](#)

**Subscribe to:** [Post Comments \(Atom\)](#)

Copyright 2013 PennFuture. All Rights Reserved.  
Simple template. Powered by Blogger.

3042

Louis F. Pochet  
915 Essex Drive  
Greensburg, PA 15601  
Jan 22, 2014



Dear EQB (Environmental Quality Board).

As a citizens of Westmoreland County and the state of Pennsylvania – and a retired Chemist/Chem Engineer, I find myself concerned with the environmental laxity of the DEP and EPA in addressing the potential issues of harm to the environment that can be the collateral damage of the natural gas – fracking technology as it is currently regulated and practiced. We here in PA have been blessed with an environment that we can all be proud of but we must be extremely concerned about the impacts of this new industry.

A major concern has to be our water supplies – particularly after the poorly regulated situation in Charleston, WV that just occurred. A simple chemical spill took out the water supply for 300,000 people because of the lack of regulations and oversight. Open pits and wastewater impoundments, also lacking sadly in WV, have a tendency to fail – from poor construction or by forces of nature – which imply that the safest feature that would minimize environmental hazards would be the requirement for a closed loop system as a basic water handling technique. It must be appreciated that somewhere between 1 million and 7 million gallons of water are needed to frack a single well – which may be fracked over the course of its lifetime possibly up to 6 or 7 additional times. Water – even abundant here in PA compared to the western part of the US is still a valuable resource and must be protected from inadvertent mishaps.

An additional concern has to be the radioactive waste as generated from oil and gas operations. This is radon country – and radon gas will be released in the drilling process as well as contamination in the shale waste. As I recall several years ago, the interstate 99 portion of that road between Altoona and Penn State was held up for years because no one wanted to take the sulfur – pyrite contaminated shale fill that was being produced in the road cuts because of their acidic waste content, As a concerned citizen, This unwanted material needs to be disposed of properly not haphazardly and not permitted to blow around as an air pollutant

It is extremely important that the EQB and DEP act not solely in the interests of the gas industry but primarily in the interests of the citizens of our state in preserving our environment. This includes proper regulation as well as proper oversight. What I have found over my 40 years in industry is that environmental and safety directors when held accountable, will typically follow lawful regulations since they are primarily the fall guy and would be blamed for inadequacies by those further up the management tier. This implies again the need for real regulations.

As stipulated by the Pennsylvania state constitution, I would like to reiterate my concern in how the EQB and the DEP plans to address these areas to protect all of our rights to a clean and healthy environment. Several points that follow **MUST** be addressed properly:

- 1) Water supplies must be restored to Safe Drinking Water standards at a **MINIMUM** when a water source is impacted. We are still fighting the clean-up of many of our water resources after a century of mine acid water drainage.
- 2) The DEP must be required to proactively establish standards for pre-drill testing of the water in impacted areas using impact fees with cost burdens to be the responsibility of the drilling company. A fund needs to be established to handle future problems that may be generated by the driller.
- 3) The DEP can not allow the storage of wastewater in open pits or impoundments--and must be responsible for any contamination that they accidentally or knowingly caused. This also protects our wildlife, birds and fish from collateral poisoning.
- 4) The DEP needs to require drill cuttings to be tested for radioactivity and to find a way to dispose of those radioactive waste products.
- 5) Residual waste disposal on roads and land is not a beneficial use and common sense says that this is what happened at Times Beach, MO years ago and the disposal of residual waste from gas and oil development has many of the same problems. It spreads the waste far afield but byproduct wastes can pollute waterways and landscapes in a more significant manner than other residual wastes. DEP regulations must ensure that land spreading does not result in contamination of soil, vegetation, and groundwater, particularly near drinking water supplies, streams, and rivers.
- 6) Potential stray gas migration is also not being addressed by the proposed rules. Stray gas migration has been and continues to be a major problem in the gas fields of Pennsylvania. Old unplugged and abandoned wells are a source of gas which migrates and if and when the concrete casings crack, which is a 50% certainty over a decade even more problems will occur. There must be a means to eliminate potential pathways for fluid movement into groundwater before conducting hydraulic fracturing operations. The proposed rules for pre-fracking surveys must require on-site inspections and assessments for the purposes of identification of orphaned or abandoned wells prior to drilling.
- 7) There must be provisions in regulations to require the original driller – gas well owner to provide for the capping of all played out wells.

Thank You,

Lou Pochet

JANUARY 20, 2014 EDITED BY WILLIAM G. SCHULZ &amp; EMILY BONES

## TOXICITY UNKNOWN

**POLLUTION:** Lack of hazard data hampers response to chemical spill in West Virginia

**A** LACK OF TOXICITY data stymied officials in Charleston, W.Va., last week as they rushed to clean up the city's contaminated drinking water system.

They ordered more than 300,000 people not to drink or wash in tap water for nearly a week after a leaking chemical storage tank poured thousands of gallons of a coal-processing liquid into the Elk River. They advised pregnant women to drink bottled water until the chemical is no longer detectable in the water system.

The leaking tank is about 1 mile upstream from the intake pipe for Charleston's water supply system, which is the state's largest. Freedom Industries, a chemical supplier and blender, owns the tank.

Polluting the water system was crude 4-methylcyclohexanemethanol (MCHM), which is used to clean coal for electricity-generating plants.

Little is known about the hazards of the substance, a situation that left officials scrambling for answers as they faced a frightened and angry public.

"That was a new chemical for us. We never encountered it in any of our previous investigations," says Daniel M. Horowitz, managing director of the Chemical Safety & Hazard Investigation Board. CSB began probing the incident at the urging of Sen. John D. Rockefeller IV (D-W.Va.) soon after the leak was discovered on Jan. 10.

"There is not a great deal known about MCHM's toxicity, and that is one of the reasons this accident has been difficult," Horowitz says. "You never want to be in the position of performing a toxicity experiment like this on your own drinking water supply."

A 2011 material safety data sheet from Eastman Chemical, the maker of MCHM, warns that the substance is "harmful if swallowed" and "causes skin and eye irritation." But it offers little more information, with more than two dozen entries marked "no data available." These include inhalation effects, carcinogenicity, reproductive toxicity, biodegradability, and physical-chemical properties including evaporation rate.

The lack of toxicity data on MCHM, Horowitz says, demonstrates "a very profound point: There are literally tens of thousands of chemicals that are out there

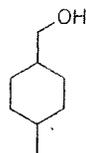
for which we don't have complete hazard information."

"We really need these chemical data to be available at the time something happens so that intelligent decisions can be made," agrees Richard Denison, senior scientist with the Environmental Defense Fund, an activist group.

But the 37-year-old federal law governing chemical production, the Toxic Substances Control Act (TSCA), doesn't require chemical makers to generate this information. Companies are not mandated to submit hazard information they have to the Environmental Protection Agency, except when data suggest the possibility of substantial risk. Instead, TSCA sets up complex legal requirements that EPA must meet before the agency can require manufacturers to provide toxicity data for a chemical in commerce.

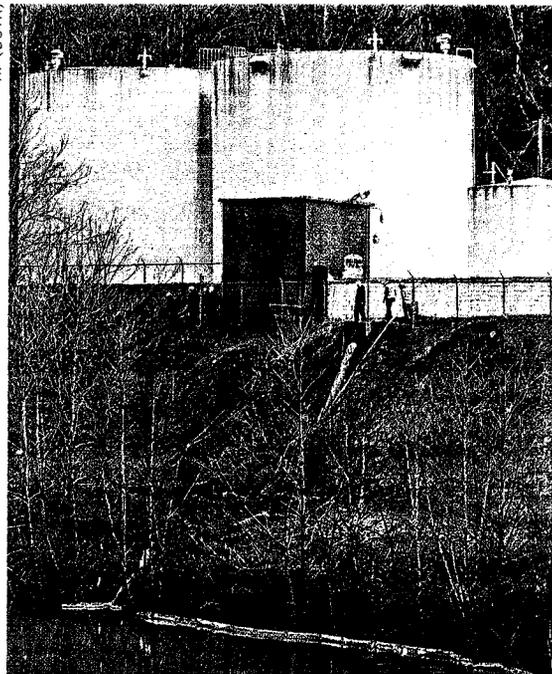
The MCHM incident marks the third major chemical industry accident near the West

Virginia capital that CSB has investigated in the past six years, Horowitz says. In 2010,



4-Methylcyclohexanemethanol

AP (BOTH)



396



Freedom Industries' storage tanks (above) are adjacent to the Elk River. Tank number 396 (left) is the one that leaked the coal-processing chemical, tainting the Charleston, W.Va., water supply.

a worker died at the DuPont chemical manufacturing plant in Belle, W.Va., east of Charleston, when three accidents, one involving phosgene, occurred within 33 hours. In 2008, two workers were killed by a blast at the Bayer CropScience plant in Institute, W.Va., west of the capital, and some 40,000 nearby residents were ordered to shelter in place.—JEFF JOHNSON & CHERYL HOGUE

1/2/14  
CORPORATE NEWS

# For U.S. Drillers, Less Cash

## Foreign Investors Back Away From Energy Projects Amid Low Natural-Gas Prices

BY DANIEL GILBERT

Since 2008, deep-pocketed foreign investors have subsidized the U.S. energy boom, as oil and gas companies spent far more money on leasing and drilling than they made selling crude and natural gas.

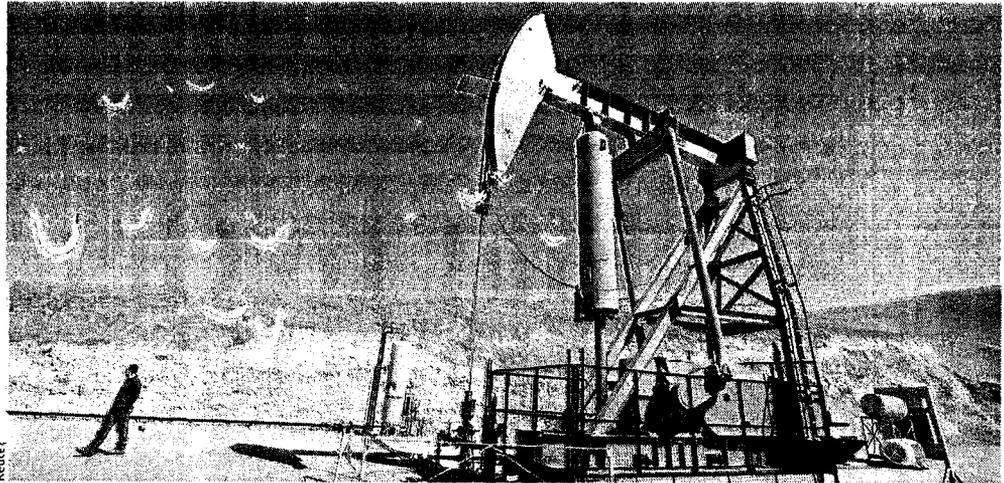
But the rivers of foreign cash are running dry for U.S. drillers. In 2013, international companies spent \$3.4 billion for stakes in U.S. shale-rock formations, less than half of what they invested in 2012 and a tenth of their spending in 2011, according to data from IHS Herold, a research and consulting firm.

It is a sign of leaner times for the cash-hungry companies that have revived American energy output. The value of deals involving U.S. energy producers plunged 48% this year from 2012, to \$47 billion, the first annual decline since 2008, according to an IHS report to be published Thursday.

So U.S. oil and gas producers have started to slash spending. "The days of easy money are over," said Amy Myers Jaffe, executive director of energy and sustainability at the University of California-Davis. "The emphasis is going to be on lowering costs."

Foreign cash helped cover the cost of the deep wells and heavy horsepower required to unlock oil and gas from shale and other dense rock in the U.S. The need for it has been acute: Last year, 80 big energy companies in North America spent a combined \$50.6 billion more than they brought in from their operations, according to data from S&P Capital IQ. That deficit was twice as high as in 2011, and four times as high as in 2010.

The same producers have dialed back through the first nine months of 2013, though they still spent about \$18.7 billion more



Foreign shale-drilling investment sank in 2013 compared with 2012. Above, drilling for oil in the Monterey Shale.

than their cash flow.

U.S. and Canadian producers are "returning to spending within their means," analysts at Sanford C. Bernstein wrote in a research note last week that analyzed spending patterns of 50 companies.

They are also turning to other investors, including private equity and the stock market, as overseas buyers lose their appetite for American energy projects. The shift has big implications for the oil and gas industry, analysts say, because Wall Street investors tend to be more sensitive to profits and stock prices, while foreign investors have historically been more focused on acquiring energy reserves and technology.

John Walker has seen this shift up close. The chief executive of closely held EnerVest Ltd. had courted big energy companies in Japan, Korea and China when he decided to sell vast holdings in Ohio's Utica Shale.

But more than a year later, Houston-based EnerVest and its publicly traded arm, EV Energy Partners LP, have sold only a portion of their Utica acreage for

\$284 million, well shy of the \$6 billion Mr. Walker sought for all Utica interests. The buyer came not from Asia but Oklahoma: A new company backed by private equity and led by Aubrey McClendon, the former head of Chesapeake Energy Corp.

"The whole market changed," Mr. Walker said in a recent interview. Asian investors were interested in the company's Utica Shale assets, he said, but very few bid. EnerVest has shifted gears, marketing the Utica properties in smaller packages to appeal to other energy companies with less cash on hand.

Chronically low natural-gas prices have prompted international firms to cool on American shale, with some experiencing buyers' remorse. Royal Dutch Shell PLC in July concluded that its shale properties in North America were worth \$2 billion less than it had estimated. A year earlier, BHP Billiton Ltd. wrote down the value of its U.S. shale-gas fields by \$2.8 billion.

In 2013 natural gas prices rebounded 26% to end the year at \$4.23 per million British thermal units. But that increase came off

near-historic lows. Natural gas prices sunk below \$2 in 2012, the lowest level in a decade, as surging output across the U.S. and mild weather left a glut of the fuel. Prices rose last year as some power companies shifted to gas to reduce use of coal.

Some of the biggest financiers of the shale boom don't expect the major Asian and European firms to reopen the spigot any time soon.

"They're in digestion mode," said Ralph Eads, vice chairman and global head of energy investment banking at Jefferies Group LLC. Still, he said, "as the foreign guys have withdrawn, we've seen a step-up in activity from private equity."

Riverstone Holdings LLC, a private-equity giant focused on energy, said last month it would invest up to \$300 million in closely held oil-and-gas producer Eagle Energy Exploration LLC.

The IPO market, too, remains a big source of financing for energy producers. Antero Resources Corp.'s \$1.6 billion public offering last month was the year's fifth-biggest among U.S. listed firms.

less people in  
times.

B6  
B1  
C8  
B6  
B3, B5

C2  
B6  
B2  
B3  
B1  
B2  
C3  
B2  
B2  
R4  
B2  
B3  
B2  
B1  
A1  
A2, R1

B6  
ns  
C3  
B2  
B1  
B6  
B1  
C2

2  
5  
4

1  
2  
3  
4



Your One-Stop Source for Process Measurement &amp; Control

1-888-TC-OMEGA (1-888-826-6342) US and Canada  
1-203-359-1660 INTERNATIONAL


[Home](#)
[Quick Order](#)
[Products](#)
[Search Tools](#)
[Support](#)
[About OMEGA](#)
[My Account](#)
[Select Region](#)

[Home](#) >> [Environmental](#) >> [Water Analysis](#) >> [Water Analysis](#) >> PHH60 and PHH80 POCKET PAL® Series of Handheld Instruments

PHH60 and PHH80 POCKET PAL® Series of Handheld Instruments

### PHH60 and PHH80 POCKET PAL® Series of Handheld Instruments



pH Probe


[Click for larger image.](#)
**\$360.00** PHH-60BMS

- Measures pH, pH/Conductivity, or pH/ORP
- Two Buttons Control All Operations
- Electrodes Fold Away into Handle When Not in Use
- Detachable Electrodes
- Integral Benchtop Stand

[View related products - Water Analysis](#)

[Scroll to Order](#)

[Specs](#)

[Related Products](#)

[Printer Friendly](#)

The POCKET PAL Series of handheld instruments are rapidly becoming an industry favorite for field and laboratory applications. The electrodes are designed for easy field replacement and can be quickly calibrated with easy access twopoint calibration potentiometers. Digital display, chemical resistant ABS plastic housings and probes that fold-away for protection make the POCKET PAL series ideal for portability and reliability.

The low cost PHH-81A is ideally suited for general pH measurements in field, plant, production line or laboratory environments. The PHH-81A features manual temperature compensation and a standard BNC connector allowing for use with a wide variety of laboratory and industrial pH electrodes.

For versatility in the field or the laboratory, the PHH-60BMS/TDS and PHH80BMS/TDS feature the ability to make pH, conductivity and total dissolved solids measurements in one handheld instrument. The PHH-60B measures pH from 0 to 14 and conductivity from 0 to 19,990  $\mu\text{mhos}$  or  $\text{ppm}$ , and the PHH-80B extends the conductivity measuring range to 199,900  $\mu\text{mhos}$  or  $\text{ppm}$ . Recessed switches control all functions, and an easy access panel contains adjustments for pH calibration and slope, zero and span for conductivity. Features include automatic temperature compensation (ATC), detachable electrodes and integral benchtop stand.

The PHH-82B is a dual-function instrument that measures pH and ORP (oxidationreduction potential). It is ideal for measurements of ORPs that are pH dependent. Applications include swimming pool maintenance, drinking water disinfection, chrome reduction and cyanide destruction of electroplating. Features include detachable electrodes and integral benchtop stand.

#### SPECIFICATIONS

##### PHH-60BMS/TDS and PHH-80BMS/TDS

**pH Range:** 0 to 14 pH

**Resolution:** 0.01 pH

**Accuracy:**  $\pm 0.02$  pH Temperature

**Compensation:** Automatic 0 to 70°C (32 to 158°F)

##### Conductivity

###### Range:

**PHH-60BMS:** 0 to 19,990  $\mu\text{mhos}$

**PHH-60BTDS:** 0 to 19,990  $\text{ppm}$

**PHH-80BMS:** 0 to 199,900  $\mu\text{mhos}$

**PHH-80BTDS:** 0 to 199,900  $\text{ppm}$

###### Resolution:

**PHH-60BMS/TDS:** 10  $\mu\text{mhos/ppm}$

**PHH-80BMS/TDS:** Range 0 to 2000 1  $\mu\text{mhos/ppm}$ ; 0 to 20,000 10  $\mu\text{mhos}$ / 0 to 200,000, 100  $\mu\text{mhos}$

**Accuracy:**  $\pm 2\%$  of span

**Temperature Compensation:** Automatic 0 to 50°C (32 to 122°F)



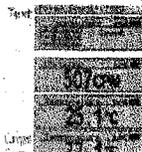
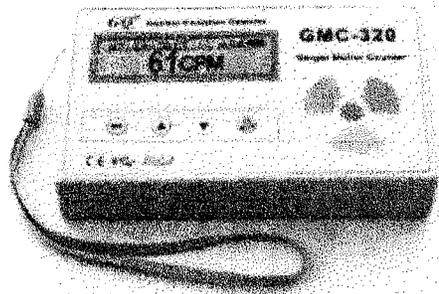
ALKALINE WATER IONIZERS GEIGER COUNTERS

Register | Login | My Account | Checkout | Shopping Cart

HOME ABOUT STORE NEWS CONTACTS

SEARCH

Home > Radiation Detectors > Dosimeters > Radiation Detector Dosimeter Geiger Counter GMC-320 GQ



Category: Dosimeters, Geiger Counters, Radiation Detectors.

### RADIATION DETECTOR DOSIMETER GEIGER COUNTER GMC-320 GQ

Price: \$175.00

IN STOCK

Not rated

No reviews

GMC-320 Radiation Detector Geiger Counter GQ Electronics

1

Tweet 0

Radiation detection: Beta, Gamma and X-Ray .

Sensitivity to Gamma Radiation: 0.1-1 MeV

Own Background: 0,2 Pulses/s

Working Voltage: 3.2-4.0V

LCD Display: Dot matrix with back light

Working power: 0.045W - 0.2W

Power: 3.6V/3.7V battery / USB power

#### CATEGORIES

- Shower Filters
- Home and Garden
- Water Quality Testers
  - Thermometers
  - EC Meters Testers
  - ORP Meters Testers
  - TDS Meters Testers
  - pH Meters Testers
- Health and Beauty
  - Alkaline Water Ionizers
    - Under Sink Water Ionizers
    - Basic Water Ionizers
    - Economic Water Ionizers
    - Advanced Water Ionizers
    - Luxury Water Ionizers
    - Alkaline Water Filters
- EMF Meters
- Nitrate Testers
- Radiation Defense
- Radiation Detectors
  - Geiger Counters
  - Dosimeters

#### TOP RATED



Ecotester Soaks 2 in 1: Nitrate Tester and Radiation Detector

\$249.00

Radiation Dosimeter Defender



Product Search


[About](#) | [What's New](#) | [Where to Buy](#) | [Service & Support](#) | [Products/Catalogs](#) | [Register Products](#) | [Promotions](#) | [Updates/Downloads](#) | [Contact Us](#)

## POPULAR PRODUCTS

Search for a product by part number, or keyword: 

Example: enter 79 for all products with 79 in the part number

Search for a product by category 

Search

TIF8900

Combustible Gas Detector



- Solid state sensor technology, long life and precision
- Broad band of combustible gas detection
- Sensitivity as low as 5 ppm
- Adjustable sensitivity
- Audible "Geiger counter" signal
- LED Leak Intensity Lights
- Automatic warm up
- Cordless operation
- Flexible 16" stainless probe for hard to reach places
- Rechargeable battery and charger included
- Rugged custom carrying case
- Made in the USA

## Applications:

TIF8900 is the perfect tool to be used in a situation where a combustible gas, vapor or residue needs to be found.

- Gas lines and Pipes
- Exhaust and Fuel leaks
- Propane filling stations
- Fuel in marine bilges
- Heat Exchanger leaks
- Check manholes for safety
- Detect arson residue
- IAQ tests
- Liquid or gas fired heating systems

## Specifications

Battery Life: 4 Hours/Charge

Voltage (Charger): 115V, 60Hz

Probe Length: 15" (38cm)

Power Supply: (Two) 2.4V Ni-Cad Batteries

Operating Time: Instantaneous

Warm-up Time: 30 seconds

## Image Files

[Low Quality](#)[High Quality](#)

## Document Files

[English Operating Instructions](#)

Bosch Automotive Service Solutions | 655 Eisenhower Drive, Owatonna, MN 55060  
 Customer Service Phone: 800-327-5060 | Fax: 866-287-7222 | Email: [inquiry@service-solutions.com](mailto:inquiry@service-solutions.com)  
 Tech Service Phone: 800-327-6060 | Fax: 866-259-1241  
 International Sales Phone: 507-455-7223 | Fax: 507-455-7063  
 © 2013 Bosch Automotive Service Solutions LLC

[Legal © Copyright Disclaimer](#)[Customer Service](#) | [Give us some feedback](#) | [Join our mailing list](#)

I'm here to talk about a family who lives in Duke Center, (McKean County), Pennsylvania.  
(Duke Center, Otto Twp. borders New York State)

The Thomases. When they look out their window they see abandoned wells and oil tanks.

A large number of these wells are leaking oil and natural gas. There are puddles of oil, acres of contaminated soil, pump-jacks, an abandoned brine pit, plastic and metal pipelines, electric wires, deteriorating storage tanks, all abandoned.

The Thomases recently discovered another abandoned well on their property, bringing the number of found wells up to 32. Some wells have had their wellheads and the entire related infrastructure removed, in areas where the vegetation is heavy, locating wells has been difficult. 65 are identified on a historic map.

Sometimes there is a light sheen of oil flowing down Knapp Creek, a tributary of the Allegheny River. During rain and flood events, the flow of oil increases.

The situation recently took a turn for the worse when a large oil storage tank failed, sending its contents of oil downstream. Another well, (one of the 32 wells) that has not leaked in the past; started to leak (oil) the other day.

Thirteen of the wells don't have API numbers. None of the 32 wells are identified on DEP's online map; even after many reports to DEP officials.

In addition to the DEP, Rep. Martin Causer, many individuals, and officials, from local on up to the governor's office, organizations including the McKean County Conservation District, the Fish and Boat Commission, The National Response Center, the EPA, and many others have been contacted about this.

An administrative order was issued (several months ago) by the DEP to the administrator of the deceased operator's estate; it doesn't seem to be worth the paper it's printed on.

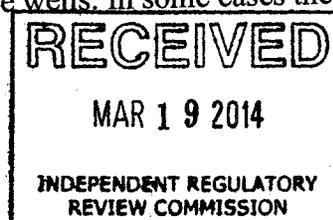
None of the 19 wells that are identified in the order has made it to the DEP's online map either.

Despite emails, phone calls & many pleas for help, oil from these wells continues to enter the watershed many New York State and Pennsylvania citizens rely.

Currently operators are required to post bonds equal to *only a fraction*\* of the actual cost of plugging. This *increases* the likelihood of improper well abandonment.

Regulations which would require operators to post bonds *equal to the approximate cost* of plugging their wells would immediately *reduce* the risks associated with improper well abandonment.

Some operators have accrued large numbers of inactive wells. In some cases these represent a great percentage of their well inventories.



Limiting the number of inactive wells, and also the percentage of inactive wells operators are permitted to accrue in their inventories by setting regulatory limits will minimize the risk of inheritance these wells present to surface owners, stakeholders and more importantly, The Commonwealth.

Requiring operators through regulations to plug orphan, abandoned and inactive wells in their inventories, before authorizing permits to drill and operate new wells will encourage operators to plug their depleted wells and would also provide much needed protection for the environment, surface owners and other stakeholders.

Allowing operators who have accrued large numbers of depleted\*\* inactive wells that may never be commercially viable to apply for Act 13 impact funds to be used to plug inactive (depleted) wells would go a long way to addressing these risks, while providing employment opportunities.

Allowing surface owners to apply for Act 13 impact funds to be used to plug legacy wells on their property would enable citizens to take a pro-active role in reducing contamination and The Commonwealth's green house gas emissions.

Conservation districts, and other organizations that have refused to assist or chosen not to respond to oil and gas related contamination incidents, should not be eligible to receive Act 13 funds.

This will encourage conservation districts, and other organization to take a pro- active role in remediating oil and gas related impacts on The Commonwealth's natural resources.

This was one of the intended uses for Act 13 funds. The organizations that would use Act 13 funds for pet projects while turning their backs on needed remediation is an insult to the spirit of Act 13.

\* See attached: Economic Incentives and Regulatory Framework for Shale Gas Well Site Reclamation in Pennsylvania, by Austin L. Mitchell and Elizabeth A. Casman  
Department of Engineering and Public Policy, Carnegie Mellon University  
[http://www.hydrorelief.org/frackdata/new\\_nov/Mitchell2011\\_pluggingwells.pdf](http://www.hydrorelief.org/frackdata/new_nov/Mitchell2011_pluggingwells.pdf)

\*\* Not depleted, wells that are granted "inactive" status while waiting for associated infrastructure such as gathering lines etc.

Laurie Barr  
275 Kim Hill Road  
Roulette, Pa  
16746  
[saveourstreamspa@gmail.com](mailto:saveourstreamspa@gmail.com)  
814-203-9772



## Sen. Bob Casey wants feds to help investigate Pennsylvania house explosions

The Associated Press By The Associated Press

on March 29, 2011 at 6:00 PM, updated March 29, 2011 at 6:12 PM

BRADFORD, Pa. — U.S. Sen. Bob Casey wants the federal Department of Energy to help local, county and state emergency and environmental officials investigate migrating methane gas as the likely cause of two house explosions in northwestern Pennsylvania.

A state police fire marshal has said he can't yet pinpoint that as the cause of the explosions that leveled two Bradford Township homes, one on Dec. 12, the other on Feb. 28. But the Pennsylvania Democrat said in his letter to Energy Secretary Steven Chu that migrating methane from nearby oil or gas wells is believed to be the culprit.

"The belief that the source of the explosions is some type of thermogenic gas migration caused by extensive drilling appears to be widespread," Casey said in the letter, first reported Tuesday by the Bradford Era.

Casey's letter detailed not just the house explosions, but other "nonresidential incidents" in nearby Mount Jewett Borough and a "well ignition" in the same general area. Nobody was killed in either explosion, though an elderly couple was home and injured in the December blast. The owner of the home that blew up in February was outside and sustained only minor injuries.

"While investigations are ongoing, the initial determinations are that these harrowing incidents were not caused by any gas utility issue," Casey wrote. "Rather, it appears that the gas may have migrated from deep underground during periods of high barometric pressure coupled with seismic activity and extensive new deep drilling activities."

Trooper Greg Agosti, the fire marshal, told the newspaper it was too soon to blame the house explosions on gas or oil well drilling.

"We don't have enough data that says for sure that gas drilling is at fault," Agosti said, though he acknowledged that remains a key scenario under investigation.

Casey also noted in his letter that the Pennsylvania Department of Environmental Protection has already held Schreiner Oil & Gas Co. of Massillon, Ohio, responsible for methane gas contamination of residential well water in the same area and said, "The explosion of the two houses in close proximity of this troubled area



[View full size](#)

The Associated Press, 2007

U.S. Sen. Robert P. Casey Jr, D-Pa.

certainly appears to be more than coincidence ... "

A business phone number for Schreiner Oil was disconnected Tuesday, and another number for the company could not be immediately located by The Associated Press. A website address once linked to the company also yielded no information.

The DEP has deemed Schreiner responsible for at least seven contaminated residential water wells and has worked with the drilling company and local officials to provide alternative water supplies to those people. DEP spokeswoman Freda Tarbell said the agency continues to be in frequent contact with the company's owner on that matter.

Casey's letter touts the economic potential of Marcellus Shale and other natural wells in Pennsylvania, but urged the Department of Energy to work with federal and state environmental officials to ensure such wells are safe and that all potential hazards are studied.

© 2014 PennLive.com. All rights reserved.

NATIONAL RESPONSE CENTER 1-800-424-8802

\*\*\* For Public Use \*\*\*

Information released to a third party shall comply with any applicable federal and/or state Freedom of Information and Privacy Laws

Incident Report # 1065112

INCIDENT DESCRIPTION

\*Report taken at 08:31 on 07-NOV-13

Incident Type: FIXED

Incident Cause: EQUIPMENT FAILURE

Affected Area: WETL

The incident occurred on 07-NOV-13 at 08:33 local time.

Affected Medium: WATER WETLANDS

SUSPECTED RESPONSIBLE PARTY

Organization: NORRIS OIL  
DUKE CENTER, PA

Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

364 OIL VALLEY RD County: MCKEAN  
City: DUKE CENTER State: PA Zip: 16729

RELEASED MATERIAL(S)

CHRIS Code: OIL Official Material Name: OIL: CRUDE

Also Known As:

Qty Released: 0 UNKNOWN AMOUNT Qty in Water: 0 UNKNOWN AMOUNT

DESCRIPTION OF INCIDENT

CALLER IS REPORTING THAT MULTIPLE WELLS ARE LEAKING CRUDE OIL ONTO HER PROPERTY.  
CALLER STATED THIS IS DUE TO NEGLIGENCE ON THE PART OF THE OWNER OF THE WELLS.

INCIDENT DETAILS

Package: N/A  
Building ID:  
Type of Fixed Object: WELLHEAD  
Power Generating Facility: UNKNOWN  
Generating Capacity:  
Type of Fuel:  
NPDES:  
NPDES Compliance: UNKNOWN

---WATER INFORMATION---

Body of Water: WETLANDS  
Tributary of: KNAPP CREEK  
Nearest River Mile Marker:  
Water Supply Contaminated: UNKNOWN

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN  
INJURIES: NO Hospitalized: Empl/Crew: Passenger:  
FATALITIES: NO Empl/Crew: Passenger: Occupant:  
EVACUATIONS: NO Who Evacuated: Radius/Area:  
Damages: NO

<u>Closure Type</u>	<u>Description of Closure</u>	<u>Length of Closure</u>	<u>Direction of Closure</u>
Air:	N		
Road:	N		Major Artery: N
Waterway:	N		

Track: N

Passengers Transferred: NO  
Environmental Impact: UNKNOWN  
Media Interest: UNKNOWN Community Impact due to Material:

---

REMEDIAL ACTIONS

NOTIFIED THE LOCAL EPA  
Release Secured: UNKNOWN  
Release Rate:  
Estimated Release Duration:

---

WEATHER

Weather: RAINY, °F

---

ADDITIONAL AGENCIES NOTIFIED

Federal:  
State/Local: EPA  
State/Local On Scene:  
State Agency Number:

---

NOTIFICATIONS BY NRC

ATLANTIC STRIKE TEAM (MAIN OFFICE)  
07-NOV-13 08:38  
DHS NOC (NOC)  
07-NOV-13 08:38  
CGIS RAO ST. LOUIS (COMMAND CENTER)  
07-NOV-13 08:38  
DOT CRISIS MANAGEMENT CENTER (MAIN OFFICE)  
07-NOV-13 08:38  
U.S. EPA III (MAIN OFFICE)  
07-NOV-13 08:40  
NATIONAL INFRASTRUCTURE COORD CTR (MAIN OFFICE)  
07-NOV-13 08:38  
NJ STATE POLICE (MARINE SERVICES BUREAU)  
07-NOV-13 08:38  
NOAA RPTS FOR PA (MAIN OFFICE)  
07-NOV-13 08:38  
NATIONAL RESPONSE CENTER HQ (AUTOMATIC REPORTS)  
07-NOV-13 08:38  
BUREAU TOXIC SUBSTANCE (MAIN OFFICE)  
07-NOV-13 08:38  
PA ENVIRONMENTAL PROTECTION AGENCY (EMERGENCY ENVIRONMENTAL RESPONSE)  
07-NOV-13 08:38  
PA STATE POLICE (BUREAU OF CRIMINAL INVESTIGATION)  
07-NOV-13 08:38  
SECTOR OHIO VALLEY (COMMAND CENTER)  
07-NOV-13 08:38  
PA EMERG MGMT AGCY (MAIN OFFICE)  
07-NOV-13 08:38  
USCG DISTRICT 5 (D5 DRAT)  
07-NOV-13 08:38  
USCG DISTRICT 8 (MAIN OFFICE)  
07-NOV-13 08:38

---

ADDITIONAL INFORMATION

PREVIOUS NRC REPORT NUMBERS 1037045 & 1046210

---

\*\*\* END INCIDENT REPORT # 1065112 \*\*\*

NATIONAL RESPONSE CENTER 1-800-424-8802

\*\*\* For Public Use \*\*\*

Information released to a third party shall comply with any applicable federal and/or state Freedom of Information and Privacy Laws

Incident Report # 1037045

INCIDENT DESCRIPTION

\*Report taken at 10:35 on 30-JAN-13

Incident Type: FIXED

Incident Cause: UNKNOWN

Affected Area: KNAPP CREEK

The incident occurred on 30-JAN-13 at 10:42 local time.

Affected Medium: WATER KNAPP CREEK

SUSPECTED RESPONSIBLE PARTY

Organization: NORTH OIL  
DUKE CENTER, PA 16729

Type of Organization: PRIVATE ENTERPRISE

INCIDENT LOCATION

364 OIL VALLEY RD County: MCKEAN

SEE LAT AND LONG

City: DUKE CENTER State: PA Zip: 16729

Latitude: 41 58' 36" N

Longitude: 078 29' 42" W

RELEASED MATERIAL(S)

CHRIS Code: MTH Official Material Name: METHANE

Also Known As:

Qty Released: 0 UNKNOWN AMOUNT Qty in Water: 0 UNKNOWN AMOUNT

CHRIS Code: OIL Official Material Name: OIL: CRUDE

Also Known As:

Qty Released: 0 UNKNOWN AMOUNT Qty in Water: 0 UNKNOWN AMOUNT

DESCRIPTION OF INCIDENT

CALLER STATED THAT THERE WAS A DISCHARGE OF CRUDE OIL, METHANE GAS FROM A WELL HEAD AND INJECTION WELL, THE CAUSE IS DUE TO UNKNOWN REASONS.

INCIDENT DETAILS

Package: N/A

Building ID:

Type of Fixed Object: WELLHEAD

Power Generating Facility: UNKNOWN

Generating Capacity:

Type of Fuel:

NPDES:

NPDES Compliance: UNKNOWN

---SHEEN INFORMATION---

Sheen Color: RAINBOW

Sheen Odor Description: CRUDE OIL AND METHANE GAS

Sheen Travel Direction:

Sheen Size Length:

Sheen Size Width: 1 FEET

---WATER INFORMATION---

Body of Water: KNAPP CREEK

Tributary of: ALLEGANY RIVER

Nearest River Mile Marker:

Water Supply Contaminated: UNKNOWN

DAMAGES

Fire Involved: NO Fire Extinguished: UNKNOWN

INJURIES: NO Hospitalized: Empl/Crew: Passenger:

FATALITIES: NO Empl/Crew: Passenger: Occupant:

EVACUATIONS: NO Who Evacuated: Radius/Area:

Damages: NO

<u>Closure Type</u>	<u>Description of Closure</u>	<u>Length of Closure</u>	<u>Direction of Closure</u>
Air:	N		
Road:	N		Major Artery: N
Waterway:	N		
Track:	N		

Passengers Transferred: NO  
Environmental Impact: UNKNOWN  
Media Interest: NONE Community Impact due to Material:

REMEDIAL ACTIONS

DEP HAS BEEN TO THE LOCATION WITH AN EPA REP.  
Release Secured: NO  
Release Rate:  
Estimated Release Duration:

WEATHER

Weather: RAINY, 53°F

ADDITIONAL AGENCIES NOTIFIED

Federal: DEP, EPA  
State/Local:  
State/Local On Scene:  
State Agency Number:

NOTIFICATIONS BY NRC

ATLANTIC STRIKE TEAM (MAIN OFFICE)  
30-JAN-13 10:45

DHS NOC (NOC)  
30-JAN-13 10:45

CGIS RAO ST. LOUIS (COMMAND CENTER)  
30-JAN-13 10:45

DOT CRISIS MANAGEMENT CENTER (MAIN OFFICE)  
30-JAN-13 10:45

U.S. EPA III (MAIN OFFICE)  
30-JAN-13 10:47

NATIONAL INFRASTRUCTURE COORD CTR (MAIN OFFICE)  
30-JAN-13 10:45

NJ STATE POLICE (MARINE SERVICES BUREAU)  
30-JAN-13 10:45

NOAA RPTS FOR PA (MAIN OFFICE)  
30-JAN-13 10:45

NATIONAL RESPONSE CENTER HQ (AUTOMATIC REPORTS)  
30-JAN-13 10:45

BUREAU TOXIC SUBSTANCE (MAIN OFFICE)  
30-JAN-13 10:45

PA STATE POLICE (BUREAU OF CRIMINAL INVESTIGATION)  
30-JAN-13 10:45

SECTOR OHIO VALLEY (COMMAND CENTER)  
30-JAN-13 10:45

SECTOR OHIO VALLEY (MSU PITTSBURGH)  
30-JAN-13 10:47

PA EMERG MGMT AGCY (MAIN OFFICE)  
30-JAN-13 10:45

USCG DISTRICT 5 (D5 DRAT)  
30-JAN-13 10:45

USCG DISTRICT 8 (MAIN OFFICE)  
30-JAN-13 10:45

ADDITIONAL INFORMATION

---

\*\*\* END INCIDENT REPORT # 1037045 \*\*\*

J. On May 8, 1992, the Department issued an Administrative Order to Norris Oil Company regarding the Wells. The May 8, 1992 Administrative Order, is a final order of the Department and is a also public record of the Department and is hereby incorporated herein.

K. During its inspections set forth in Paragraph H, above, the Department also determined that twelve (12) unpermitted wells exist in addition to the Wells. These "Unpermitted Wells" are either located on the Schenfield Lease or had been operated by Jerry Brennan at the following GPS locations:

GPS Location
N 41 58 37.3/W 78 29 44.6
N 41 58 38.7/W 78 29 29.1
N 41 58 36.3/W 78 29 29.3
N 41 58 31.6/W 78 29 37.2
N 41 58 31.2/W 78 29 38.9
N 41 58 25.9/W 78 29 40.3
N 41 58 30.3/W 78 29 49.2
N 41 58 30.7/W 78 29 52.6
N 41 58 32.7/W 78 29 49.7
N 41 58 35.4/W 78 29 53.7
N 41 58 35.2/W 78 29 48.2
N 41 58 35.7/W 78 29 48.5

L. The Unpermitted Wells have not been used to produce, extract, or inject any gas, petroleum or other liquid within the preceding 12 months and/or have the equipment necessary for production, extraction or injection.

M. The Unpermitted Wells are discharging brine and other production fluids to the ground and into Knapp Creek and an adjacent wetland, without a permit from the Department.

Well Name	GPS Location
Well 1	N 41 58 36.3/W 78 29 42.1
Well 2	N 41 58 30.6/W 78 29 30.8
Well 3	N 41 58 35.0/W 78 29 38.2
Well 4	N 41 58 34.5/W 78 29 41.2
Well 5	N 41 58 37.9/W 78 29 34.5
Well 6	N 41 58 30.4/W 78 29 35.0
Well 7	N 41 58 32.7/W 78 29 36.8

1. The Department has determined that:
  1. Well tags have not been installed on the Wells (as identified in Paragraph G, above);
  2. The Wells have not been used to produce, extract, or inject any gas, petroleum or other liquid within the preceding 12 months and/or do not have the equipment necessary for production, extraction or injection;
  3. The Wells are discharging brine and other production fluids to the ground and into Knapp Creek and an adjacent wetland, without a permit from the Department;
  4. Brine and other production fluids are also being discharged from the Wells to a pit at the Schenfield Farm Lease, without a permit from the Department;
  5. Brine and other production fluids are not being properly controlled, stored or disposed at the Schenfield Farm Lease;
  6. Erosion and sedimentation control Best Management Practices ("BMPs") have not been designed, installed or maintained at the Schenfield Farm Lease; and
  7. The Wells are in disrepair and the entire Schenfield Farm Lease is in poor condition.

## Life on the Wrong Side of the Oil Field Tracks

Dec. 2013 (SOSPA)

By Laurie Barr

Save Our Streams PA

[www.saveourstreamspa.org](http://www.saveourstreamspa.org)



Fluid leaking from well on the Thomas' Property (SOSPA photo)

The industry can be broken down into two distinct groups, the old and the new.

While Gov. Tom Corbett promotes the successes of the new unconventional drilling industry during his re-election campaign, oil rises up from the shadows of the dilapidated pump-jacks, helping to shed light, revealing a long history of a dysfunctional agency charged with the oversight of both the old and new style drilling.

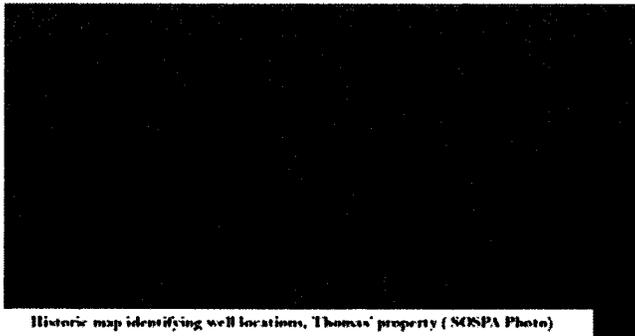
Some operators who work in the oil and gas fields are conscientious; when they experience a spill or an equipment failure that results in oil ending up somewhere it shouldn't be; it's promptly cleaned up. That's the best case scenario.



Fluid leaking from well on the Thomas' Property (SOSPA photo)

Imagine a worst-case scenario: an operator abandons a well and the unplugged well oozes oil and/or brine continuously; contaminating your property and nearby aquatic resources. Now imagine that there are dozens, as many as 65 such wells, and then imagine gallons of oil and other contaminants pouring from the wells daily.

The Thomases of Duke Center, McKean County don't have to imagine this scenario. They have had to live it. They have reached out to State and Federal officials for help to little avail. The scenario has plagued the Thomas' lives daily; for decades.



Historic map identifying well locations, Thomas' property (SOSPA Photo)

The Pennsylvania Department of Environmental Protection's (PADEP) well records are incomplete. It's a mystery how many of the wells on the Thomas' property were pumped by the operator who passed away in October of 2012. An even bigger mystery is; why Pennsylvania officials haven't been able to figure out how to stop the constant flow of contamination from the wells, allowing the plumes of contamination to grow. To date, after many reports have been made to the PADEP and the Environmental Protection Agency (EPA), and also after several calls to the National Response Center to report some of the (daily) discharges of crude oil, a comprehensive survey of the oil field has yet to be conducted. Nobody knows exactly how many wells are on the Thomas' property or even how many of these

wells are contributing to the contamination plumes that cover large areas of the property.



Crude oil leaking from well on the Thomas Property (SOSPA photo)

The Thomases have managed to locate over 30 wells in various stages of disrepair. A historic map, published prior to the permitting of 7 contemporary wells, identifies approximately 65 wells bringing some estimates to 72 wells but early oil and gas operators did not always document every well so there may be more wells hidden among the forested areas and heavily vegetated wetlands included in this 40 acre parcel.

There are health and safety hazards associated with these wells and these have essentially rendered the majority of the property unusable. While a number of wells have pump-jacks or well casings attached, others are simply open holes hidden among the underbrush of the forest canopy and wetland vegetation.

Pump-jacks sit idle on some of the wells; while emerald green crude flows from pipes and wellheads.

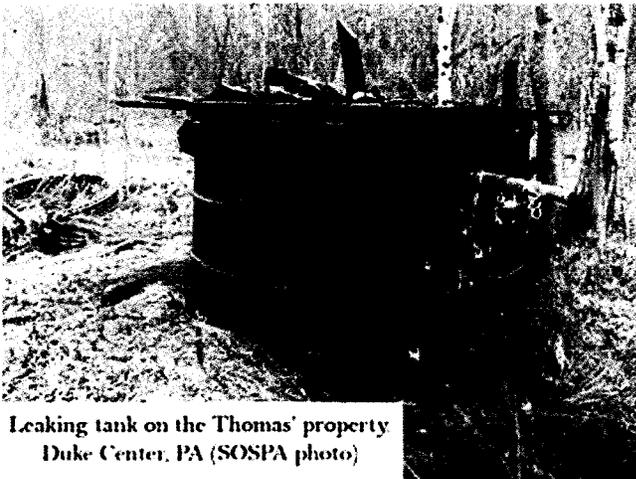


Fluid near unplugged well, Duke Center, PA ( SOSPA photo)

In some areas the ground is completely saturated, puddles have formed and brine flows continuously across these areas to ultimately reach Knapp Creek, a tributary of the Alleghany River.

Broken pipes, tangled wires, leaking oil and brine tanks litter the oil field.

Large tanks surrounded by dark oil stains leak oil and other fluids while the unmistakable oil field odors and gases permeate the air.



Leaking tank on the Thomas' property  
Duke Center, PA (SOSPA photo)

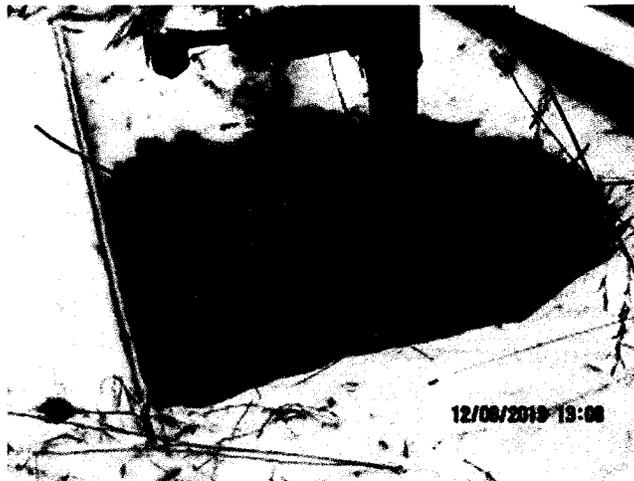
Many abandoned wells constantly pour natural gas into the atmosphere. Several of the wells on the Thomas' land are leaking natural gas; contributing to climate change. While gases pour into the atmosphere, and as the contamination plume grows, PADEP officials and representatives for the deceased operator's estate mull over how to divide the oil pie and draw straws to figure out who is going to take the first bite.

According to the National Response Center a report, dated March 06, 2013 "this has been an ongoing issue for years." The oil and fluids continue to flow from wells situated in these wetlands, along the creek, in the creek and on the steep mountainside,

where eventually it washes downstream while officials mull over what to do.

It seems the Department of Environmental Protection or any other agency of the Commonwealth will probably not be able to figure out how to appropriately address this. Contaminants are entering into the watershed daily, a fact that officials, from the local level including Rep. Martin Causer, and others on up to governor Corbett's office have been made aware of, yet none seem to be able to grasp the idea that this needs their immediate attention, a remedy, sooner rather than later and some office, department, agency needs to step in and take the lead. Do something, anything to stop the contaminants from entering Pennsylvania and New York State waterways.

The idea that the agency continues to authorize more permits to drill wells; while existing abandoned and unplugged wells are continuously dumping contaminants directly into the watershed, as the alarmingly clueless buffoons try to figure out who's on first, is simply astounding. When will the PA Department of Environmental Protection start actually, you know, protecting the environment?



According to a recent press release, dated October 15, 2013 Reps. Martin Causer (R-Turtlepoint) and Kathy Rapp (R-Warren) joined hundreds of independent oil producers and supporters at the site of the world's first oil well to highlight the challenges threatening the future of this 150-year-old industry. Causer spoke to the crowd during the event. "Our independent oil and gas producers are vital contributors, not only to our local economy but to our statewide economy as well," Causer said. "We can't afford to have government regulate them out of business. It's time for the administration to work with us to ensure the future of Penn Grade crude and all the business and industry it supports."



**Abandoned Duke Center, 2013**

Rapp stated "I am proud to stand with all of you in the fight to not only protect this industry but to get government out of the way so it can grow and thrive," Rapp continued "It's time for the bureaucrats who write these regulations to be held accountable to the people."  
Ditto! By the way Kathy, the Thomases are people too.



**10 Helen Lane, Bradford, Pennsylvania. Exploded (Above SOSPA Photo)**

Improperly abandoned wells are known to provide direct pathways to the aquifer and to the surface. The Thomas' water well contains explosive levels of methane. Due to the risk of explosion a PADEP official's advice to the Thomases?

"I don't recommend you take a nice soak bath while smoking a cigar and enjoying a glass of wine."

XXXX

NRC Incident report number 1037045 dated 30-JAN-2013 10:35. "CALLER STATED THAT THERE WAS A DISCHARGE OF CRUDE OIL, METHANE GAS FROM A WELL HEAD AND INJECTION WELL, THE CAUSE IS DUE TO UNKNOWN REASONS." Link: [http://www.nrc.uscg.mil/reports/rwservlet?standard\\_web+inc\\_seq=1037045](http://www.nrc.uscg.mil/reports/rwservlet?standard_web+inc_seq=1037045)

NRC Incident report number 1046210 dated 06-MAY-2013 16:18. "THE CALLER IS REPORTING A DISCHARGE OF CRUDE OIL INTO NAP CREEK. THE CALLER STATED THAT LEAKING WELLS ARE THE SOURCE OF THE DISCHARGE. THE CALLER STATED THAT THIS HAS BEEN AN ONGOING ISSUE FOR YEARS, DISCHARGING APPROXIMATELY 30-150 GALLONS OF CRUDE OIL PER DAY.." Link: [http://www.nrc.uscg.mil/reports/rwservlet?standard\\_web+inc\\_seq=1046210](http://www.nrc.uscg.mil/reports/rwservlet?standard_web+inc_seq=1046210)

NRC Incident report number 1065112 dated 07-NOV-2013 08:31. "CALLER IS REPORTING THAT MULTIPLE WELLS ARE LEAKING CRUDE OIL ONTO HER PROPERTY. CALLER STATED THIS IS DUE TO NEGLIGENCE ON THE PART OF THE OWNER OF THE WELLS." Link: [http://www.nrc.uscg.mil/reports/rwservlet?standard\\_web+inc\\_seq=1065112](http://www.nrc.uscg.mil/reports/rwservlet?standard_web+inc_seq=1065112)

Rep. Martin Causer website: <http://www.repcauser.com/>

Press release "Causer, Rapp Join Call to Action for PA Conventional Oil Industry" 10/15/2013 : <http://www.repcauser.com/NewsItem.aspx?NewsID=18750>

Perilous Pathways: Behind The Staggering Number Of Abandoned Wells In Pennsylvania  
<http://stateimpact.npr.org/pennsylvania/2012/10/10/perilous-pathways-behind-the-staggering-number-of-abandoned-wells-in-pennsylvania/>

Sen. Bob Casey wants feds to help investigate Pennsylvania house explosions  
[http://www.pennlive.com/midstate/index.ssf/2011/03/sen\\_bob\\_casey\\_wants\\_feds\\_to\\_he.html](http://www.pennlive.com/midstate/index.ssf/2011/03/sen_bob_casey_wants_feds_to_he.html)

## Economic Incentives and Regulatory Framework for Shale Gas Well Site Reclamation in Pennsylvania

Austin L. Mitchell and Elizabeth A. Casman\*

Department of Engineering and Public Policy, Carnegie Mellon University, 5000 Forbes Avenue, Baker Hall 129, Pittsburgh, Pennsylvania, 15213

**ABSTRACT:** Improperly abandoned gas wells threaten human health and safety as well as pollute the air and water. In the next 20 years, tens of thousands of new gas wells will be drilled into the Marcellus, Utica, and Upper Devonian shale formations of Pennsylvania. Pennsylvania currently requires production companies to post a bond to ensure environmental reclamation of abandoned well sites, but the size of the bond covers only a small fraction of the site reclamation costs. The economics of shale gas development favor transfer of assets from large entities to smaller ones. With the assets go the liabilities, and without a mechanism to prevent the new owners from assuming reclamation liabilities beyond their means, the economics favor default on well-plugging and site restoration obligations. Policy options and alternatives to bonding are discussed and evaluated.



The emergence of technologies for economic recovery of natural gas from tight shale formations across the U.S. is responsible for a resurgence in domestic natural gas production. Even though the national average wellhead price has dropped by more than two-thirds in three years, shale gas production continues to increase. The Marcellus shale formation underlies numerous Appalachian states and is considered to be the largest gas-bearing shale formation in the U.S. Rapid development of this resource, evidenced by thousands of new wells in the region since the first well in 2004, is charting a new course for natural gas supply and utilization in the Northeast. In Pennsylvania, where there are more drilled wells than any other Appalachian state, this development already dwarfs past oil and gas booms in areal extent and production

### ■ ECONOMIC, ENVIRONMENTAL, AND HUMAN HEALTH RISKS OF IMPROPERLY ABANDONED SHALE GAS WELLS

Disturbance of the surface environment and subsurface geological strata is a necessary outcome of shale gas development in Appalachia. Surface disturbance is caused by the construction of well pads, impoundments, access roads, and pipelines. Reclamation of the disturbed surface occurs in two stages. Shortly after a well begins production the size of the well pad is reduced and the impoundment is removed. Full reclamation does not occur until after a well is abandoned (permanently taken out of production) because site access is necessary for routine maintenance and removing produced water (brine that comes up with gas).

If a well site is not properly reclaimed after abandonment, the well pad and access roads may cause permanent changes to the

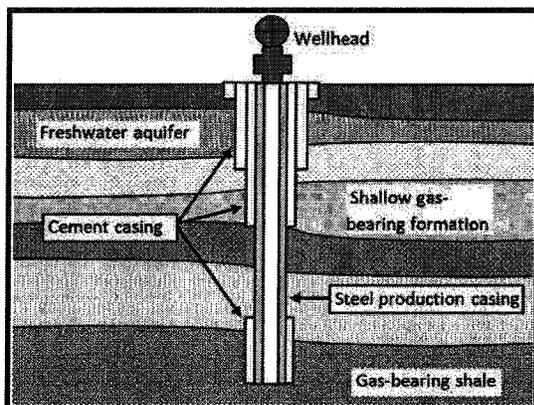
natural environment. The deterioration of erosion control features increases siltation, which results in the loss of nutrient-rich topsoil and increased sedimentation of nearby surface waters, impairing natural habitats of aquatic species.<sup>1–3</sup> Compared to natural forest clearing occurrences (e.g., fire), the recruitment, growth, and mortality rate of native plant species at reclaimed oil and gas well sites in boreal forests was found to be significantly worse.<sup>4</sup> Without restoration of topsoil and proper revegetation, the regeneration of natural habitat will be delayed and the environmental impacts of forest fragmentation, including loss of biodiversity and introduction of invasive species, will be exacerbated. The adverse effects of forest fragmentation on the nesting success of migratory birds have been documented,<sup>5</sup> and the impacts extend to other plant and animal species dependent on shade, humidity, and tree canopy protection characteristic of deep forest environments in the region.<sup>6,7</sup> The construction of well pads, water impoundments, and access roads is projected to disturb 129 000–310 000 acres of forested land in Pennsylvania.<sup>6</sup> In northern Pennsylvania forests, where largest blocks of public forests exist, the potential for lasting forest fragmentation and associated environmental impacts could negatively affect economic interests related to timber management, game, and tourism.<sup>7</sup>

To reach the Devonian Shale formations, wellbores transect a mile or more of geologic strata, including fresh and saline aquifers and shallow gas-bearing formations. Shale gas wells will need to be plugged to prevent environmental damage

Received: June 27, 2011

Accepted: October 10, 2011

Revised: October 4, 2011



**Figure 1.** Simple representation of shale gas well anatomy. Layers of cement and steel casing are used to isolate production zones from freshwater aquifers. To properly close a shale gas well, the wellhead and steel production casing are removed and cement plugs are installed to prevent fluid movement in the wellbore and annulus. This diagram is not drawn to scale.

caused by the disturbance of the subsurface, namely the movement of oil, gas, and brine to the surface and between geologic formations connected by the wellbore. General plugging procedures in most states, including Pennsylvania, begin with the removal of steel production casing, which extends from the surface to producing formations, for scrap value. Next, a series of cement plugs will be installed in the wellbore to isolate freshwater and saline aquifers and gas producing formations.<sup>8</sup> (Figure 1)

Unplugged wells may provide a direct pathway to the environment for fluids in the wellbore,<sup>9</sup> which results in ecological harm, property damage, and surface and groundwater contamination. Additional pathways in the annulus (an industry term for the space between two concentric objects, such as between the wellbore and casing or between casing and tubing) may develop that would allow oil, gas, and brine to move vertically across geologic formations and contaminate groundwater. Substances dissolved in the brine may include those that occur naturally in the shale formations (some radioactive) and others injected during the hydraulic fracturing process (some toxic). Also upwardly migrating gas, known as stray gas, represents an explosion hazard if not properly vented away from buildings and drinking water wells.<sup>10–12</sup>

The risk that annular pathways will develop increases over time as chemical, mechanical, and thermal stresses causes deterioration of well structures and components. Failure modes of improperly abandoned wells (defined here as nonproducing wells not in compliance with Pennsylvania plugging requirements or inactive status rules) include the formation of cracks in the cement casing or packers, corrosion of steel production casing, faulty valves, and leaking temporary plugs or surface caps.<sup>9,13–17</sup> Properly performed, the plugging process reinforces existing casing and seals and prevents fluid movement in the wellbore, which may retard the deterioration of vital well components and structures. Therefore, prompt plugging once a shale gas well becomes uneconomic may reduce the risk of negative environmental and human health impacts,<sup>13,14</sup> while also avoiding additional plugging costs that may be incurred if the mechanical integrity of a casing has been compromised.<sup>18</sup> However, the risk of failures leading to fluid migration pathways

still exists after a well has been plugged and increases with time.<sup>9,14–16</sup>

The impacts and remediation costs resulting from gas migration and groundwater contamination due to failures at unplugged and improperly abandoned gas wells is well documented in Pennsylvania and elsewhere.<sup>10,12,19–21</sup> Property values can be negatively affected if gas wells contaminate groundwater used for drinking.<sup>22–24</sup> Moreover, the presence of an improperly abandoned gas well may prevent landowners from using their property for other purposes.<sup>25</sup> Stray gas, which is mostly methane, is also a potent source of greenhouse gas emissions.<sup>26</sup>

## ■ THE SAUDI ARABIA OF NATURAL GAS AND THE SWISS CHEESE OF APPALACHIA

Approximately 350 000 conventional oil and natural gas wells have been drilled in Pennsylvania since the 1859 discovery of oil in Titusville.<sup>11</sup> Many of these legacy wells that are no longer producing oil or gas were never plugged. Some leak gas, oil, and/or brine into freshwater aquifers and the surface environment.<sup>27,28</sup> To remedy this situation, Pennsylvania's Oil and Gas Act of 1984 required all wells from which economic benefits were accrued after 1979 to be plugged according to the latest standards and the well sites reclaimed by their owners. To promote compliance with this statute and cover the cost in the event of owner insolvency, a bonding requirement was established. In 1985, Pennsylvania started plugging oil and gas wells lacking a legally responsible owner, known as orphan wells, and supported these activities with fees on new oil and natural gas well permits (\$200 and \$50 per well for the Orphan Well Plugging Fund and Abandoned Well Plugging Fund, respectively), monies collected for regulatory violations, and grants distributed by Pennsylvania's taxpayer-funded Growing Greener program.<sup>29</sup> From 2007 to 2008, the most recent years for which data are available, a total of \$1,066,000 in Growing Greener grants were awarded to reclaim orphan and abandoned wells.<sup>30,31</sup> Before the current shale gas boom, the Pennsylvania Department of Environmental Protection (PADEP) estimated that at 2004 funding rates it would take around 160 years to plug all the existing orphan wells in the Commonwealth.<sup>11</sup>

## ■ COSTS OF SITE RESTORATION AND SHALE GAS WELL CLOSURE

Pennsylvania's 1984 Oil and Gas Act defines a natural gas operator's drinking water, site restoration, and well closure responsibilities. Once a well is abandoned, the owner has 12 months to properly plug it and restore the well pad to its previous condition. Restoration of the production well pad (which typically covers 1–3 acres<sup>32</sup>) may involve regrading of land, removing access roads and impoundments, restoring top soil, planting native flora, or other necessary restoration required for compliance with Pennsylvania's Clean Streams Law of 1937. Operators must also remove all equipment used in the production of gas as part of the well abandonment process. This equipment includes the production casing (innermost steel casing that extends down to the production zone), Christmas tree (a grouping of pipes, valves, and fittings used to control the flow of gas from a well), dehydrator, compressor, and tank battery.

The cost to plug a deep shale gas well has not been formally estimated by the PADEP, however, it is understood that the cost to plug a well depends primarily on its measured depth (full length of wellbore including horizontal portions). Plugging costs

increase when the condition of the wellbore is poor or access to the site is difficult. For orphan oil and gas wells in Southwestern Pennsylvania, the PADEP estimates the total cost to plug and restore the site of a well approximately 914 m (3000 feet) in depth averages \$60,000, but per well reclamation costs have also exceeded \$100,000.<sup>18</sup> Reclamation costs of wells drilled into the Devonian Shale (Marcellus, Utica, and Upper Devonian), which range from 1524 to 2744 m deep, will be greater because costs are strongly correlated with depth. Using reclamation data from 255 orphan wells in Wyoming, Andersen and Coupal (2009) estimated the relationship between reclamation costs and depth.<sup>33</sup> They estimated that total reclamation costs (well plugging, site restoration, and equipment removal) were approximately \$34.45 per meter (\$10.50 per foot). They also noted that economies of scale exist when more than one well is on each well pad, which is the norm for wells in the Marcellus Shale. Summarizing data from approximately 1000 individual well completion reports catalogued by the Pennsylvania Department of Conservation and Natural Resources,<sup>34</sup> the average measured depth of hydraulically fractured shale gas wells completed in Pennsylvania during 2010 was approximately 3254 m (10 675 feet). Thus, for a single well, at \$34.45 per meter, the average reclamation cost for a well in the Marcellus Shale will be in the vicinity of \$100,000. However, in some cases the costs for plugging and abandonment of a shale gas well in Pennsylvania have been substantially higher. For instance, in 2010, Cabot Oil & Gas Corporation estimated that it spent \$2,190,000 to properly abandon three vertical Marcellus Shale gas wells in Susquehanna County, Pennsylvania, about \$700,000 per well.<sup>35</sup>

#### ■ PENNSYLVANIA BONDING REQUIREMENTS ON PRIVATE LANDS DO NOT INCENTIVIZE RECLAMATION

Issues of operator insolvency due to the boom and bust cycles of oil and gas development complicate efforts to hold liable parties responsible and provide for timely environmental reclamation. In theory, requiring that operators post bonds prior to drilling bolsters traditional liability rules by incentivizing compliance.<sup>36</sup> In Pennsylvania, bonded monies are released one year after the PADEP deems regulatory requirements associated with reclamation have been satisfied. If the level of bonding is set less than the associated reclamation costs, companies could be tempted to pursue strategies that avoid their liabilities.

Oil and gas bonding requirements vary across states and on federal lands, but most have established minimum bonding levels (blanket or for individual wells).<sup>25</sup> In general, the dollar amount of state and federal bonds for oil and gas wells often do not reflect expected reclamation costs. The full effect of this imbalance has not yet been felt because oil and gas wells may have long life spans (up to 50 years, which can be prolonged further on paper via regulatory allowances), and bonding requirements are relatively new.<sup>36</sup>

Pennsylvania's experience with bonding of coal mining sites may be indicative of what to expect. From 1985 to 1999, bonds for surface mining permits covering approximately 10% of total acreage were forfeited.<sup>37</sup> Since the cost to reclaim a mine in most cases was higher than the amount bonded, funding to bring abandoned mine lands into compliance has generally been inadequate.<sup>37–39</sup> In 1986, only 33% of acreage covered by forfeited bonds had been reclaimed, according to a U.S. General Accounting Office study. The discrepancy was attributed to inadequate funding from forfeited bonds and legal delays in bond forfeiture.<sup>39</sup> Following a lawsuit and increased Federal scrutiny thereafter, Pennsylvania modified its

regulatory framework related to the reclamation of abandoned mine lands.<sup>38</sup> Pennsylvania now requires mine operators to perform site-specific estimation of reclamation liabilities to ensure posted bonds cover the full cost of reclamation.<sup>40</sup>

Today, shale gas operators in Pennsylvania must post either a bond of \$2500 for each well or a blanket bond of \$25,000 to cover all the wells they drill in the state. This is the same dollar amount required in 1984, despite statutory provisions that empower the Environmental Quality Board to adjust the level of bonding to match projected reclamation costs every two years. A bond of \$2500 is inadequate to cover the costs to plug a deep shale gas well and restore the land (approximately 100–700 thousand dollars). The inadequacy of the blanket bond is even more pronounced, as many operators are expected to drill thousands of wells. For example, Chesapeake Energy, operating in a joint venture with Statoil, plans to drill up to 17 000 shale gas wells in Appalachia over the next 20 years.<sup>41</sup>

The Oil and Gas Act prohibits private landowners from securing financial assurances from the operator independent of Pennsylvania regulations. The situation is different on Pennsylvania's state-owned land. Pennsylvania includes a condition in all of its lease agreements for drilling in state forests that requires operators to submit additional individual well bonds. The dollar amount required scales with the measured depth, so operators in state forests are required to post bonds of \$50,000–100,000 per well drilled.<sup>42</sup>

It is important to note that the substantial bonds required in drilling leases in state forests did not preclude a successful lease auction, proceeds of \$128 million far exceeded original expectations of \$60 million.<sup>43</sup> This suggests that bonds in the \$100,000 range are not prohibitive for large exploration and production companies, though they may be an obstacle for smaller concerns.

#### ■ TRANSFERRING ASSETS SHIFTS ENVIRONMENTAL LIABILITY

Over the next two decades, drilling rates of 1000 or more new shale gas wells per year are projected, as production from Pennsylvania's Marcellus Shale is expected to reach approximately 110 million cubic meters (4 billion cubic feet) of natural gas per day by 2015.<sup>44,45</sup> To sustain such high levels of production, the shale gas industry needs to constantly drill and complete new wells because gas production rapidly declines in the first few years of production.

Figure 2 shows a type curve published by a Marcellus Shale operator, EQT Production.<sup>46</sup> A type curve is a gas production curve modeled from initial and historic production data and reservoir characteristics. The precipitous decline in production rate of gas is typical of deep shale gas wells in Pennsylvania and elsewhere. (Refracking is a process that can be used to increase production in a declining well. Because there are no reliable data published on this practice in Appalachia it is excluded from this analysis.)

Industry economics are dominated by high initial gas production rates. For a typical well, assuming a constant price of \$176.6 per thousand cubic meters of gas (\$5/Mcf) and a \$5.3 million cost to drill and complete a new well,<sup>46</sup> the internal rate of return (IRR) asymptotes near 79% after the seventh year, after which production revenue dwindles compared to that of the initial years. Assuming a 10% discount rate, 81% of the net present value (NPV) of gross revenue would be realized in 10 years. Compared to the potential revenue from gas sales, the present value of long-term shale gas liabilities, which are discounted

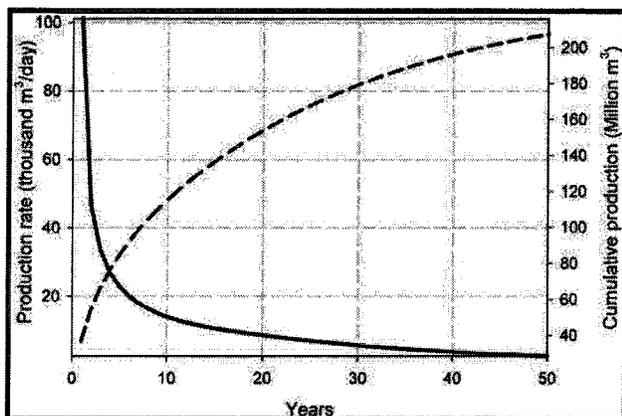


Figure 2. Expected gas production rate (solid line) and cumulative production curve (dashed) for EQT Production's Marcellus Shale operations.<sup>46</sup>

40–50 years, has negligible impact on near-term accounting. The problem of failing to internalize reclamation liabilities emerges when the liabilities begin to exceed the current asset value.

The steep decline in production may drive divestment of shale gas assets by primary exploration and production companies well before the expected closure of a shale gas well. The transfer of marginally producing assets to smaller independent operators or surface owners is common practice in the oil and gas industry.<sup>47–49</sup> Sometimes surface owners take ownership of a marginally producing well for household use. In such cases, the Oil and Gas Act permits oil and gas asset transfers as long as the prospective owner satisfies the applicable bonding requirements. In Pennsylvania, there exists no formal regulatory mechanism to prevent fully bonded owners from assuming shale gas assets with reclamation liabilities substantially above their own financial means. Large liabilities covered by limited resources could lead to large-scale insolvency, similar to the situation that spawned Pennsylvania's pervasive abandoned acid mine drainage and orphan well problems.<sup>50</sup>

In Pennsylvania and other U.S. states, individual and blanket bonds may be satisfied using a number of financial instruments and often do not even require monies to be transferred. Requiring only the demonstration of assets is common, especially for large operators. When an operator cannot demonstrate sufficient assets to cover liabilities, third party backing, usually in the form of a surety bond, may be obtained for a percentage of the bond's face value. Since surety companies or banks underwriting the bond are liable if an operator is unable to perform reclamation, bond rates are set according to an individual operator's risk of insolvency.<sup>36</sup>

Today's low bonding levels make it possible for hundreds of independent operators satisfy the Pennsylvania's blanket bonding requirements.<sup>51</sup> These operators are capable of producing marginal amounts of oil and gas economically, which allows them to maximize potential economic benefits by extending the productive lifetime of oil and gas wells.<sup>52</sup> The ability to transfer well ownership to independent operators benefits the industry, but a potential consequence of increasing bonding minima could be that smaller operators may face steep risk premiums or not qualify for third party backing and be excluded from participation.

Primary exploration and production companies rely on divestment of existing assets to fund new drilling operations. Blocking

independent operators from the market may force these companies to temporarily abandon their uneconomic wells and apply for inactive status instead. In Pennsylvania, nonproducing wells may be granted inactive status for a period of five years, but to be granted an annual extension the operator only has to declare regulatory compliance and the capacity to produce gas in the future from the inactive well. Inactive status and similar provisions in other states grant operators the ability to temporarily abandon a gas well until technology advances or favorable gas prices improve the economics of production, though in practice the decision to reopen a well is expected to be dominated by reclamation and other liabilities.<sup>13</sup>

Inactive status could be used to defer the costs of reclamation indefinitely. According to PADEP records, almost 17 000 conventional oil and gas wells did not report or produce oil or gas for three consecutive years (2007–2009), and were listed as active at the end of 2009. While it may be the case that many of the operators of these wells simply failed to report production, poor compliance with reporting requirements prevents the PADEP from enforcing plugging requirements or administering the inactive status program. In 2009 alone, only 38% of the Commonwealth's conventional oil and gas wells reported production, which indicates a majority of the wells drilled in Pennsylvania may represent environmental liabilities as opposed to a source of revenue.<sup>53</sup> Incentives (fines) are needed to improve compliance with production reporting requirements, though reporting alone will not close this loophole.

The delay between production and reclamation temporally separates revenue generation from the future liabilities. Others have recognized this undesirable trend and instituted remedies. Growth in the number of nonproducing (idle) wells in Alberta and Saskatchewan led these two Canadian provinces to implement a Licensee Liability Rating Program as a measure of insolvency risk and to minimize state financial exposure to orphan wells. The program requires individual operators to provide financial assurance equivalent to the difference between the operators' assets (active wells and assets) and liabilities (inactive wells and abandoned assets).<sup>54,55</sup> Some U.S. states offer tax breaks to promote marginal well production, while others require additional bonds or levy annual fees for inactive wells to incentivize new production or plugging, and to fund compliance monitoring.<sup>25,52</sup>

## REGULATORY POLICY AND FINANCIAL ASSURANCE OPTIONS

When bonding requirements are smaller than expected liabilities, there is a financial incentive to not comply with reclamation requirements. Individual well bonding requirements that match reclamation costs would remedy this situation, especially with the blanket bonds, where misalignments with reclamation costs can be huge. Eliminating the blanket bond would be a common sense first step for Pennsylvania. However, simply increasing the bond requirement to match reclamation costs may not be the best alternative because more operators will need to obtain third party backing. In theory, reliance on third party backing favors operators that manage assets and liabilities effectively since the underwriting firms would assess the risk of insolvency of individual operators. However, the same may not be true for third party backers. Insolvency of these financial firms is a real concern and the effects may be large.<sup>36,56</sup>

Furthermore, bonds are inherently inflexible to changes in the cost of performing reclamation, to the economics of gas extraction

when wells start to lose pressure, and the way financial risk is shared in the industry. This is problematic if reclamation costs deviate dramatically from the average. For instance, following methane migration into the aquifer supplying drinking water to 14 households in Dimock, Pennsylvania, the estimated costs for individual water filtration units and supply replacement via permanent pipeline were approximately \$8,000 and \$800,000 per household, respectively.<sup>57,58</sup> Underwriting firms will only market surety bonds when the amount and term of liability are strictly defined,<sup>36</sup> so bonds are not well suited to cover uncertain liabilities. Bonds would also fail to provide funding for maintenance and monitoring of plugged and abandoned wells and the potential environmental issues that may arise postreclamation. After the release of a bond, recovery of additional environmental costs would require aggrieved citizens or the State to pursue civil action. The State may also block the issuance of new permits to operators with outstanding reclamation liabilities, but for operators without ongoing interests in Pennsylvania, this enforcement mechanism will be limited.

### ALTERNATIVES TO BONDS

To pay for the long-term treatment of acid mine discharges, coal mine operators in Pennsylvania may establish trust accounts under contract with the State. Funding requirements are based on operator estimates of the present value of capital costs and operating expenses of pollution control projects, which depend on the inflation rate and the expected growth of the trust account. As irrevocable beneficiaries of the trust, the State will reimburse coal mine operators one year after the performance of work, or in the case of nonperformance, the State may use accumulated funds to do the work.<sup>59</sup>

If reclamation trust accounts were to be used for the shale gas industry, it would be the responsibility of the operator to determine current (time zero) reclamation costs as part of the drilling permit and the responsibility of the state to approve that figure. If fully funded trust accounts were tied to individual wells rather than pooling them, timely plugging would become independent of the solvency of the last operator.

For the mining industry, trusts are designed so that they will be fully funded one-year after production ends. The size the trust is estimated from eq 1, which shows the calculation for the present value of reclamation costs.

$$PV = \left[ \frac{RC}{(1 + [E - I])^t} \right] \times (1 + Vol) \quad (1)$$

Where RC = estimated cost of reclamation in current dollars,  $E$  = expected annual return on investments in trust,  $I$  = inflation rate, Vol = volatility premium, proportional to amount invested in stock market, and  $t$  = time in years, duration of production

For the shale gas industry, the contract between the State and individual operator would specify the firm responsible for managing the trust account and investment strategy. An inflation rate of 3.1%, bond yield of 5.25%, and market return of 11.2% are recommended by the PADEP for eq 1. At most, 80% of the trust may be invested in stock. A 20% volatility premium is required for the portion of the trust invested in stock.<sup>59</sup> It is the responsibility of the PADEP to ensure an operator's inflation, bond yield, and market return assumptions reflect current conditions. This contract would also detail the irrevocable rights held by the State to claim monies held in the trust.

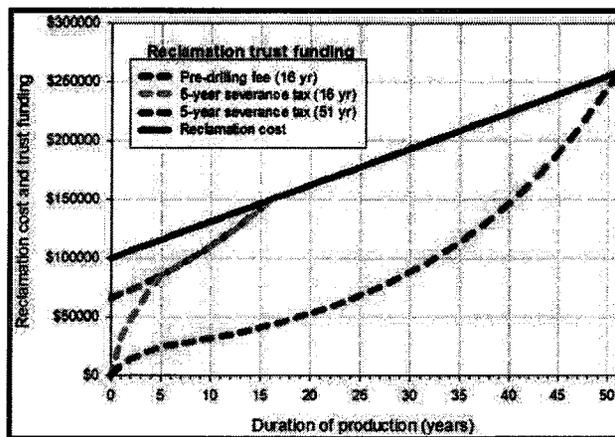


Figure 3. Comparison of financial assurance mechanisms for funding a reclamation liability costing \$100,000 at time zero. Assumptions: gas is produced according to the EQT Production type curve (Figure 2); the inflation rate is 3.1%; and monies invested in the trust have an assumed annual return of 5.25%, following PADEP guidance for bond yields.<sup>59</sup> The “no risk” cash bond option is not shown as it is equal to the cost of reclamation. The funds collected by a predrilling fee and severance tax collected for five years are contrasted. Delayed collection options run the risk of collecting insufficient funds for reclamation of the well if the number of productive years is less than the number of years used to determine present value of reclamation costs. At any given year, the funding shortfall is measured as the difference between the projected reclamation cost line and the respective delayed option line.

We compare three potential mechanisms to fund well reclamation costs estimated using eq 1: cash bond, severance tax on gas production, and a discounted predrilling fee. The properly sized cash bond represents a “no risk” scenario for Pennsylvania because operators would be required to deposit the full cost of reclamation as a precondition for drilling permit approval. Compared to the other forms of bonding allowed by the PADEP, the State Treasurer would manage the bonded monies and the risks associated with operator or third-party default or insolvency would be eliminated. A severance tax on gas production would gradually collect and reinvest monies to reach the future value of reclamation. Pennsylvania's Governor, Tom Corbett, opposes levying taxes on the natural gas industry, but has supported a one-time, per well fee to pay for local impacts of the natural gas industry. To fund a reclamation trust via a discounted predrilling fee, we assume that the fee would need to be assessed in an amount equal to the present value of expected reclamation costs at the time of well closure. The severance tax and predrilling fee represent delayed funding mechanisms, so the annual growth and security of the trust as well as the productive lifetime of a shale gas well are important variables. The cost to perform reclamation is compared to funds accrued in a reclamation trust by a severance tax (calculated for two different anticipated well lifespans) and a predrilling fee in Figure 3. To fully fund a reclamation trust by year 16, a predrilling fee of \$65,975 and a severance tax of \$0.87/TCM (\$0.25/Mcf) collected for five years would need to be assessed. A severance tax of \$0.15/TCM (\$0.004/Mcf) on the first five years of production would be assessed if full funding of the trust is not required until year 51. The cash bond option is not graphed because it is equivalent to the inflated reclamation cost each year. The options are fully

funded when they intersect the reclamation cost line. If the well is abandoned before the reclamation trust is whole, the difference between the accumulated funds and the inflated reclamation costs will be the shortfall.

No empirical evidence exists to suggest the economic lifetime of a shale gas well will reach generic industry predictions of 40–50 years. Well productivity and the economics of shale gas production have equal weight in an operator’s decision to keep a well open. The use of unrealistic expectations of well economics has implications for the application of delayed funding mechanisms and risks underfunding reclamation trust accounts. Figure 3 shows that even if a 15-year lifetime is assumed (reclamation costs discounted from year 16), the difference between the reclamation cost and the funding levels in the trust are substantial for wells abandoned sooner. For the purpose of estimating reclamation costs, it would be wise for Pennsylvania to require that reclamation costs be funded within 10 years, regardless of the actual life span of the well.

Actual production will deviate from industry type curves. Figure 4 shows the cumulative production from horizontal shale gas wells in Pennsylvania that began producing gas from January 2010 through July 2011 compared to the EQT Production type curve (Figure 2).

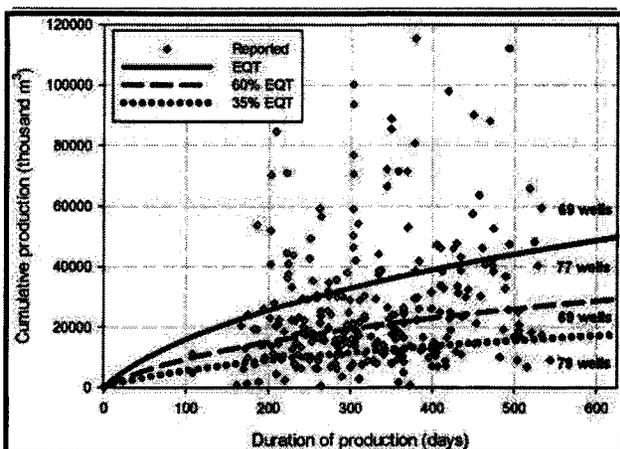


Figure 4. Reported cumulative production of 294 individual horizontal Marcellus Shale gas wells that began producing after 1/1/2010.<sup>51</sup> Three continuous cumulative production curves are modeled: EQT Production’s type curve (Figure 2), a 60% EQT, and 35% EQT. Cumulative production predicted by the 60% EQT and 35% EQT curves is exceeded by 50% and 75% of horizontal Marcellus Shale gas wells, respectively.

While nearly a quarter of the wells exceeded the EQT curve, half of the wells produced less than 60% of the EQT curve and 25% of the wells produced 35% or less of the EQT estimate. The variability in cumulative production indicates that industry type curves should not be used to set the terms of financial assurance policy. If a 5-year severance tax is calculated from EQT Production’s type curve and applied to the cumulative production of all the wells in Figure 4, independent of the tax rate, the amount of money collected in a trust would only be 62% of the target funding level, assuming that excess funds are returned to the operator.

**THE IMPACT OF THESE REGULATORY OPTIONS ON THE INDUSTRY BOTTOM LINE**

From the point of view of industry finances, the different funding mechanisms have similar impacts on the internal rate of return (IRR) of a producing well, even if total production is low. Table 1 contrasts the IRRs resulting from implementation of (1) the current bond requirement (\$2,500), (2) a cash bond equivalent to the reclamation cost, (3) a predrilling fee, and (4) a 5-year severance tax. We assume 50 years of revenue from production, but use a 10-year funding timeline to minimize the risk of underfunding the reclamation trust.

Though these are rough calculations based on simple assumptions, Table 1 shows that levying a predrilling fee and small severance tax on the first five years of production would quickly fund a trust account with minimal impact on the project’s IRR. From the industry point of view, paying the full cost of reclamation in an up-front bond is the least attractive alternative. However, actual implantation of any financial assurance requires an industry-wide evaluation of financial assumptions

**RISKS TO THE STATE**

From the State’s point of view, there is a risk that the well will become uneconomic prior to year 10, especially if production is much less than EQT Production’s type curve. If this occurs, the shortfall of the 5-year severance tax would be greatest.

The problem of underperforming wells or dry holes, however, is not adequately addressed, and unless the “no risk” cash bond is employed, it is expected that both delayed funding options will result in inadequate funding of the reclamation trust account. In the coal industry, operators are required to make underfunded trust accounts whole either by direct payments into the trust or supplementary bonds. If regulations are strictly enforced to prevent dry holes and uneconomic wells from being granted

Table 1. Gross Revenue IRRs Incorporating the Implementation Cost of Financial Assurance Mechanisms<sup>a</sup>

reclamation cost	gas production curve model	IRR with current bond	IRR with “no risk” cash bond	IRR with predrilling fee	IRR with 5-year severance tax
\$100,000	EQT	78.7%	76.7%	77.1%	78.1%
	60% EQT	34.3%	33.2%	33.5%	33.8%
	35% EQT	13.2%	12.7%	12.8%	12.9%
\$700,000	EQT	78.7%	65.6%	68.4%	74.3%
	60% EQT	34.3%	27.6%	29.0%	30.7%
	35% EQT	13.2%	10.2%	10.8%	11.0%

<sup>a</sup> Drilling and completion cost of \$5.3 million and \$176.6/TCM (\$5/Mcf) price of gas is assumed. The pre-drilling fee and 5-year severance tax are calculated to fully-fund the reclamation trust by year 11. Two target reclamation costs are contrasted, \$100,000 and \$700,000. The pre-drilling fees are \$76,000 and \$535,000 for targets of \$100,000 and \$700,000, respectively. A severance tax rate of \$1.01/TCM (\$0.029/Mcf) is required for reclamation cost of \$100,000 and the EQT production curve. The rate increases to \$20.01/TCM (\$0.57/Mcf) for reclamation cost of \$700,000 and the 35% EQT production curve. TCM = thousand cubic meters. Mcf = thousand cubic feet.

inactive status, the risk of these wells becoming State liabilities decreases.

The risk of underfunded reclamation trusts due to dry holes or otherwise underperforming wells could be reduced if individual operators pooled monies in a reclamation trust. In this case, the severance tax would need to be based on the value of the pooled trust, aggregate production data, and total reclamation liability. To prevent operators from shirking environmental responsibility and ensure the State has adequate resources in case of insolvency, adjustments to the severance tax rate may be necessary so that pooled funds cover the sum of expected reclamation costs.

PADEP may readjust trust funding levels for the mining industry to reflect changes in pollution control costs of plus or minus 10%.<sup>59</sup> However, regulatory inertia or poor oversight pose a threat to the achievement of adequate funding levels, as demonstrated by the lack of adjustment in oil and gas well bonding levels for more than a quarter-century. In theory, the potential for a downward adjustment of the required funding level incentivizes operators to invest in new technologies (or enhanced "pollution control") to lower the cost of reclamation and to have excess funds returned.<sup>60</sup>

#### ■ DISAGGREGATING ENVIRONMENTAL ACCIDENTS FROM WELL SITE RESTORATION AND CLOSURE

While bond forfeiture is commonly associated with operator failure to perform site restoration and plug abandoned wells, the intent of current bonding system for oil and gas wells is much broader. At any point during the productive life of a well, noncompliance with the Oil and Gas Act or an order of the PADEP may be grounds for bond forfeiture. Restoration of water supplies impacted by nearby shale gas operations is an example.

The formation of a competitive bond market requires that liabilities be well-defined in amount and time. Therefore, neither bonds nor trust accounts are the appropriate tool for environmental accidents that occur during production. A remedy could be for Pennsylvania to adopt financial assurance rules that separate expected liabilities from uncertain events such as casing failure or other environmental accidents. Requiring active operators to obtain liability insurance for uncertain events is a partial solution. Insurance companies would need to quantify potential risks and determine an efficient way to pool risk across multiple wells or operators. However, in the absence of a responsible operator, the State or affected citizen is likely to bear the cost in the event of an environmental issue postreclamation.

#### ■ CONCLUSION

The financial assurance mechanisms that Pennsylvania uses to ensure compliance with Pennsylvania's Oil and Gas act of 1984 are outdated and allow ownership transfers to entities less likely to be able to cover the expected costs of reclamation. Without strict enforcement of gas production reporting requirements, the PADEP will be unable to monitor compliance with plugging requirements and prevent abuse of the inactive status program. Timely plugging and abandonment should be the goal of PADEP policy because the long-term environmental and human health risks of shale gas development will increase over time and with the risk of operator insolvency. However, increasing the bonding requirements to fully cover reclamation costs, which is within the PADEP's mandate, will not address well-known limitations of environmental bonds and may limit participation in shale gas development to larger companies.

Alternative mechanisms to ensure operators pay for future reclamation costs include a cash bond, a predrilling fee, and a severance tax. If operators were to deposit the full cost of reclamation in the form of a cash bond, the risk of underfunding will be lowest. Taxing gas production to fund an individual-well trust account for future reclamation poses no additional barrier to operator entrance. This approach may force the State to assume the risk of reclaiming dry holes unless wells are pooled and a severance tax adjustable to funding levels in the trust, total reclamation liabilities, and aggregate production is developed. Comparing all three mechanisms, we found that generating funds directly from the revenue stream during the most lucrative years of gas production has the lowest impact on an operator's IRR. Though the industry generically predicts wells to operate for 40–50 years, reliance on these assumptions to define the terms of financial assurance increases the risk of underfunding and cannot be justified. Separate handling of reclamation and accidental environmental liabilities would promote the development of a competitive bond market if the current system is kept in place.

#### ■ AUTHOR INFORMATION

##### Corresponding Author

\*Phone: (412) 268 3756; fax (412) 268 3757; e-mail: casman@andrew.cmu.edu.

##### Author Contributions

Both authors contributed to the content and writing of this manuscript.

#### ■ ACKNOWLEDGMENT

We are grateful to W. Michael Griffin (CMU), Joel Tarr (CMU), Roma Sidortsov (Vermont Law School), and Susan Ghoweri (PADEP) for their valued advice and perspective. This work was funded by the Climate Decision Making Center (SES-3045798) and by the Center for Climate and Energy Decision Making (SES-0949710), both through cooperative agreements between the National Science Foundation and Carnegie Mellon University; and by the Gordon and Betty Moore Foundation (Award Number 1625) in support of the Carnegie Energy Research Initiative.

#### ■ NOMENCLATURE

BCF, billion cubic feet

Mcf, thousand cubic feet

TCM, thousand cubic meters

PADEP, Pennsylvania Department of Environmental Protection

IRR, internal rate of return

NPV, net present value

#### ■ REFERENCES

- (1) Oil Industry International Exploration and Production Forum (E&P Forum) and United Nations Environmental Programme (UNEP). *Environmental Management in Oil and Gas Exploration and Production: An Overview of Issues and Management Approaches*; UNEP: London, U.K., 1997.
- (2) Angradi, T. R. Fine sediment and macroinvertebrate assemblages in Appalachian streams: A field experiment with biomonitoring applications. *J. North Am. Benthol. Soc.* 1999, 18 (1), 49–66.
- (3) Berkman, H.; Rabeni, C. Effect of siltation on stream fish communities. *Environ. Biol. Fishes* 1987, 18 (4), 285–294.

- (4) MacFarlane, A. *Revegetation of Wellsites and Seismic Lines in the Boreal Forest*. Honour's Thesis University of Alberta, Edmonton, Alberta, 1999.
- (5) Robinson, S. K.; Thompson Iii, F. R.; Donovan, T. M.; Whitehead, D. R.; Faaborg, J. Regional forest fragmentation and the nesting success of migratory birds. *Science* 1995, 267 (1), 1987–1990.
- (6) Johnson, N. *Pennsylvania Energy Impacts Assessment*; The Nature Conservancy—Pennsylvania Chapter : Harrisburg, PA, 2010; p 47. [http://www.nature.org/media/pa/tnc\\_energy\\_analysis.pdf](http://www.nature.org/media/pa/tnc_energy_analysis.pdf).
- (7) Pennsylvania Department of Conservation and Natural Resources, Bureau of Forestry. *Pennsylvania Statewide Forest Resource Assessment* Pennsylvania Department of Conservation and Natural Resources: Harrisburg, PA, 2010; p 210 [www.dcnr.state.pa.us/forestry/farmbill/pdfs/assessment.pdf](http://www.dcnr.state.pa.us/forestry/farmbill/pdfs/assessment.pdf).
- (8) Railroad Commission of Texas. Well Plugging Primer. In *Railroad Commission of Texas Oil and Gas Division Well Plugging Section*: 2000; p 20 <http://www.rrc.state.tx.us/forms/publications/plugprimer1.pdf>.
- (9) Gurevich, A. E.; Endres, B. L.; Robertson, J. O., Jr; Chilingar, G. V. Gas migration from oil and gas fields and associated hazards. *J. Pet. Sci. Eng.* 1993, 9 (3), 223–238.
- (10) Pennsylvania Department of Environmental Protection. *Stray Natural Gas Migration Associated with Oil and Gas Wells*; Pennsylvania Department of Environmental Protection: Harrisburg, 2009; [http://www.dep.state.pa.us/dep/subject/advocoun/oil\\_gas/2009/Stray%20Gas%20Migration%20Cases.pdf](http://www.dep.state.pa.us/dep/subject/advocoun/oil_gas/2009/Stray%20Gas%20Migration%20Cases.pdf).
- (11) Pennsylvania Department of Environmental Protection, Orphan Oil and Gas Wells and the Orphan Well Plugging Fund. In Pennsylvania Department of Environmental Protection: 2007. <http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-82185/5500-FS-DEP1670.pdf>
- (12) National Energy Technology Laboratory. *Methane Emissions Project Borough of Versailles, PA*; U.S. Department of Energy, 2007; <http://www.netl.doe.gov/newsroom/versailles/Versailles%20Methane%20Emissions%20Project%20-%20Final%20Report.pdf>
- (13) Muehlenbachs, L. *Internalizing Production Externalities: A Structural Estimation of Real Options in the Upstream Oil and Gas Industry*. Doctor of Philosophy, University of Maryland, College Park, MD, 2009.
- (14) Nichol, J. R.; Kariyawasam, S. N. *Risk Assessment of Temporarily Abandoned or Shut-in Wells*; Department of the Interior, Minerals Management Service, C-FER Technologies, 2000; p 72 [www.boemre.gov/tarprojects/329/329AA.pdf](http://www.boemre.gov/tarprojects/329/329AA.pdf).
- (15) Khandka, R. K. *Leakage Behind Casing*; Norwegian University of Science and Technology, Department of Petroleum Engineering and Applied Geophysics Trondheim, Norway, 2007.
- (16) Dusseault, M. B.; Gray, M. N. *Why Oilwells Leak: Cement Behavior and Long-Term Consequences*; Society of Petroleum Engineers Inc.: Beijing, China, 2000; <http://www.onepetro.org/mslib/servlet/onepetroreview?id=00064733&soc=SPE>.
- (17) Gasda, S. E.; Bachu, S.; Celia, M. A. Spatial characterization of the location of potentially leaky wells penetrating a deep saline aquifer in a mature sedimentary basin. *Environ. Geol.* 2004, 46 (6), 707–720.
- (18) Ghoweri, S., Personal Communication. In 2011.
- (19) Bureau of Land Management. *Coalbed Methane Development in the Northern San Juan Basin of Colorado*; U. S. Department of the Interior: San Juan, CO, 1999; p 129, [http://cogcc.state.co.us/Library/sanjuanbasin/blm\\_sjb.htm](http://cogcc.state.co.us/Library/sanjuanbasin/blm_sjb.htm).
- (20) Chilingar, G. V.; Endres, B. Environmental hazards posed by the Los Angeles Basin urban oilfields: An historical perspective of lessons learned. *Environ. Geol.* 2005, 47 (2), 302–317.
- (21) Stafford, S. L.; Weaver, T. J.; Hedin, R. S. Geochemistry, hydrogeology, and effects from the plugging of artesian flows of acid mine drainage: Clarion River Watershed, Northwestern Pennsylvania. In *National Meeting of the American Society of Mining and Reclamation*; The American Society of Mining and Reclamation: Morgantown, WV, 2004; <http://www.asmr.us/Publications/Conference%20Proceedings/2004/1792-Stafford%20PA.pdf>.
- (22) Rabinowitz, H. *Economic Effects of Groundwater Contamination on Real Estate*; University of Wisconsin, Water Resources Center, 1995; <http://digital.library.wisc.edu/1711.dl/EcoNatRes.WRCGR9506>.
- (23) Boxall, P.; Chan, W.; McMillan, M. The impact of oil and natural gas facilities on rural residential property values: a spatial hedonic analysis. *Resour. Energy Econ.* 2005, 27 (3), 248–269.
- (24) Leggett, C. G.; Bockstael, N. E. Evidence of the effects of water quality on residential land prices. *J. Environ. Econ. Manage.* 2000, 39 (2), 121–144.
- (25) Interstate Oil and Gas Compact Commission. *Protecting Our Country's Resources: The states Case*; The Interstate Oil and Gas Compact Commission: Oklahoma City, OK, 2008; p 68, <http://iogcc.myshopify.com/products/protecting-our-countrys-resources-the-states-case-orphaned-well-plugging-initiative-2008>.
- (26) Intergovernmental Panel on Climate Change. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007. [http://ipcc.ch/publications\\_and\\_data/ar4/wg1/en/contents.html](http://ipcc.ch/publications_and_data/ar4/wg1/en/contents.html) (accessed April 14, 2011).
- (27) Pennsylvania Department of Environmental Protection. *Executive Summary The Oil and Gas Act*; Pennsylvania Department of Environmental Protection: Harrisburg, PA, 2009; [www.dep.state.pa.us/dep/deputate/minres/oilgas/ORPHRPT4.pdf](http://www.dep.state.pa.us/dep/deputate/minres/oilgas/ORPHRPT4.pdf).
- (28) Pennsylvania Department of Environmental Protection. *Bureau of Oil and Gas Management, Abandoned & Orphan Wells Listing*; Pennsylvania Department of Environmental Protection: Harrisburg, PA, 2011; <http://www.dep.state.pa.us/dep/deputate/minres/oilgas/AbandedOrphanWells.xls>.
- (29) Pennsylvania Department of Environmental Protection. *Bureau of Oil and Gas Management, Pennsylvania's Plan for Addressing Problem Abandoned Wells and Orphaned Wells*, Document number 550-800-001; Pennsylvania Department of Environmental Protection: Harrisburg, 2000; p 7; <http://www.elibrary.dep.state.pa.us/dsweb/Get/Version-48262/550-0800-001.pdf>.
- (30) Pennsylvania Department of Environmental Protection. *Second Year Growing Greener II Report*; Pennsylvania Department of Environmental Protection: Harrisburg, PA, 2007; <http://www.portal.state.pa.us/portal/server.pt?open=18&objID=503089&mode=2>.
- (31) Pennsylvania Department of Environmental Protection. *Third Year Growing Greener II Report*; Pennsylvania Department of Environmental Protection: Harrisburg, PA, 2008; <http://www.portal.state.pa.us/portal/server.pt?open=18&objID=503088&mode=2>.
- (32) New York State Department of Environmental Conservation. *Well Permit Issuance for Horizontal Drilling And High-Vol. Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs*; New York State Department of Environmental Conservation: Albany, NY, 2009; <ftp://ftp.dec.state.ny.us/dmn/download/OGdSGEISFull.pdf>.
- (33) Andersen, M.; Coupal, R., Economic issues and policies affecting reclamation in Wyoming's oil and gas industry. In *National Meeting of the American Society of Mining and Reclamation*, Billings, MT, 2009.
- (34) Pennsylvania Department of Conservation and Natural Resources. Bureau of Topographic and Geologic Survey, Well Completion Reports . In *Pennsylvania Internet Record Imaging System/Wells Information System (PA\*IRIS/WIS)*; Pennsylvania Department of Environmental Protection: Harrisburg, 2010.
- (35) Cabot Oil & Gas Corporation. Summary of Cabot's Good Faith Efforts, 2010. <http://cabotog.com/pdfs/ExhibitB.pdf> (accessed April 15, 2011).
- (36) Boyd, J. *Financial Responsibility for Environmental Obligations: Are Bonding and Assurance Rules Fulfilling Their Promise?*; Resources for the Future: Washington, DC, 2001; p 71, [www.rff.org/documents/RFF-DP-01-42.pdf](http://www.rff.org/documents/RFF-DP-01-42.pdf).
- (37) Pennsylvania Department of Environmental Protection. *Assessment of Pennsylvania's Bonding Program for Primacy Coal Mining Permits*; Pennsylvania Department of Environmental Protection Office of Mineral Resources Management Bureau of Mining and Reclamation: Harrisburg, PA, 2000; p 43, <http://www.dep.state.pa.us/dep/deputate/minres/bmr/bonding/>.

- (38) Office of Surface Mining Reclamation and Enforcement. *National Priority Review—Adequacy of Bonding in the Approved Pennsylvania Program*; U.S. Office of Surface Mining Reclamation and Enforcement: Pittsburgh, PA, 2010; p 407, [http://www.arcc.osmre.gov/Divisions/PFD/PDFs/2010/2010\\_Pennsylvania\\_Bonding\\_Adequacy\\_Study.pdf](http://www.arcc.osmre.gov/Divisions/PFD/PDFs/2010/2010_Pennsylvania_Bonding_Adequacy_Study.pdf).
- (39) U.S. General Accounting Office. *Surface Mining: Difficulties in Reclaiming Mined Lands in Pennsylvania and West Virginia*; General Accounting Office: Washington, DC, 1986; <http://www.gao.gov/products/RCED-86-221>.
- (40) Pennsylvania Department of Environmental Protection. *Conventional Bonding for Land Reclamation—Coal*; Department of Environmental Protection Bureau of Mining and Reclamation: Harrisburg, PA, 2006; p 30 <http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-72980/Draft%20563-2504-001.pdf>.
- (41) STATOIL, Marcellus shale gas. 2010. [www.statoil.com/en/About/Worldwide/USA/Pages/ShaleGasMarcellus.aspx](http://www.statoil.com/en/About/Worldwide/USA/Pages/ShaleGasMarcellus.aspx) (accessed April 15, 2011).
- (42) DCNR Minerals 2007 Standard Oil Gas Lease. [http://www.dcnr.state.pa.us/forestry/sfmp/documents/Minerals\\_2007\\_Standard\\_Oil\\_Gas\\_Lease.pdf](http://www.dcnr.state.pa.us/forestry/sfmp/documents/Minerals_2007_Standard_Oil_Gas_Lease.pdf) (accessed May 24, 2011).
- (43) DCNR Gov. Rendell says responsible planning generates \$128.4 million from state forest land lease, safeguards natural resources. In *News and Information Resource*; Pennsylvania Department of Conservation and Natural Resources: Harrisburg, PA, 2010; <http://www.dcnr.state.pa.us/news/resource/res2010/10-0120-gaslease.aspx> (accessed June 21, 2011).
- (44) Sherman, T. Market Effects of the Marcellus, Pittsburgh, PA, 2010; <http://www.dugeast.com/PastConferences/> (accessed November 16, 2010).
- (45) Considine, T. J. *The Economic Impacts of the Marcellus Shale: Implications for New York, Pennsylvania, and West Virginia*; Natural Resource Economics, Inc.: Larmie, WY, 2010; p 44, <http://www.api.org/policy/exploration/hydraulicfracturing/upload/APIEconomicImpactsMarcellusShale.pdf>.
- (46) E. Q. T. Production, Marcellus Decline Curve. Events & Presentation, 2011. <http://ir.eqt.com/events.cfm?AcceptDisclaimer=yes> (accessed April 15, 2011).
- (47) Koplou, D.; Martin, A., Fueling Global Warming: Federal Subsidies to Oil in the United States. In *Industrial Economics Inc*: Cambridge, MA, 1998; p 140 <http://archive.greenpeace.org/climate/oil/fdsboil.pdf>
- (48) Hager, A. V.; Shaw, K. L., Idle and Deserted Wells: Who Plugs and Who Pays? In *Proceedings of the Annual Institute of the Rocky Mountain Mineral Law Foundation*, 1999; Vol. 45 [www.mayerbrown.com/energy/article.asp?id=2144&nid=10908](http://www.mayerbrown.com/energy/article.asp?id=2144&nid=10908)
- (49) U.S. General Accounting Office. *Alaska's North Slope Requirements for Restoring Lands After Oil Production Ceases*. In U.S. General Accounting Office: Washington, DC, 2002; p 114, <http://www.gao.gov/products/GAO-02-357>.
- (50) Tarr, J. A. *Devastation and Renewal: An Environmental History of Pittsburgh and Its Region*; University of Pittsburgh Press: Pittsburgh, PA, 2003.
- (51) Pennsylvania Department of Environmental Protection. Production Reports 2003–2011. PA DEP Oil & Gas Reporting Website, 2011. <https://www.paoilandgasreporting.state.pa.us/publicreports/Modules/Production/ProductionHome.aspx> (accessed August 30, 2011).
- (52) Interstate Oil and Gas Compact Commission. *Marginal Wells: Fuel For Economic Growth*; The Interstate Oil and Gas Compact Commission: Oklahoma City, OK, 2008; [www.energy.psu.edu/swc/news/2008-Marginal-Well-Report.pdf](http://www.energy.psu.edu/swc/news/2008-Marginal-Well-Report.pdf).
- (53) Pennsylvania Department of Environmental Protection. Production Reports 2003–2009. PA DEP Oil & Gas Reporting Website, 2009. <https://www.paoilandgasreporting.state.pa.us/publicreports/Modules/Production/ProductionHome.aspx> (accessed August 30, 2011).
- (54) ECRB. Directive 006 Licensee Liability Rating (LLR) Program and License Transfer Process. In *The Energy Resources Conservation Board* 2009. <http://www.ercb.ca/docs/documents/directives/Directive006.pdf> (accessed August 15, 2011)
- (55) ER. Guideline PD-G01: Licensee Liability Rating (LLR) Program Guideline. In *The Ministry of Energy and Resources*: 2010. <http://www.ir.gov.sk.ca/adx/asp/adxGetMedia.aspx?DocID=10419,10418,3680,3384,5460,2936,Documents&MediaID=38399&Filename=LLR+Guideline+January+2011.pdf> (accessed May 25, 2011).
- (56) U.S. General Accounting Office. *Surface Mining Cost and Availability of Reclamation Bonds*; U.S. General Accounting Office: Washington, DC, 1988; <http://www.gao.gov/products/PEMD-88-17>.
- (57) Cabot Oil & Gas Corporation. 2010. <http://www.cabotog.com/pdfs/ExhibitB.pdf> (accessed April 15, 2011).
- (58) Pennsylvania Department of Environmental Protection, Consent Order and Settlement Agreement. 2010. [http://www.cabotog.com/pdfs/FinalA\\_12-15-10.pdf](http://www.cabotog.com/pdfs/FinalA_12-15-10.pdf) (accessed April 14, 2011).
- (59) Pennsylvania Department of Environmental Protection, Financial Assurance and Bond Adjustments for Mine Sites with post-mining Discharges. In *Pennsylvania Department of Environmental Protection*: Harrisburg, PA, 2007; <http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-64460/563-2504-450.pdf>.
- (60) Shogren, J. F.; Herriges, J. A.; Govindasamy, R. Limits to environmental bonds. *Ecol. Econ.* 1993, 8, 109–133.