

SCIENCE AND THE REASONABLE DEVELOPMENT OF MARCELLUS SHALE NATURAL GAS RESOURCES IN PENNSYLVANIA AND NEW YORK

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Synopsis: A fair amount of controversy concerning the development of natural gas resources in the Marcellus Shale formation has accompanied the return of significant oil and gas exploration and production to Pennsylvania. One need only look at the news headlines and legislative and regulatory dockets to appreciate the diversity of issues and positions on those issues related to the Marcellus Shale region. A growing number of lawsuits and media reports give the impression that Marcellus Shale drilling and production operations – especially the process known as hydraulic fracturing – are indisputably harmful to both the environment and to those who live in the vicinity of the wells. Lawmakers and regulators have introduced myriad measures imposing additional oversight and operational requirements on Marcellus Shale producers. The economic, environmental, and human impact of such measures will be significant – which is exactly why unbiased and informed scientific evaluation of the potential link between Marcellus Shale production activities and environmental and health concerns is essential to appropriate judicial and regulatory decisions. The success of efforts to explore and develop Marcellus Shale natural gas resources requires continued critical and scientific evaluation of information concerning all aspects of the enterprise.

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I. INTRODUCTION

Investment in the development of natural gas resources in the Marcellus Shale formation¹ continues to bring lower energy costs and new jobs to local economies. It has also attracted litigation alleging that well drilling, hydraulic fracturing,² and natural gas production have contaminated drinking water supplies and damaged property in the vicinity of some operations. Media reports of landowner complaints alleging problems with drinking water wells due to nearby Marcellus Shale operations abound. Actions regarding Marcellus Shale operations have proceeded along disparate and inconsistent paths, and often without critical technical review. Some lawmakers and regulators have introduced measures imposing additional oversight and operational requirements on Marcellus Shale producers, including rules focused on hydraulic fracturing. These measures aim to control the release and migration of new and used fracturing fluids and other well fluids from well bores, and at the surfaces of well locations, into the surrounding environment. Other measures simply prohibit any further effort to develop Marcellus Shale resources in certain locations, either before assessing the potential impact of additional activities or in response to perceived deficiencies in efforts to perform such an assessment.

Scientific evaluation of information concerning the potential link between Marcellus Shale production activities and environmental problems is essential to appropriate judicial and regulatory decisions. Rigorous investigations and objective interpretation of data can improve understanding of the extent to which Marcellus Shale operations may impact water quality or transport naturally occurring radioactive material (NORM), such as radium and uranium, from the formation to the surface. Such reliable scientific information can support appropriate regulatory and operational responses. Moreover, as technically sound data are preferred by courts, the results of deliberate and reasoned studies will assist juries in evaluating contamination and NORM claims.

This article examines the bases for regulatory and legislative actions; evaluates allegations made in environmental and personal injury actions; and describes how sound science can inform future actions by legislators, regulators, litigants, and operators regarding Marcellus Shale exploration and production in New York and Pennsylvania. It uses recent developments in those states, and actions by the United States Environmental Protection Agency (EPA) and the Delaware River Basin Commission (DRBC) as case studies. Officials in Ohio, West Virginia, and Maryland have also begun to address and implement changes to laws and regulations pertaining to natural gas operations in those states.³ An

1. The Marcellus Shale is a sedimentary rock formation, extending from southern New York across Pennsylvania, and into western Maryland, West Virginia, and eastern Ohio, which contains significant quantities of natural gas. Daniel J. Soeder & William M. Kappel, *Water Resources and Natural Gas Production from the Marcellus Shale Fact Sheet* (2009) at 1, available at <http://pubs.usgs.gov/fs/2009/3032/pdf/FS2009-3032.pdf>.

2. Hydraulic fracturing is a process involving the injection of water, sand, and chemicals down a drilled well to crack open rock and keep the cracks open to allow natural gas to flow into the well. *Id.* at 2.

3. See, e.g., Alison Knezevich, *Lawmakers Look at Marcellus Shale Drilling Issues*, CHARLESTON GAZETTE, Jan. 27, 2011, available at <http://www.wvgazette.com/News/201101271498>; Randy Huffman, *Important Work Awaits Us in Session*, INDEPTH (W. Va. Dep't of Env'tl. Prot.), Jan. 2011, at 3, 10, available at <http://www.dep.wv.gov/pic/Documents/INDEPTH%20newsletter/January%202011.pdf>; Michael A. Sawyers, *Governor Touts Statewide Broadband Internet Service*, CUMBERLAND TIMES-NEWS, Jan. 28, 2011, available

analysis of initiatives in those states is beyond the scope of this article, because changes to laws and regulations in Pennsylvania and New York were initiated earlier, and more information is available concerning how science has informed these actions.⁴

II. STATE AND FEDERAL OVERSIGHT OF MARCELLUS SHALE OPERATIONS

Speculation about a possible connection between hydraulic fracturing and groundwater contamination, and about the potential for Marcellus Shale production to generate waste containing slightly elevated amounts of NORM, has fueled opposition to the industry's drilling, production, and waste management practices. Despite efforts to rely on technical information and reviews by appropriately qualified experts, regulators must sometimes make public policy decisions in response to public opinion and media reports. There are a number of examples at both the state and federal level of policies which illustrate the tension between science and public perception in regulations and legislation.

A. *Suspension of New Drilling in New York State*

On November 29, 2010, the New York State Assembly approved legislation which would suspend any permitting of hydraulic fracturing in low-permeability natural gas formations in the state until May 2011.⁵ This action followed the New York State Senate's vote to impose a moratorium on new drilling in the Marcellus Shale formation.⁶ In justifying the moratorium, the Senate bill's sponsor noted only possible, but unidentified, "catastrophic [e]ffects on our natural resources and families" and concluded, without support, that hydraulic fracturing chemicals injected into the Marcellus Shale formation "work their way into the regular water supply."⁷ New York Governor David Paterson vetoed this legislation on December 11, 2010, because he found that the moratorium, to the extent that it prevented hydraulic fracturing used in drilling "conventional, low-volume, vertical oil and gas wells[,] was too broad, would "put people out of work[,] and "send hundreds and perhaps thousands of jobs, and millions of

at <http://times-news.com/local/x376908728/-NEW-Governor-touts-statewide-broadband-Internet-service> (Maryland Governor O'Malley stated that he would not approve Marcellus Shale development in Western Maryland until he was assured that it is environmentally safe); *ODNR Tries to Reassure; Crowd Wary*, CANTONREP.COM, Jan. 27, 2011, available at <http://www.cantonrep.com/topstories/x1145628433/ODNR-tries-to-reassure-crowd-wary> (noting that Ohio legislature made "significant changes" to strengthen laws regarding oil and gas operations in the state).

4. In addition, a comprehensive review of all issues pertaining to Marcellus Shale exploration and production in Pennsylvania, New York, the Delaware River basin, or elsewhere is also beyond the scope of this article, because environmental, hydrogeologic, geologic, and human health matters play a more limited role in decisions concerning issues such as severance taxes, leasing, and pooling production than they do in the topics addressed in this article.

5. B. S8129, 2010 Leg., 233d Sess. (N.Y. 2010). See also, Matt Day, *NY State Assembly Passes Hydraulic Fracturing Moratorium*, DOW JONES NEWSWIRES, Nov. 30, 2010, available at http://www.rigzone.com/news/article.asp?a_id=101718.

6. B. S8129B, 2010 Leg., 233d Sess. (N.Y. 2010).

7. Press Release, N.Y. State Sen. Antoine M. Thompson (Former), Sen. Antoine Thompson, Residents & Advocates Urge Moratorium on Gas Drilling Which Could Pollute New York's Drinking Water (Aug. 17, 2010), available at <http://www.nysenate.gov/press-release/senator-antoine-thompson-residents-advocates-urge-moratorium-gas-drilling-which-could->

dollars in capital investment” out of the state.⁸ In connection with his veto, Governor Paterson issued an Executive Order which prohibits the New York Department of Environmental Conservation (NY DEC) from issuing permits for projects using “high-volume hydraulic fracturing combined with horizontal drilling” until after it completes a supplemental generic environmental impact statement which addresses how this new technology should be regulated within the state.⁹ For now, no hydraulic fracturing of horizontal natural gas wells will be permitted in New York, despite its “rigorous regulatory process,” which has prevented “the types of problems reported to have occurred in states without such strong environmental laws and [other] rigorous regulations[,]” and despite the fact that “[n]o known instances of groundwater contamination have occurred from previous horizontal drilling or hydraulic fracturing projects in New York State.”¹⁰

The New York State legislature and executive took these preemptive actions despite ongoing work by the NY DEC to review and revise requirements for permitting oil and gas wells, particularly horizontal wells in the Marcellus Shale which will be hydraulically fractured. In 2008, New York Governor Paterson first directed the NY DEC to prepare an updated Generic Environmental Impact Statement (SGEIS) which would address potential impacts to groundwater, surface water, wetlands, air quality, noise, traffic, community character, and cumulative impacts from hydraulic fracturing and horizontal drilling.¹¹ This review and assessment was intended to identify additional safety measures, protection standards, and mitigation strategies for Marcellus Shale operators who seek permits. The draft SGEIS was released for public comment on September 30, 2009. The comment period ended on December 31, 2009.¹² The final SGEIS must include a set of measures protecting human health and the environment from any impacts identified in the revised draft SGEIS.¹³ Governor Paterson’s executive order extends the moratorium on permitting drilling of natural gas wells requiring horizontal drilling, and high-volume hydraulic fracturing beyond the state legislature’s proposed May 2011 ending date. By requiring the NY DEC to complete its public comment review, and publish a revised draft SGEIS by June 1, 2011, providing no less than thirty days following publication of the revised draft

8. Press Release, N.Y. Governor’s Press Office, Governor Paterson Issues Executive Order on Hydraulic Fracturing (Dec. 11, 2010), *available at* <http://www.ny.gov/governor/press/121110PatersonExecutiveO-HydraulicFracturing.html>.

9. N.Y. Exec. Order No. 41, Requiring Further Environmental Review of High-Volume Hydraulic Fracturing in the Marcellus Shale (Dec. 13, 2010), *available at* <http://www.governor.ny.gov/archive/paterson/executiveorders/EO41.html>.

10. *Marcellus Shale*, N.Y. DEP’T OF ENVTL. CONSERVATION, <http://www.dec.ny.gov/energy/46288.html> (last visited Dec. 3, 2010).

11. Press Release, N.Y. Governor’s Press Office, Governor Paterson Signs Bill Updating Oil and Gas Drilling Law; Pledges Environmental and Public Health Safeguards (July 23, 2008), *available at* http://s3.amazonaws.com/propublica/assets/natural_gas/paterson_environment_080723.pdf. *See also*, N.Y. Exec. Order No. 41, *supra* note 9.

12. *Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program, Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs*, N.Y. DEP’T OF ENVTL. CONSERVATION, <http://www.dec.ny.gov/energy/58440.html> (last visited Dec. 3, 2010).

13. N.Y. Exec. Order No. 41, *supra* note 9.

SGEIS for public comment and hearings on the revisions, the executive order extends the moratorium through, at least, July 1, 2011.¹⁴

Meeting the June 1, 2011 deadline for publishing a revised draft SGEIS may prove unworkable. The NY DEC reportedly received over 13,000 public comments regarding the draft SGEIS, and must review and respond to those comments before it can publish a revised draft.¹⁵ Concerns common to a number of the comments that the NY DEC received include the following:

- calls for the NY DEC to set aside the draft SGEIS as deficient and develop a new document which includes specific proposed regulations and revisions to existing regulations;
- the cumulative impact of withdrawal of water needed for hydraulic fracturing on stream flow and on environmentally sensitive watersheds;
- inadequate guidance for monitoring of the impact of water withdrawal on local streams;
- calls for categorically prohibiting all drilling and production activities in locations with sensitive habitats and those which supply water to New York City and other jurisdictions;
- omission of consideration of the cumulative impacts to roads used for hauling water, equipment, and supplies;
- inadequate guidance regarding and controls for the cumulative impact that waste water disposal could have on receiving water quality;
- limited or absent consideration of the impact of disposal of flowback water and solid materials containing NORM; and
- insufficient requirements for disclosing the chemicals used in hydraulic fracturing fluids, and for reporting spills and drilling activities.¹⁶

The comments to the draft SGEIS conclude that only additional guidance and further restrictions on drilling and production operations in New York can prevent the adverse impacts which they predict will follow from additional natural gas drilling and production in the state.

Several comments raise concerns about radioactive contamination being brought to the surface in water and solid waste, and charge the NY DEC with failing to adequately account for the risk from NORM in Marcellus Shale drilling cuttings.¹⁷ Other comments challenge the NY DEC's conclusion that levels of radioactivity in Marcellus Shale drilling cuttings "do not indicate an exposure concern for workers or the general public."¹⁸ An existing dose assessment from NORM in Marcellus Shale drilling cuttings which was prepared by Radioactive Waste Management Associates (RWMA) on behalf of a group opposed to permitting disposal of cuttings in solid waste landfills contains

14. *Id.*

15. *Id.*

16. Comments of New York City, *Draft Supplemental Generic Environmental Impact Statement (dSGEIS) on the Oil, Gas and Solution Mining Regulatory Program – Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs* (Dec. 22, 2009) (on file with authors).

17. *See, e.g., id.* at 40-42.

18. N.Y. DEP'T OF ENVTL. CONSERVATION, *Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program, Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs* 5-30 (Sept. 2009).

misstatements and errors.¹⁹ The RWMA used Argonne National Laboratory's RESRAD (residual radioactivity) dose calculation program to estimate landfill worker and resident farmer doses and concluded that these doses were excessive. However, if reasonable assumptions are employed in operating the RESRAD program, the resulting landfill worker doses are below the public dose limits, and the hypothetical resident farmer's dose is essentially zero.

For example, the RWMA's report states that if "landfill workers . . . come in contact with" the shale cuttings, their doses "would exceed current health-based dose limits."²⁰ New York requires that licensed or registered activities involving radioactive material may not result in a dose to a member of the public in excess of 100 millirem per year.²¹ Even if a worker stood for eight hours a day directly on top of the cuttings in a landfill, his dose from the pertinent pathways (external radiation, dust inhalation, radon, and soil ingestion) would not exceed the public dose limit.²²

The RWMA also used a number of unreasonable assumptions when it calculated the radiation dose to a potential agricultural resident from drilling cuttings disposed of in a landfill. The RWMA's dose calculation assumed that the potential resident was a farmer who built a home, maintained a garden, orchards, and a grains (corn, wheat, etc.) field directly on top of the shale cuttings (i.e., non-organic, powdered rock), from which 350 pounds of food are improbably harvested each year.²³ Most jurisdictions, of course, would not permit farming or residential construction directly on top of a landfill. If, however, one assumes that one meter of soil covers the landfill, then the farmer's dose from the same pathways that the RWMA considered²⁴ is essentially zero. It is approximately 0.001 millirem per year, or about 100,000 times lower than the public radiation dose limit.²⁵

19. Marvin Resnikoff, Ekaterina Alexandrova & Jackie Travers, *Radioactivity in Marcellus Shale, Report Prepared for Residents for the Preservation of Lowman and Chemung* (RFPLC), RADIOACTIVE WASTE MGMT. ASSOC., (May 19, 2010), available at <http://www.rwma.com/Marcellus%20Shale%20Report%205-18-2010.pdf> [hereinafter *RWMA Report*].

20. *Id.* at 6 & 7.

21. N.Y. COMP. CODES R. & REGS. tit. 12, § 38.19(a)(1)(ii) (2010).

22. This statement is based on a very conservative (exaggerated) calculation using the Argonne National Laboratory RESRAD Program (Version 6.4), the same program that the RWMA used. The calculation assumes a shale cutting radium-226 concentration of 20 pCi/g (the same radium concentration assumed by RWMA); a shale cutting density of 2.5 g/cm³; the worker is assumed to be standing for eight hours per day, 365 days per year, directly on top of cuttings, which have an area of 10,000 square meters and a depth of five meters. Even using these conservative assumptions, the dose would be approximately seventy millirem per year; i.e., below the 100 millirem public limit.

23. ARGONNE NAT'L LAB., *RESRAD Computer Code (Version 6.4), Ingestion: Dietary Menu for Fruit, Vegetable and Grain Consumption*, available at <http://web.cad.anl.gov/resrad/home2/>.

24. *RWMA Report*, *supra* note 19, at 7. The RWMA Report did not include radon in the potential resident's dose, probably because the primary public dose limit of 100 millirem per year does not apply to radon. See NAT'L RESEARCH COUNCIL, *EVALUATION OF GUIDELINES FOR EXPOSURES TO TECHNICALLY ENHANCED NATURALLY OCCURRING RADIOACTIVE MATERIALS 147* (Nat'l Acads. Press 1999).

25. The resident farmer RESRAD Version 6.4 calculation was made assuming a radium-226 concentration of twenty pCi/g, default occupancy factors, 2.5 g/cm³ density for shale cuttings, cuttings were 10,000 square meters in area and five meters in depth. Cover material with a depth of one meter and default density were also assumed.

B. The Delaware River Basin Commission Moratorium

In May 2009, the Delaware River Basin Commission (DRBC) announced a determination that natural gas producers may not commence projects in shale formations that lie within the Delaware River Basin without first applying for and obtaining DRBC approval. The DRBC also announced that approvals will not be granted until after the Commission adopts new rules.²⁶ In announcing this requirement, the DRBC executive director noted simply that natural gas extraction projects in the Marcellus Shale formation in areas of the basin “may individually or cumulatively affect the water quality . . . by altering . . . physical, biological, chemical or hydrological characteristics” of waters in those areas.²⁷ In June 2010, the DRBC Executive Director extended the requirement for approval of projects to include exploratory wells. The DRBC did allow work to proceed on a limited number of “grandfathered” exploratory wells, those which had already been permitted when the new rules were announced.²⁸ At a September 15, 2010 DRBC meeting, those present, including officials representing the federal government, approved continuing limited exploratory drilling in the basin and denied a request from Rep. Maurice Hinchey (D-N.Y.) to halt drilling in the Delaware River Basin until completion of a joint study of the cumulative impact of water withdrawals from the basin could be completed by the United States Geological Survey and the DRBC.²⁹

Both oil companies and environmental groups challenged the DRBC’s actions. The environmental groups questioned the DRBC’s decision to allow drilling of some “grandfathered” exploratory wells to proceed. The oil companies, along with Northern Wayne County Property Owners Alliance and other individuals, challenged the DRBC’s authority to require companies that have already received state permits for drilling to obtain the DRBC’s approval before they proceed with their projects.³⁰ A January 19, 2011 hearing regarding these challenges had been scheduled before the Honorable Edward N. Cahn, a former United States District Court Judge for the Eastern District of Pennsylvania.³¹ However, the January 2011 hearing was subsequently canceled as the result of an agreement by the parties to take actions which would avoid the

26. Carol R. Collier, *Determination of the Executive Director Concerning Natural Gas Extraction Activities in Shale Formations Within the Drainage Area of Special Protection Waters*, DEL. RIVER BASIN COMM’N (May 19, 2009), available at <http://www.state.nj.us/drbc/EDD5-19-09.pdf>.

27. *Id.*

28. Mike Soraghan, *Obama Admin Rejects Timeout for Natural Gas Drilling in N.Y., Pa.*, N.Y. TIMES, Sept. 22, 2010, available at <http://www.nytimes.com/gwire/2010/09/22/22greenwire-obama-admin-rejects-timeout-for-natural-gas-dr-60467.html>. See also, Carol R. Collier, *Amendment to Supplemental Determination of the Executive Director Concerning Natural Gas Extraction Activities in Shale Formations Within the Drainage Area of Special Protection Waters*, DEL. RIVER BASIN COMM’N (July 23, 2010), available at <http://www.state.nj.us/drbc/AmendedSuppEDD072310.pdf>.

29. Soraghan, *supra* note 28.

30. *Natural Gas Drilling in the Delaware River Basin*, DEL. RIVER BASIN COMM’N (Mar. 2, 2011), <http://www.state.nj.us/drbc/naturalgas.htm> (last visited Dec. 15, 2010).

31. *Id.* Copies of materials submitted in support of challenges to be heard at the hearing are available on the DRBC’s website.

need for a hearing, and the DRBC's publication of draft Natural Gas Development Regulations, issued December 8, 2010.³²

The DRBC's draft regulations are likely to fuel additional challenges and a volume of public comments rivaling the number that were submitted to the NY DEC. The draft Article 7 of the DRBC's Water Quality Regulations applies to "all natural gas development projects . . . in the Basin regardless of the target geologic formation, and to water withdrawals, well pad and related activities and wastewater disposal activities comprising part of, associated with or serving such projects."³³ These draft regulations impose restrictive and duplicative requirements on operators who plan to drill and operate natural gas wells in the Delaware River Basin. For example, in addition to bonds and other financial assurance that a state may require for a permitted well, the DRBC's draft regulations require operators to maintain an additional \$125,000 in financial assurance per natural gas well, and to contribute to a separate excess financial assurance account of up to \$25 million.³⁴ The draft regulations also impose broad reporting requirements on operators who receive DRBC approval of natural gas well projects, including reporting to the DRBC any "circumstances that may reasonably lead to a finding of a violation [of the DRBC's rules]," and any complaints that an operator receives regarding a project.³⁵ The draft regulations further require that operators repair, replace, or otherwise mitigate impacts to "[a]ny ground or surface water user which is substantially adversely affected, rendered dry or otherwise diminished as a result of the project sponsor's withdrawal."³⁶ Comments to the draft regulations must be submitted by March 16, 2011.

C. Recent Pennsylvania Rulemaking

Pennsylvania regulators have allowed Marcellus Shale drilling and production operations to proceed and have adapted their regulations and enforcement efforts to respond to problems that have arisen. Pennsylvania regulators have increased supervision of natural gas operations through increased oversight and enhanced drilling and production operations. Many of the regulatory changes received favorable comment by an independent review of Pennsylvania's regulation of hydraulic fracturing when compared with the organization's 2010 hydraulic fracturing guidelines.³⁷

Since 2008, the Pennsylvania Department of Environmental Protection (PA DEP) has doubled the number of oil and gas inspection staff and implemented new water quality standards and other changes concerning Marcellus Shale

32. Status of Exploratory Well Administrative Adjudicatory Hearing, DEL. RIVER BASIN COMM'N (Mar. 2, 2011), available at <http://www.state.nj.us/drbc/naturalgas.htm#AdminAdjudHearing>.

33. DRBC Draft Natural Gas Development Regulations 'At-a-Glance' Fact Sheet, DEL. RIVER BASIN COMM'N (Dec. 9, 2010), http://www.state.nj.us/drbc/notice_naturalgas-draftregs.htm.

34. DEL. RIVER BASIN COMM'N, NATURAL GAS DEV. REGS. §§ 7.3(k)(8), (16) (proposed Dec. 9, 2010), available at <http://www.state.nj.us/drbc/naturalgas-draftregs.pdf>.

35. *Id.* § 7.3(m).

36. *Id.* The draft regulations make the DRBC the final arbiter, in consultation with the host state, of the validity of any complaints and the extent of the appropriate mitigation measures.

37. PA. DEP'T OF ENVTL. PROT., PENNSYLVANIA HYDRAULIC FRACTURING STATE REVIEW 3-6 (Sept. 2010), available at <http://www.strongerinc.org/documents/PA%20HF%20Review%20Print%20Version.pdf>.

operations.³⁸ In fact, Pennsylvania now has more oil and gas inspectors than the State of Louisiana (one of the top four oil-producing states).³⁹ Along with increased enforcement staff, limited modifications and clarification of existing regulatory requirements may prove a better alternative for ensuring water quality in the Marcellus Shale play. For example, on October 12, 2010, the Pennsylvania Environmental Quality Board (PA EQB) approved proposed changes to Chapter 78 of the Pennsylvania Code – administrative regulations governing oil and gas wells.⁴⁰

Although “[i]t was determined that many, if not all, Marcellus well operators met or exceeded current well casing and cementing regulations,” the proposed changes to the existing regulations detail the requirements for properly casing and cementing wells, and reflect existing requirements for operators to restore or replace a water well supply that has been affected by oil or gas well drilling.⁴¹ The proposed amendments also impose additional obligations on operators for well control, immediate response to gas migration complaints, and routine inspection of existing wells.⁴² The PA DEP’s amended rules also require operators to provide any pre-drilling water testing results to the PA DEP and to water supply owners within ten days of receipt.⁴³ The Pennsylvania Independent Regulatory Review Commission approved these rules on November 18, 2010.⁴⁴ Before taking effect, the amendments will also require review and approval by the House and Senate Environmental Resources and Energy Committees.⁴⁵ If approved, the regulations will take effect upon publication in the Pennsylvania Bulletin.

The PA EQB has also recently implemented changes, approved by the Pennsylvania Independent Regulatory Review Commission in June 2010, to regulations permitting discharge of treated wastewater to Pennsylvania surface waters.⁴⁶ The rules allow discharge of wastewater that comes from natural gas exploration and production operations only if it is treated at a centralized wastewater treatment (CWT) facility and meets the following standards: average monthly concentration of 500 mg/L of TDS, 250 mg/L of total chlorides, 10 mg/L of total barium, and 10 mg/L of total strontium.⁴⁷ The new rules, which became effective on August 21, 2010, exempt existing, permitted wastewater

38. Donald Gilliland, *Pennsylvania Department of Environmental Protection Chief Defends Regulation of Marcellus Shale Drilling*, PATRIOT-NEWS, Sept. 11, 2010, available at http://www.pennlive.com/midstate/index.ssf/2010/09/pennsylvania_department_of_env_1.html. According to Hanger, “Pennsylvania’s waters have never had more protection in the history of the state.” *Id.*

39. Donald Gilliland, *Marcellus Shale Drilling Industry ‘Is Not Operating at an Excellent Level,’ State Official Says*, PATRIOT-NEWS, Aug. 4, 2010, available at http://www.pennlive.com/midstate/index.ssf/2010/08/marcellus_shale_drilling_indus.html.

40. Press Release, Pa. Dep’t of Env’tl. Prot., Environmental Quality Board Approves Improved Well Construction Standards to Prevent Gas Migration, Protect Public and Environment (Oct. 12, 2010), available at <http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=14737&typeid=1>.

41. 25 PA. CODE ch. 78 (2010), 40 Pa. Bull. 3845, 3846 (July 10, 2010).

42. 40 Pa. Bull. 3846, 3856 (July 10, 2010).

43. *Id.*

44. Pennsylvania Independent Regulatory Review Commission Approval Order, Reg. No. 7-459 (Nov. 18, 2010).

45. Pa. Dep’t of Env’tl. Prot., *supra* note 40.

46. 25 PA. CODE ch. 95 (2010), 40 Pa. Bull. 4835 (Aug. 21, 2010).

47. 40 Pa. Bull. 4858 (Aug. 21, 2010).

discharges, and discharges that are specifically identified in the regulations.⁴⁸ This exemption includes existing CWT facilities that accept oil and gas wastewater, provided they continue to process this water at currently approved levels.⁴⁹ In addition, the rules prohibit publicly owned treatment works (POTW), which treat municipal wastewater from receiving wastewater from natural gas exploration and production operations, unless the wastewater has first been treated at a CWT facility to the standards set by the new rules.⁵⁰

Local governments have also taken actions in the name of preventing perceived threats from Marcellus Shale development. Citing significant, but unspecified, threats to residents' health, safety, and welfare, and unidentified "widespread environmental and human health impacts . . . from commercial gas extraction in other areas," the City of Pittsburgh passed an ordinance which prohibits any corporation from extracting natural gas within the city.⁵¹ The Brockway Borough Municipal Authority (Municipal Authority) filed suit against three entities engaged in developing and clearing land for drilling operations in Jefferson County, Pennsylvania: Flatirons Development LLC, the permittee under DEP Sedimentation and Erosion Control Permit ESX10-065-0014, Force Inc., the contractor who plans to construct an impoundment on the land in question, and New Growth Resources, a timber contractor.⁵² The Municipal Authority alleges that it entered into a surface use and damage agreement and easement with Flatirons for a specific parcel of land but that Flatirons' drilling operations involve construction of an impoundment and timber clearing on a parcel of land not covered by the agreement.⁵³ Raising allegations of nuisance, the Municipal Authority seeks injunctive relief, oversight, and regulation of defendants' activities above and beyond existing legislation and what is allegedly required to obtain the required permits.⁵⁴

D. United States Environmental Protection Agency's Further Study of Potential Impacts of Hydraulic Fracturing

Marcellus Shale drillers and operators are regulated pursuant to state oil and gas, and environmental laws. They are also subject to federal Clean Water Act regulations which control the disposal of flowback fluids into surface water.⁵⁵ The Energy Policy Act of 2005 specifically excludes underground injection for purposes of hydraulic fracturing, except where it involves injection of diesel fuels, from regulation by the United States Environmental Protection Agency

48. *Id.* at 4844-45.

49. *Id.* at 4839.

50. *Id.* at 4846.

51. Pittsburgh, Pa., Ordinance Supplementing the Pittsburgh Code, tit. six, Conduct, art. 1, Regulated Rights and Actions, by Adding Chapter 618 Entitled Marcellus Shale Natural Gas Drilling, No. 2010-0909 (Nov. 16, 2010). The ordinance does except gas wells which were installed and operating at the time the ordinance was enacted. *Id.* § 618.04(a).

52. Complaint at 2-4, Brockway Borough Mun. Auth. v. Flatirons Dev., L.L.C. (Nov. 22, 2010), available at <http://gdacc.wordpress.com/2010/11/25/town-files-lawsuit-to-protect-water-supply/>.

53. *Id.* at 5, 34-37.

54. *Id.* at 51.

55. *Regulation of Hydraulic Fracturing by the Office of Water*, EPA, http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_hydroreg.cfm#safefyfr (last visited Oct. 15, 2010).

(EPA) under the Safe Drinking Water Act (SDWA).⁵⁶ The responses by public interest groups, federal government, and the oil and gas industry to efforts to bring hydraulic fracturing under the EPA's control illustrate the challenges to setting policy and performing scientific evaluations for regional oil and gas operations at the federal level.

Between 1997 and 2004, the EPA investigated the potential impacts to drinking water from hydraulic fracturing of coalbed methane reserves. That investigation included analysis of more than 200 peer-reviewed publications, interviews with fifty employees from state or local government agencies, and input from approximately forty citizens who expressed concern that coalbed methane production had impacted their drinking water wells.⁵⁷ The EPA found no evidence suggesting that the fracturing of shallow coalbed methane wells had contaminated drinking water wells.⁵⁸ However, the 2004 study has since been roundly criticized as "politically motivated and scientifically unsound," reviewed by those who had conflicts of interest, and because it did not completely study the issue.⁵⁹

In 2009, legislation was introduced in both the United States House of Representatives and the Senate to eliminate the SDWA exemption for hydraulic fracturing. The Fracturing Responsibility and Awareness of Chemicals Act of 2009 (the FRAC Act)⁶⁰ also called for oil and gas companies to disclose the specific names of chemicals used in hydraulic fracturing operations. In response to this proposed legislation, the Interstate Oil and Gas Compact Commission performed a survey of state regulators regarding experiences with hydraulic fracturing in their states. Those state regulators reported that their state programs are protective of drinking water and that they found no verified case of

56. MARY TIEMANN, CONG. RESEARCH SERV., RL 34201, SAFE DRINKING WATER ACT (SDWA): SELECTED REGULATORY AND LEGISLATIVE ISSUES 18 (2010). The EPA's website states that "the use of diesel fuel during hydraulic fracturing is still regulated by the UIC program," and that companies using diesel fuel in hydraulic fracturing must first obtain permission from the UIC program. *Regulation of Hydraulic Fracturing by the Office of Water*, EPA, http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_hydroreg.cfm (last visited Feb. 4, 2011). The EPA's announcement of this requirement on its website precipitated a challenge by the Independent Petroleum Association of America to the agency's authority, despite the absence of a regulation addressing this, to require companies that still use diesel fuel in their hydraulic fracturing fluids to seek authorization from the UIC program. Abraham Lustgarten, *Drilling Industry Says Diesel Use Was Legal*, PROPUBLICA, Feb. 2, 2011, available at <http://www.propublica.org/article/drilling-industry-says-diesel-use-was-legal>.

57. EPA, EVALUATION OF IMPACTS TO UNDERGROUND SOURCES OF DRINKING WATER BY HYDRAULIC FRACTURING OF COALBED METHANE RESERVOIRS; NATIONAL STUDY FINAL REPORT 2 (June 2004), available at http://www.epa.gov/safewater/uic/pdfs/cbmstudy_attach_uic_final_fact_sheet.pdf.

58. *Id.* at 1.

59. Abraham Lustgarten & Sabrina Shankman, *Congress Tells EPA to Study Hydraulic Fracturing*, PROPUBLICA, Nov. 10, 2009, available at <http://www.propublica.org/article/congress-tells-epa-to-study-hydraulic-fracturing-hinchey-1110>. See also, Letter from Weston Wilson, EPA employee, to Sens. Wayne Allard and Ben Nighthorse Campbell and Rep. Diana DeGette (Oct. 8, 2004) (on file with authors). Interestingly, while Mr. Wilson's article criticizes the 2004 study committee for unsound science, his "technical analysis" offers only conclusory statements which are unsupported by any independent geologic or petroleum engineering evaluations of the connections he posits between hydraulic fracturing in coalbed methane formations and possible impacts to drinking water.

60. Fracturing Responsibility and Awareness of Chemicals (FRAC) Act, S. 1215, 111th Cong. (2009); H.R. 2766, 111th Cong. (2009).

groundwater contamination associated with hydraulic fracturing.⁶¹ No action has been taken on either of these bills since they were introduced and referred to their respective committees.

In 2010, in response to concerns regarding the impact of hydraulic fracturing on human health and the environment, Congress instructed the EPA to “conduct analyses to assess the potential risks to drinking water posed by hydraulic fracturing of formations including coalbeds and shale for extraction of natural gas.”⁶² The EPA, noting “serious concerns from citizens and their representatives about hydraulic fracturing’s potential impact on drinking water, human health and the environment,” initiated further study to investigate “possible relationships between hydraulic fracturing and drinking water.”⁶³ It is apparent that the EPA hopes to avoid the criticisms of its previous study by soliciting significant public input on this study, and it has emphasized the role that good science will play in informing the study’s conclusions.⁶⁴ The EPA’s Scientific Advisory Board identified nearly ninety nominated candidates to serve on a panel to review the plan for hydraulic fracturing study before selecting twenty-two individuals from colleges and universities around the country and Canada.⁶⁵ The EPA has also used its mandate to request that nine hydraulic fracturing service providers disclose to it the chemical composition of their hydraulic fracturing fluids. Eight of the nine companies responded voluntarily.⁶⁶ The ninth company, Halliburton Co., announced that it will post detailed information on its website about the chemicals in its hydraulic fracturing fluids.⁶⁷

61. INTERSTATE OIL AND GAS COMPACT COMM’N, REGULATORY STATEMENTS ON HYDRAULIC FRACTURING (June 2009), available at <http://www.ioGCC.state.ok.us/Websites/ioGCC/Images/2009StateRegulatoryStatementsonHydraulic%20Fracturing.pdf>.

62. Science Advisory Board Staff Office; Notification of a Public Meeting of the Science Advisory Board; Environmental Engineering Committee Augmented for the Evaluation and Comment on EPA’s Proposed Research Approach for Studying the Potential Relationships Between Hydraulic Fracturing and Drinking Water Resources, 75 Fed. Reg. 13125 (Mar. 18, 2010).

63. *Hydraulic Fracturing*, EPA, <http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/index.cfm> (last visited Dec. 6, 2010).

64. Jennifer A. Dlouhy, *Fracturing to Get Close Look*, HOUS. CHRON., Feb. 2, 2011, available at <http://www.chron.com/dispatch/story.mpl/business/energy/7410152.html>.

65. EPA SCIENTIFIC ADVISORY BD., INVITATION FOR PUBLIC COMMENT ON THE LIST OF NOMINATED CANDIDATES FOR THE EPA SCIENCE ADVISORY BOARD PANEL FOR THE REVIEW OF HYDRAULIC FRACTURING STUDY PLAN (Sept. 10, 2010), available at [http://yosemite.epa.gov/sab/sabproduct.nsf/0/D3483AB445AE61418525775900603E79/\\$File/List+of+Candidates-Hydraulic+Fracturing+Study+Plan-9-10-10+Final.pdf](http://yosemite.epa.gov/sab/sabproduct.nsf/0/D3483AB445AE61418525775900603E79/$File/List+of+Candidates-Hydraulic+Fracturing+Study+Plan-9-10-10+Final.pdf); EPA SCIENTIFIC ADVISORY BOARD, INVITATION FOR PUBLIC COMMENT FOR THE EPA SCIENCE ADVISORY BOARD PANEL FOR THE REVIEW OF HYDRAULIC FRACTURING STUDY PLAN (Nov. 1, 2010), available at [http://yosemite.epa.gov/sab/SABPRODUCT.NSF/0/D3483AB445AE61418525775900603E79/\\$File/List+of+Candidates-Hydraulic+Fracturing+Study+Plan-2nd+List-11-1-2010.pdf](http://yosemite.epa.gov/sab/SABPRODUCT.NSF/0/D3483AB445AE61418525775900603E79/$File/List+of+Candidates-Hydraulic+Fracturing+Study+Plan-2nd+List-11-1-2010.pdf). See also, *Hydraulic Fracturing Study Plan Review Panel*, EPA SCIENCE ADVISORY BOARD, <http://yosemite.epa.gov/sab/sabpeople.nsf/WebCommitteesSubcommittees/Hydraulic%20Fracturing%20Study%20Plan%20Review%20Panel> (last visited Feb. 4, 2011).

66. Press Release, EPA, Eight of Nine U.S. Companies Agree to Work with EPA Regarding Chemicals Used in Natural Gas Extraction (Nov. 9, 2010), available at <http://yosemite.epa.gov/opa/admpress.nsf/d0cf6618525a9efb85257359003fb69d/a96496444c546959852577d6005e63d6!OpenDocument>.

67. Mike Soraghan, *Industry Backs Voluntary Disclosure of Fracking Chemicals Through States*, GREENWIRE, Dec. 3, 2010, available at

Since announcing its study in March 2010, the EPA has solicited input from various groups regarding the scope and design of the study. Over the summer, the EPA held a series of public meetings where it described the study and received suggestions regarding the study's design.⁶⁸ The proposed study will likely be conducted by the EPA and will involve contractors and collaboration with universities, outside groups, and other federal agencies, and will include collection of data, case studies, as well as chemical fate and transport analyses.⁶⁹ Initial results from this study are not expected until late 2012.

III. MARCELLUS SHALE GROUNDWATER CONTAMINATION CLAIMS IN PENNSYLVANIA

The development of Marcellus Shale will likely initiate a flood of litigation by plaintiffs claiming that the drilling, storage, and/or containment process and procedure causes contamination of groundwater and/or the water supply. Four lawsuits, filed in various Pennsylvania venues, exemplify the types of claims that the industry can anticipate.

In November 2009, multiple plaintiffs filed suit against Cabot Oil & Gas Corporation and Gas Search Drilling Services Corporation claiming that the drilling activities surrounding at least sixty-two gas wells within a nine-square-mile tract in Dimock Township, Pennsylvania, caused the release and discharge of hazardous chemicals and pollutants into the plaintiffs' water supply.⁷⁰ Plaintiffs maintain that fracking fluid used by Cabot includes carcinogenic and toxic chemicals that are discharged into the ground.⁷¹ Plaintiffs also claim that diesel fuel, lubricating agents, and related materials used during the drilling process and well operation contributed to the alleged contamination and increased levels of 1, 2, 4-trimethylbenzen, aluminum, iron, N-propylbenzene, and P-isopropyl toluene.⁷² Plaintiffs assert causes of action under the Hazardous Sites Cleanup Act and under theories of strict liability, negligence, private nuisance, breach of contract, fraudulent misrepresentation, and medical monitoring.⁷³ Ultimately, the plaintiffs claim that they are entitled to damages for harms suffered, including: contaminated water supplies, diminished property

<http://www.eenews.net/Greenwire/2010/12/03/archive/9?terms=industry+backs+voluntary+disclosure+of+fracking+chemicals>. In addition to EPA's efforts, the Department of the Interior has announced plans to require companies which use hydraulic fracturing on federal lands to disclose the chemicals contained in those fracturing fluids. Phil Taylor, *Salazar Pledges to Develop Disclosure Rules for Fracking Fluids*, E&E NEWS, Dec. 2, 2010, available at <http://www.eenews.net/Landletter/2010/12/02/3/>.

68. See, e.g., *Hydraulic Fracturing EPA Public Informational Meeting, Binghamton, N.Y., Afternoon Session, Summary of Public Comments*, EPA (Sept. 13, 2010) <http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/hfsummarybinghamton.pdf>.

69. *Hydraulic Fracturing Study Consultation with Environmental Organizations*, EPA (June 23, 2010) <http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/consultationwithenvironmentalorganizations.pdf>.

70. Second Amended Complaint at 33, *Fiorentino v. Cabot Oil & Gas Corp.*, No. 3:09-cv-02284-JEJ (M.D. Pa. Nov. 19, 2009).

71. *Id.* ¶¶ 39, 40.

72. *Id.* ¶ 47.

73. *Id.* at ¶¶ 17-54. Plaintiffs included a claim for gross negligence which the court dismissed upon motion and after argument. *Fiorentino v. Cabot Oil & Gas Corp.*, No. 3:09-cv-02284-TIV, 2010 WL 4595524 at *6 (M.D. Pa. Nov. 15, 2010).

value, personal injuries, and emotional distress.⁷⁴ Plaintiffs also seek a permanent injunction barring Cabot from “engaging in the acts complained of” and for remediation costs.⁷⁵

Southwest Energy Production Company and Southwestern Energy Company have also been named as defendants by multiple plaintiffs, including Suzanne Berish, in a lawsuit filed in September 2010 in Susquehanna County and later removed to the United States District Court for the Middle District of Pennsylvania.⁷⁶ Similarly, a single plaintiff, Judy Armstrong, filed suit against Chesapeake Appalachia, L.L.C., Chesapeake Energy Corporation, and Nomac Drilling, L.L.C., in October 2010.⁷⁷ These plaintiffs’ allegations are quite similar to those articulated above. The Berish and Armstrong Complaints allege that the affected groundwater contains elevated levels of methane, ethane, barium, and other unidentified harmful substances.

Finally, in September 2009, George and Lisa Zimmerman, Pennsylvania tomato farmers, filed suit against Atlas Energy, Inc., alleging that chemicals used in or released by hydraulic fracturing contaminated their land.⁷⁸ The Zimmermans complain that, although baseline water tests results were “perfect,” tests performed after drilling commenced revealed the presence of elevated levels of arsenic, benzene, and naphthalene.⁷⁹ While the initial complaint sought injunctive relief, the Zimmermans amended their complaint in August 2010.⁸⁰ The Amended Complaint more closely resembles those discussed above as it discontinues the claim for injunctive relief, focuses upon alleged groundwater contamination, and seeks monetary compensation for inter alia diminution of property value, exposure to allegedly hazardous pollutants, loss of enjoyment of their property, and physical injuries.⁸¹ The Zimmermans also seek recovery for the loss of a water well on their property that they claim became compromised as a result of Atlas’ activities and for lost profits associated with tomato farming. Plaintiffs claim that the property became polluted with acetone, benzene, toluene, trimethylbenzene, isopropyl toluene, and other unidentified compounds as a direct result of drilling and related activities.⁸²

IV. SCIENCE-BASED PROOF IN GROUNDWATER AND NORM CONTAMINATION CASES

When groundwater contamination claims reach the pretrial motion and trial stage, state and federal court rules for admission of scientific information and testimony by experts should serve as a limit on the influence of media reports

74. Second Amended Complaint, *supra* note 70, at 54.

75. *Id.*

76. Complaint at 1, *Berish v. Sw. Energy Prod. Co.*, No. 3:10-cv-01981-ARC (M.D. Pa. Sept. 14, 2010).

77. *See* Complaint at 1, *Armstrong v. Chesapeake Energy Corp.*, No. 10-cv-000681 (M.D. Pa. Nov. 29, 2010).

78. John Hurdle, *Pennsylvania Lawsuit Says Drilling Polluted Water*, REUTERS, Nov. 9, 2009, available at <http://www.reuters.com/article/idUSTRE5A80PP20091109>.

79. *Id.*

80. Amended Complaint, *Zimmerman v. Atlas America, LLC*, No. 7564 (Washington Cnty. Ct. of C.P. Nov. 9, 2010).

81. *Id.* ¶ 38.

82. *Id.* ¶ 26.

and political agendas on the outcome of groundwater contamination cases. Federal courts applying the *Daubert* standard examine whether scientific evidence will assist the trier of fact and whether the evidence is the product of a reliable and scientifically valid methodology.⁸³ Pennsylvania courts use a different, but related, admissibility standard articulated in *Frye v. United States*.⁸⁴ These rules prevent the admission of scientific evidence which is not the reliable product of generally-accepted scientific methods and exclude consideration of opinions offered by unqualified lay persons. Compiling admissible evidence requires a technically-based plan, careful collection, and accurate analysis of data.

A. Alleged Sources and Scope of Groundwater Impacts

Beyond demonstrating that Marcellus Shale operations occurred near their property and that their wells contain elevated concentrations of certain contaminants, claimants seeking to recover damages for groundwater contamination must present additional evidence linking particular operations at a specific location to the impacts to their water supplies. A number of opponents of hydraulic fracturing believe that the process causes cracks in rocks that allow gas and materials to migrate upward to drinking water zones, and that “[t]here is just no way to control where the fluid goes.”⁸⁵ Modeling of the possible movement of Marcellus Shale fluids or gas to a water well can permit objective evaluation of possible pathways that the fluids or gas may follow, how that path was created, and the rate at which fluids or gas are capable of moving through rock formations or soil. Obviously, alleged contaminants found in wells should be compared with known constituents in fluid or gas from the Marcellus Shale formation or materials used in drilling or production from that formation to determine whether Marcellus Shale operations could even be considered a source for the alleged contaminants.

Petroleum engineers and hydrogeologists can examine gas well records and permits to evaluate operational issues, such as the performance of the well and the effect of drilling and production on the underground pressure in the rock formation. These experts can also evaluate the mobility of various substances in soil and rock formations in the region. Geologists can provide information about the type and characteristics of the rock formations in the area. Using these data, experts can determine whether it is possible or likely that fluids from deep in the ground could have migrated from one rock formation into another. Geologists can also help locate old, improperly closed, or abandoned wells or coal mines

83. *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 589-591 (1993).

84. *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923) (holding that scientific evidence is admissible if the methodology underlying it has general acceptance in the relevant scientific community and that judges should be guided by scientists when assessing the reliability of a scientific method); *Grady v. Frito-Lay, Inc.*, 839 A.2d 1038 (2003). Pennsylvania is one of only a few states which have not adopted *Daubert*'s standard for admissibility of expert witness testimony. Information regarding other states that have not adopted the *Daubert* standard is available from resources prepared by the Judicial Gatekeeping Project at the Berkman Center for Internet and Society. *Judicial Gatekeeping Project*, BERKMAN CTR. FOR INTERNET AND SOC'Y, <http://cyber.law.harvard.edu/daubert/> (last visited Feb. 4, 2011).

85. See Stephanie Berberick, *Frack Checks*, ARTVOICE.COM, Dec. 1, 2010, available at http://artvoice.com/issues/v9n48/frack_checks#SlideFrame_0 (quoting Richard Young, Ph.D.).

which could be alternative pathways for methane gas and other substances to contaminate drinking water wells.

It is important to obtain as much information as possible regarding other potential sources for contaminants allegedly detected in drinking water. Many of the substances which are claimed to be present in drinking water at elevated concentrations due to Marcellus Shale production operations occur naturally or as the result of other common activities, such as farming, handling and disposal of common materials such as gasoline, household trash, sewage, or other industrial operations near the property, including coal mining. For example, elevated nitrate in water wells is often due to application of fertilizer or sewage and wastes from livestock farming operations in the area.⁸⁶

Chemical concentrations in affected wells should be compared with corresponding concentrations in wells which are believed to be unaffected by hydraulic fracturing. For example, regarding barium, one of the contaminants identified by the Lenox Township residents, the EPA has noted that “[t]he drinking water of many communities in Illinois, Kentucky, Pennsylvania, [and] New Mexico contains concentrations of barium that may be 10 times higher than the drinking water standard. The source of these supplies is usually well water.”⁸⁷ This observation was reported many years before recent efforts to produce gas from the Marcellus Shale.⁸⁸ Likewise, exceedances of drinking water standards of substances such as iron, total dissolved solids, manganese, and low pH in groundwater quality testing in Pennsylvania have been determined to be the result of naturally elevated concentrations of those substances.⁸⁹ In addition, several methods exist for determining the source of elevated levels of minerals in water wells, including tests to assess the age of the contaminant and chemical fingerprinting – determining whether the materials in the water wells are present in the same ratios as in the water that has been injected or recovered.

Producers should also consider collecting baseline groundwater and surface water quality data for an area where future production operations are planned. In Pennsylvania, preoperational water quality data is especially important. Pennsylvania’s Oil and Gas Act⁹⁰ includes a provision requiring an operator who affects a ground water supply by pollution or diminution to restore or replace the affected supply.⁹¹ Where the affected supply is within 1,000 feet of the oil or gas well, the operator is presumed to have caused the alleged pollution or diminution unless it can prove at least one of five defenses articulated in the statute.⁹² An

86. See, e.g., *Human Health, U.S. EPA Drinking Water Consumer Information, Private Wells*, EPA, <http://water.epa.gov/drink/info/well/health.cfm> (last visited Oct. 26, 2010).

87. *Technical Factsheet on: Barium*, EPA, <http://www.epa.gov/safewater/pdfs/factsheets/ioc/tech/barium.pdf> (last visited Sept. 16, 2010).

88. See SAFE DRINKING WATER COMMITTEE, NAT’L RESEARCH COUNCIL, DRINKING WATER AND HEALTH 231 (National Academy of Sciences Press 1977).

89. Stuart O. Reese & Joseph J. Lee, SUMMARY OF GROUNDWATER QUALITY MONITORING DATA (1985-1997) FROM PENNSYLVANIA’S AMBIENT AND FIXED STATION NETWORK (FSN) MONITORING PROGRAM, SELECTED GROUNDWATER BASINS IN SOUTHWESTERN, SOUTHCENTRAL AND SOUTHEASTERN PENNSYLVANIA, PA. DEP’T OF ENVTL. PROT. 1-2, 21 (1998).

90. 58 PA. STAT. ANN. §§ 601.101-601.605 (West 2010).

91. 58 PA. STAT. ANN. § 601.208 (West 2010).

92. *Id.* §§ 601.208(d)(1)-(5).

operator may be able to rebut the presumption that its activities on the land in question contaminated or diminished the water supply by, for example, providing proof that the alleged problem existed prior to the commencement of drilling operations and/or that the alleged pollution occurred as a result of some other cause. Without pre-drilling and on-going groundwater and surface water quality data, operators may be unable to refute the presumption, be required to provide an adequate alternative water supply, and potentially, be held liable for other damages that may relate to an allegedly contaminated water supply.⁹³

B. *Methods for Evaluating Personal Injury Claims*

Scientific evidence and expert testimony will also play a significant part in deciding claims that exposure to elevated levels of constituents associated with natural gas drilling and production has caused residents to experience various illnesses or adverse health effects. In evaluating those claims, it is helpful to establish thorough health histories for each claimant and to identify relevant occupational, lifestyle, and environmental exposures to agents other than the alleged contaminants for each claimant. This information may provide an alternative explanation for alleged diseases. Medical doctors can assist with analyzing these data and performing differential diagnoses.

Proving that exposure to a contaminant caused a particular injury requires more evidence than mere test results indicating that constituents in an injured person's water well exceeded a specific standard. As a starting point, one or more of the contaminants associated with Marcellus Shale production must have been identified as a potential cause of a resident's injury. For example, in its report regarding Marcellus Shale drilling cuttings in landfills, the RWMA claimed that ingested or inhaled radium from those cuttings could cause leukemia.⁹⁴ The health effects of radium exposure have been studied comprehensively for many decades. Exposed populations, such as the radium dial painters, have been carefully followed by several research groups. Summarizing these studies, one of the leading toxicology treatises states that "[i]t is significant that no study has identified a statistically significant excess of leukemia after even massive doses of radium."⁹⁵

Likewise, Tracy Bank, a geology professor at the State University of New York at Buffalo, announced that her laboratory studies of Marcellus Shale

93. At the time of submission of this article, there have been no reported decisions in Pennsylvania discussing the impact, if any, of the presumption articulated in section 601.208 upon groundwater contamination and/or land use litigation with respect to burdens of proof. The data required to rebut the presumption that drilling activities contaminated or diminished a water supply under section 601.208 are among the same type of evidence that would be required to defend against claims for damages pertaining to a polluted or diminished water supply. Likewise, no reported decision has specifically addressed whether the presumption, and the attendant liability imposed by section 601.208, could support a finding of negligence per se where plaintiffs seek compensatory damages in a civil suit for groundwater contamination. Because courts have consistently required plaintiffs to prove causation in groundwater contamination cases — i.e., a causal connection between the drilling and the contamination of ground water — operators are well advised to collect pre-drilling and on-going water data. See *Mateer v. U.S. Aluminum*, No. 88-2147, 1989 WL 60442 (E.D. Pa. 1998).

94. *RWMA Report*, *supra* note 19, at 6.

95. Curtis Klaasen, *CASARETT & DOULL'S TOXICOLOGY – THE BASIC SCIENCE OF POISONS* 1063 (McGraw-Hill, 7th ed. 2008). See also, Robert E. Rowland, *RADIUM IN HUMANS – A REVIEW OF U.S. STUDIES* 99, Rpt. No. ANL/ER-3 (Argonne Nat'l Lab. 1994).

demonstrated that hydraulic fracturing could solubilize uranium, “potentially polluting streams and other ecosystems and generating hazardous waste.”⁹⁶ Although Dr. Bank did note that there was no radioactive risk from the uranium in the produced water, she declared that uranium “is still a toxic, deadly metal.”⁹⁷ Dr. Bank’s observation is unsupported by a 2008 thorough review of uranium epidemiologic research conducted by the National Academy of Sciences Institute of Medicine Committee. The Committee concluded that “there is inadequate/insufficient evidence to determine whether an association [exists] between exposure to uranium” and kidney disease, various cancers, cardiovascular, genotoxic, cardiovascular, immunologic and skeletal effects.⁹⁸ Further, comprehensive studies of the military personnel who were exposed to depleted uranium have been followed for fifteen years at the University of Maryland. These studies indicate that “no clinically significant [uranium] related health effects have been observed in the cohort, including those with retained [depleted uranium] fragments.”⁹⁹

In addition to showing that one or more of the alleged contaminants in a water well have been identified as a cause of a particular injury, it is also necessary to demonstrate that an individual’s exposure to one or more of those contaminants was more likely than not the cause of his alleged injury. In most cases, this requires proof of the amount of the injured person’s exposure. The estimated exposure can then be compared to exposure levels reported in studies of groups of people who have been exposed to the same agent and were observed to have suffered from illnesses or diseases associated with that agent. Causation decisions must also consider alternative explanations for a person’s disease. The United Nations Scientific Committee on the Effects of Atomic Radiation has noted that the lung cancer risk associated with smoking twenty-five or more cigarettes per day is 13.3, while the relative risk due to a very high level of radiation exposure (100 rem) is only 2.2.¹⁰⁰

In comments to the NY DEC regarding the SGEIS, Dr. Peter J. Davies, Professor of Biology at Cornell University, noted EPA reports of concentrations of 9,000 pCi/l of radioactivity in flowback water, which is “9,000 times the natural radiation in normal well water.”¹⁰¹ Based on reports of elevated radioactivity, specifically radium, in the Marcellus Shale, and his observation that “[i]nhalation, ingestion, or body exposure to radium can cause cancer and

96. Press Release, State Univ. of N.Y. at Buffalo, ‘Fracking’ Mobilizes Uranium in Marcellus Shale, UB Research Finds (Oct. 25, 2010), available at <http://www.buffalo.edu/news/11885>.

97. *Id.*

98. NAT’L RESEARCH COUNCIL COMM. ON GULF WAR AND HEALTH, COMMITTEE ON GULF WAR AND HEALTH: UPDATED LITERATURE REVIEW OF DEPLETED URANIUM 193-262 (National Academies Press 2008).

99. Carrie D. Dorsey, Susan M. Engelhardt, Katherine S. Squibb & Melissa A. McDiarmid, *Biological Monitoring for Depleted Uranium Exposure in U.S. Veterans*, 117:6 ENVTL. HEALTH PERSP. 956 (2009).

100. U.N. SCIENTIFIC COMM. ON THE EFFECTS OF ATOMIC RADIATION, EFFECTS OF IONIZING RADIATION, UNSCEAR 2006 REPORT TO THE GENERAL ASSEMBLY WITH SCIENTIFIC ANNEXES (United Nations 2008).

101. Peter J. Davies, RADIOACTIVITY: A DESCRIPTION OF ITS NATURE, DANGERS, PRESENCE IN THE MARCELLUS SHALE AND RECOMMENDATIONS BY THE TOWN OF DRYDEN TO THE NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION FOR HANDLING AND DISPOSAL OF SUCH RADIOACTIVE MATERIALS 3 (2009), available at <http://www.tcgasmap.org/media/Radioactivity%20from%20Gas%20Drilling%20SGEIS%20Comments%20by%20Peter%20Davies.pdf>.

other disorders,” Dr. Davies concluded that significant restrictions on Marcellus Shale flowback water and other wastes are warranted.¹⁰² In reaching this conclusion, Dr. Davies apparently did not calculate how much radium residents near Marcellus Shale operations might actually take in from exposure to produced water or how that intake compares with levels at which health effects have been detected. Long-term studies of the radium dial painters show that while exposure to enormous internal radium-226 doses can cause bone sarcomas and head carcinomas, there is an observed threshold that significantly exceeds the radium dose a person could receive by regularly drinking Marcellus Shale produced water. Based on the radium dial painter research, even if Marcellus Shale flowback fluid or produced water contained EPA’s maximum reported 9,000 pCi/l of radium-226, a person could drink a quart of flowback fluid or produced water every day for over 300 years and not exceed the threshold for radium-induced bone sarcoma.¹⁰³

V. CONCLUSION

The success of efforts to explore and develop Marcellus Shale natural gas resources progress depends on continued critical and scientific evaluation of information concerning all aspects of this enterprise. Claims regarding water well contamination and NORM arising from Marcellus Shale operations will likely continue. Reasoned and technically-informed assessment of available data is vital to determining the appropriate level of regulation, industry best practices, and allocation of resources to address environmental impacts and potential health effects.

102. *Id.*

103. *See* U.N. COMM. ON THE EFFECTS OF ATOMIC RADIATION, SOURCES AND EFFECTS OF IONIZING RADIATION, UNSCEAR 2000 REPORT TO THE GENERAL ASSEMBLY WITH SCIENTIFIC ANNEXES (United Nations 2000). This figure shows a radium-induced sarcoma threshold at approximately 9,000 kilobecquerels (systemic intake) or 1.2 billion picocuries (oral intake). Assuming that a person consumes a liter (or quart) of produced water each day containing the EPA maximum concentration of 9,000 picocuries, it would require about 365 years to reach the 1.2 billion picocurie threshold.