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Chapter 9

Water Sourcing and Wastewater Disposal for Marcellus Shale Development in Pennsylvania

Kevin J. Garber[1]
Jean M. Mosites
Babst Calland Clements& Zomnir, P.C.
Pittsburgh, Pennsylvania

Synopsis

§ 9.01. Introduction 340
§ 9.02. Flowback — Recycling, Reuse, Treatment and Disposal Issues 344
[1] — Federal and State Regulation of Wastewaters 345
[a] — Federal Regulation 345
[b] — State Regulation 346
[c] — Delaware River Basin Commission Proposed Regulations 348
[2] — Wastewater Management 349
[a] — Treatment Technologies 349
[b] — Recycle and Reuse 350
[c] — Underground Injection Control 351
§ 9.03. Water Sources 352
[1] — The Major Pennsylvania River Basins 352

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1 Kevin Garber is a shareholder and chairman of the Environment, Energy and Natural Resources Group of Babst, Calland, Clements and Zomnir, P.C, practicing out of the firm's Pittsburgh and State College offices. Mr. Garber graduated with Distinction from The Pennsylvania State University with a B.S. in Biology/Chemistry, took his M.S. in Oceanography and Limnology from the University of Wisconsin, his Ph.D. in Ecology from the University of Pittsburgh and his law degree from the Duquesne University School of Law, where he was a member of the Duquesne University Law Review. Mr. Garber is an adjunct professor of environmental law at the Duquesne University School of Law. Jean Mosites is an associate in the Environmental, Energy and Natural Resources Group of Babst, Calland, Clements, and Zomnir, P.C., practicing in the Pittsburgh office. Ms. Mosites graduated from the University of Pittsburgh with a B.A. in Political Science/Economics and an M.A. in Political Science, and graduated *magna cum laude* from the Duquesne University School of Law, where she served as the Executive Comment Editor of the Duquesne Law Review. Ms. Mosites previously taught political science at the University of Pittsburgh as a Teaching Fellow.

[a] — Ohio River Basin..... 352
[b] — Susquehanna River Basin..... 353
[c] — Delaware River Basin 354
[2] — Basin-specific Regulatory Requirements 354
[a] — Department of Environmental Protection's (DEP) Regulatory Regime for Water Sourcing 355
[b] — The Susquehanna River Basin Commission (SRBC) Regulatory Regime for Water Sourcing 357
[c] — The Delaware River Basin Commission's (DRBC) Regulatory Regime for Water Sourcing 358
§ 9.04. Conclusion.....360

§ 9.01. Introduction.

Development of the Marcellus Shale in Pennsylvania has expanded rapidly in recent years. The Pennsylvania Department of Environmental Protection (DEP or Department) issued 3,314 permits for Marcellus wells in 2010; 1,446 Marcellus wells were drilled in 2010, up from 795 drilled in 2009.[2] Of the 71,000 active gas wells in Pennsylvania, however, only 3.5 percent are Marcellus wells. This chapter reviews the interrelationships among Marcellus Shale development in Pennsylvania, water resources of the Commonwealth, and the evolving regulatory regimes that manage the drilling activities affecting those resources.

Recovering natural gas from the Marcellus Shale requires horizontal drilling and hydraulic fracturing ("fracking") technologies, which implicate significant water management and logistics issues throughout many phases of Marcellus drilling operations. First, operators must locate reliable sources of water and purchase or withdraw sufficient water in accordance with various regulatory regimes. Second, water sources are often some distance from the well sites, requiring transportation by trucks and/or pipelines. Third, once the water arrives on site, operators provide for storage in various impoundments and tanks, which may be on a particular pad or centralized for multiple well pads. Fourth, before water is used for fracking, it is blended with

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2 2010 Year End Workload Report (Jan. 25, 2011), available at: http://www.dep.state.pa.us/dep/depatate/minres/oilgas/reports.htm (last visited on March 22, 2011).

sand and chemical additives to facilitate the release of gas from the shale.[3] Approximately 10-30 percent of this "slickwater" used for fracking comes back up to the surface as flowback, which must be recovered, handled and stored before it is treated for recycling and reuse or disposal and discharge. The scope of this chapter is limited to the two ends of this water management spectrum — water sourcing and wastewater reuse and disposal.[4]

The regulatory regime for water withdrawal and wastewater disposal depends on the activity and the location where the drilling occurs. Some aspects of sourcing are managed bythe Department of Environmental Protection; other aspects are managed by one of two Commissions — the Susquehanna River Basin Commission (SRBC) or the Delaware River Basin Commission (DRBC). With regard to disposal of wastewaters, the relevant federal agency is the Environmental Protection Agency, which has delegated its permitting authority to DEP but retains its oversight and supervision of wastewater disposal to waters of the United States. DEP is the relevant state agency. The major federal statutes include the Clean Water Act and the Safe Drinking Water Act; major Pennsylvania laws include the Clean Streams Law, the Dam Safety and Encroachments Act, the Solid Waste Management Act, and the Oil and Gas Act.[5]

State and federal regulatory regimes, as well as industry practices, are rapidly evolving and responding to water management issues as they arise.

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3 *Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources* ("EPA HF Study Plan"), United States Environmental Protection Agency, Office of Research and Development, EPA/600/D-11/001 (February 7, 2011), available at: http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/index.cfm. Table 4 provides an example of the volumetric composition of hydrofracturing fluid ("HF Fluid" or "slickwater").

4 Other surface water issues, not addressed here, include stormwater management, erosion and sedimentation plans, spills and releases. Gas migration impacts on groundwater are also outside the scope of this chapter.

5 Clean Water Act, 33 U.S.C. § 1251 *et seq.*; Safe Drinking Water Act, 42 U.S.C. § 3 00f *et seq.*; Clean Streams Law, 35 P.S. § 691.1 *et seq.*; Dam Safety and Encroachments Act, 32 P.S. § 693.1 *et seq.*; Solid Waste Management Act 35 P.S. § 6018.101 *et seq.*; and Oil and Gas Act, 58 P.S. § 601.101 *et seq.*

While there is a public perception that the water demands of Marcellus drilling are excessive, the relevant regulatory agencies recognize that other uses are significantly higher and that this particular use can be accommodated with proper management. Likewise, there is a public perception that wastewater disposal from Marcellus drilling activities threatens our rivers and drinking waters, but the industry has significantly reduced its wastewater volume through recycling and reuse of flowback and DEP has adopted strict discharge limitations on the treated effluent from this source of wastewater. Thus, while the system is somewhat in flux, there are significant protections in place, as well as widespread awareness of best practices to ensure that the development of this energy source takes place in a manner that protects both the people and the environmental resources of this Commonwealth.[6]

In addition, Pennsylvania's new Governor Tom Corbett created a Marcellus Shale Advisory Commission, which is to "develop a comprehensive, strategic proposal for the responsible and environmentally sound development of Marcellus Shale."[7] The Commission is made up of key stakeholders and experts from the environmental community, natural gas industry, local government representatives and state government officials. The Commission has begun meeting, formed work groups, and is to report to the Governor by July 22, 2011.[8]

"Unconventional" gas, which includes shale gas like Marcellus, accounts for about 60 percent of onshore recoverable gas resources, with enough estimated natural gas to supply the United States for the next 100-plus years.[9]

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6 *See Pennsylvania Hydraulic Fracturing State Review*, State Review of Oil and Natural Gas Environmental Regulations ("STRONGER") (Sept. 2010) at 5, available at: http://www.strongerinc.org/documents/PA%20HF%20Review%20Print%20Version.pdf. In 2010, STRONGER conducted an in-depth multi-stakeholder review of Pennsylvania's regulatory program and concluded that it is "well-managed, professional, and meeting its program objectives."

7 Executive Order 2011-01, Creation of Governor's Marcellus Advisory Commission, available at: www.oa.state.pa.us.

8 The report, dated July 22, 2011, can be accessed at http://www.mde.state.md.us/programs/land/mining/Marcellus/documents/msac_Final_Report.Pdf.

9 *Modern Shale Gas Development in the United States: A Primer*, prepared for the U.S. Department of Energy, Office of Fossil Energy and National Energy Technology

Shale formations across the United States have been developed to produce gas since 1821.[10] Large scale hydraulic fracturing, developed in Texas in the 1950s, has been used in shale plays across the United States.[11] In 2009, unconventional gas production accounted for over 40 percent of the total U.S. gas production. According to many, it is the fuel of the century.

The Marcellus Shale covers about 95,000 square miles, more technically recoverable resources than any other shale play.[12] The Marcellus Shale spans six states[13] and spreads across the upper Appalachian Water Basin. The Marcellus Shale play in Pennsylvania crosses three key river basins — the Delaware, Susquehanna, and Ohio River Basins. Each basin has its unique features, which will be discussed in more detail below. The geology of the Marcellus formation suggests that areas in the northcentral and northeastern regions of Pennsylvania that have not traditionally seen much gas well drilling may be particularly productive.

Drilling and completion of Marcellus gas wells differs from conventional gas wells because it includes both vertical and horizontal wells, at a depth of 5,000 to 8,000 feet below surface. While fracking has been used in Pennsylvania since the 1950s, a key element enabling shale gas production in recent years has been the development of cost-effective horizontal drilling and fracking technologies. Since the 1980s, most wells drilled in Pennsylvania have been fractured or stimulated.[14]

Because of its tight formations and low permeability, Marcellus Shale development requires fracking to create fractures in geologic layers of shale and coal to allow the natural gas to flow to a well.[15] Fracking in Pennsylvania

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Laboratory by the Ground Water Protection Council and ALL Consulting (April 2009) at ES-1. ("DOE Primer"). These estimates are likely to change as new information, experience, and technological advances become available.

10 *Id.* at 13.

11 *Id.*

12 *Id.* at 17, Exhibit 11.

13 The Marcellus Shale extends from west central New York down into Pennsylvania, Ohio and West Virginia, with minor portions extending into Maryland and Virginia.

14 STRONGER at 10.

15 DOE Primer at ES-4, 15.

involves forcing a combination of water, sand, and chemical additives into a rock layer at high pressure, with water and sand making up from 98 percent to 99.5 percent of the frac fluid, or slickwater.[16] Fracking occurs in phases over the course of several days and the process requires one to five million gallons of frac fluid per well. While there is a public perception that this volume of water consumption is high, regulatory authorities believe that the water use, which is relatively small compared to other uses, can be accommodated; it is just a matter of careful management.[17]

§ 9.02. Flowback — Recycling, Reuse, Treatment and Disposal Issues.

Anywhere from 10-30 percent of hydraulic fracturing fluid used in fracking Marcellus wells is brought back to the surface after fracking.[18] Flowback in Pennsylvania is managed in four different ways: 1) reuse to fracture additional wells; 2) treatment and discharge to surface waters; 3) injection into underground disposal wells; or 4) transportation to out-of-state facilities. Typical flowback contains 4-25 percent salts, including constituents from underground formations. Flowback and produced waters present treatment and discharge challenges because of high total dissolved solids (TDS), as well as high chlorides.[19] Other constituents of concern include barium, strontium, and naturally occurring radioactive material (NORM).[20] With TDS levels exceeding 100,000 mg/l, flowback and

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16 DOE Primer at 61. The makeup of HF fluid varies to meet specific needs of each area; there is no one formula. *Id.* at 62.

17 Comments from Tom Beauduy, Deputy Executive Director and Counsel, SRBC, Shale Gas Water Management Conference, Canonsburg, PA (April 13, 2011).

18 EPA HF Study Plan at 36.

19 Chemical additives in hydraulic fracturing fluid, which account for .01 percent to .05 percent of the volume, include biocides, corrosion inhibitors, acids and friction reducers. *See* DOE Primer at 61; EPA HF Study Plan Table 4. Operators and service providers are actively researching and developing 'green' alternatives to accomplish the same functions as the chemical additives.

20 The *New York Times* conducted data reviews and printed stories alleging that Pennsylvania waters were contaminated with radiation from natural gas production wastewaters. *See* http://