



NYS Hydraulic Fracturing Waste Tracking Program

Columbia University
Master of Public Administration in
Environmental Science and Policy | MPA ESP 2013

**Workshop in Applied
Earth Systems Management**

**NYS Senate Bill 6892-2011:
The High-volume Hydraulic Fracturing Waste Tracking Program**

NYS Senate Bill 6892-2011: The High-volume Hydraulic Fracturing Waste Tracking Program

December 2012

Student Members:

Fernando Arias, Amy Burns, Elizabeth Engoren, Sarah Finn, Mary Flannelly, Katherine Hoffmaster, Olivia Kemp, Max Litt, Dan Robicheaux, James Spencer, Claire van Zuiden, and Karl Wasmuth

Faculty Advisor: Steven Cohen, PhD.

Executive Summary

The passage of New York State Senate Bill 6892, the High-volume Hydraulic Fracturing Waste Tracking Program, would establish a tracking system to regulate and monitor waste generated from hydraulic fracturing operations in New York. While there is currently a moratorium on hydraulic fracturing in New York, it is expected that it will soon be lifted due to the economic potential of shale gas. In order to prepare for the future development of the natural gas industry in New York, this legislation mandates proper waste management protocols to minimize the potential environmental and health risks of hydraulic fracturing waste. This report presents a recommended program design for the successful implementation of these proposed mandates.



Columbia University
School of International and Public Affairs | The Earth Institute
MPA in Environmental Science and Policy | Fall Workshop 2012

Table of Contents

1. Executive Summary
2. Table of Contents
3. Introduction
4. Hydraulic Fracturing and the Marcellus Shale Potential
5. Support and Opposition to Hydraulic Fracturing and Senate Bill 6892
6. Senate Bill 6892 - Stipulations and Discretionary Components
7. A New Waste Tracking and Permitting System
 - DEC Organizational Changes
 - Waste Permitting
 - Storage Duration
 - Compliance Inspections
 - Tracking, Reporting, and Auditing
 - Enforcement: Fees, Fines, and Penalties
8. Budget
9. Calendar
10. Conclusion
11. Appendices
12. Works Cited

Introduction

In recent years, the natural gas industry in the United States has experienced a dramatic expansion due to technological improvements in hydraulic fracturing, also known as “hydrofracking” (NRDC, 2012). Hydraulic fracturing is a drilling technique that employs large volumes of pressurized water, sand, and chemicals to break underground shale rock formations to release natural gas (NRDC, 2012). As the largest shale rock formation in the eastern United States, the Marcellus shale has attracted the interest of the gas industry, which plans to harness this untapped energy reserve. However, significant concern exists within the New York State community over the potential environmental and human health impacts of hydraulic fracturing (NYSDEC, 2011). To prevent these possible harmful effects and ease public fears, the New York State Assembly imposed a statewide moratorium on hydraulic fracturing in August 2010 (NYSDEC, 2011).

The New York State government has recently begun pushing to lift the moratorium (NYSDEC, 2011). Governor Andrew Cuomo and Department of Environmental Conservation (DEC) Commissioner Joe Martens refuse to release a definite timeline detailing when the moratorium will end, stating the final decision to allow hydraulic fracturing will only come after a comprehensive environmental and health impact review is completed and appropriate regulations are in place (Esch, 2012). One such regulation that has been presented is New York State Senate Bill 6892, introduced into the New York State Senate for consideration on April 4, 2012 (S6892, 2012). If passed, S6892 would establish a waste tracking system to monitor fracturing fluid that returns to the surface (flowback fluid)¹ and mandate the disclosure of this fluid’s composition to the public (S6892, 2012). The success of S6892 will depend on the establishment of an effective plan to properly implement the bill’s mandates. This report presents a plan for the successful execution of the mandates presented in S6892.

¹ Flowback fluid is defined as “liquids produced during initial completion and clean-up of the well or clean-up of a well following re-fracture or work over of a well” (NYSDEC, 2011).

Hydraulic Fracturing and Marcellus Shale Potential

Technological advancements in hydraulic fracturing have rapidly advanced an expansion in domestic production of natural gas in the United States (IEA, 2012). The hydraulic fracturing process requires deep drilling into shale formations followed by horizontal drilling in order to access a large area of shale (NYSDEC 6, 2012). Vertical well sections extend at least 2,000 feet from the surface and horizontal sections can extend 1,000 to 6,000 feet away from the well (NYSDEC 6, 2012). Next, a highly pressurized mixture of water, sand, and chemicals is injected into the well to fracture the rock and release natural gas for collection (NYSDEC 6, 2012).

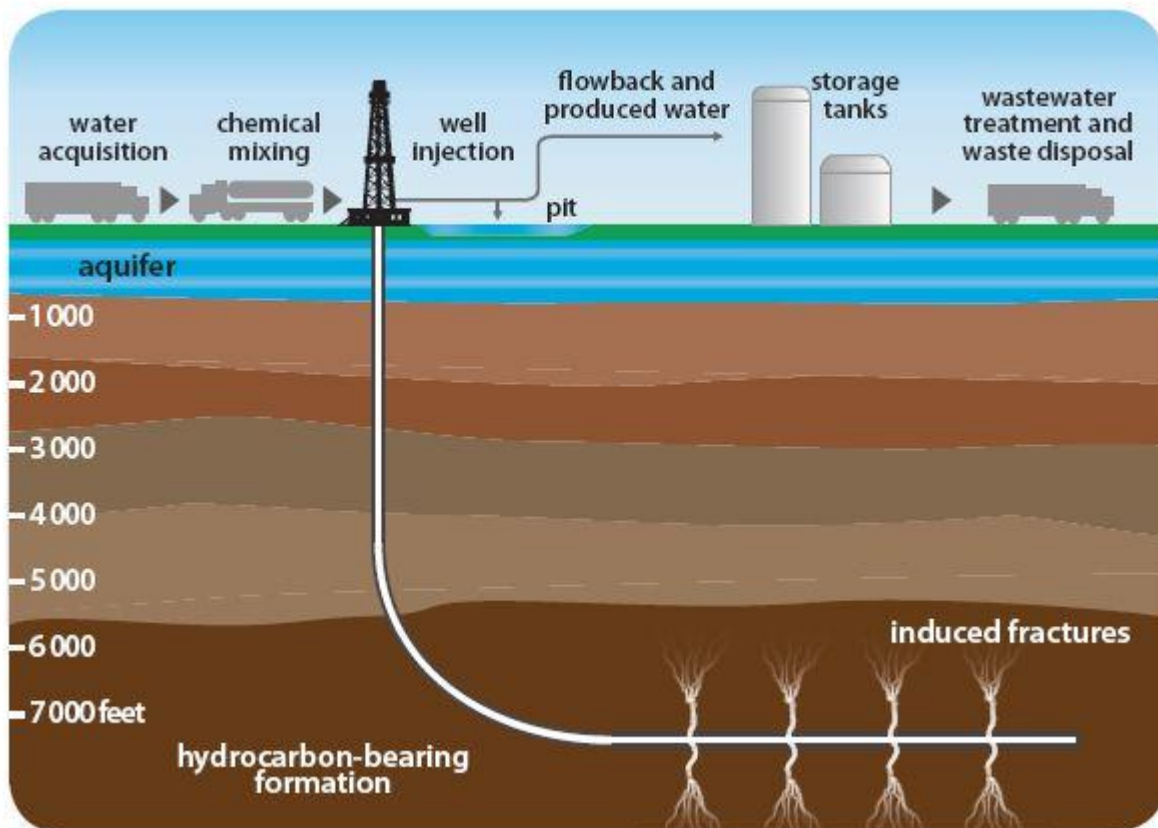


Figure 1. Diagram of hydraulic fracturing process (The Ozone Hole Inc., 2012).

Hydraulic fracturing has been practiced in the US since 1949 but remained uneconomical until the late 1990s, when Mitchell Energy & Development Corporation developed a less expensive type of fracturing fluid called 'slickwater' to replace the conventional expensive gels (YSI Environmental, 2011; Geny, 2010). The cost of hydraulic fracturing also fell after the development of horizontal drilling, which enables drilling

companies to extract the same amount of gas from fewer wells than traditional vertical drilling requires (ANGA, 2012). The development of horizontal drilling and usage of slickwater fracturing fluid has made natural gas extraction from shale formations economically competitive with other fossil fuels and a viable energy resource (Pleass, 2012; Geny 2010).

The feasibility and economics of natural gas extraction depends on the type of shale formation. The Marcellus formation is black shale composed of various clay minerals and quartz grains (Vine and Tourtelot, 1970). Like all other shale formations, the Marcellus shale was formed through the process of compaction, where layers of sediment deposited over millions of years were compressed and subjected to increasing levels of pressure (Vine and Tourtelot, 1970). The Marcellus shale is a source rock, meaning it is a rich source of hydrocarbons (Nelson, 2012). The most common hydrocarbon in shale is natural gas, which was created by the natural conversion of trapped organic matter exposed to heat and pressure over long periods of time (Nelson, 2012).

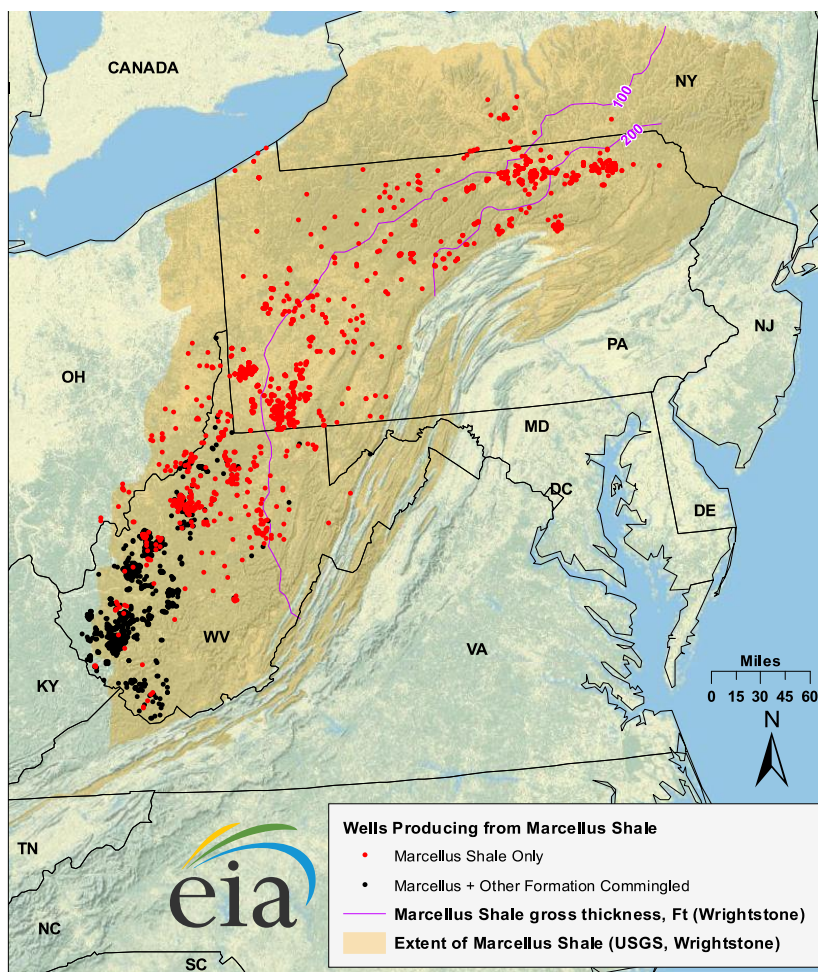


Figure 2. Map of Marcellus Shale distribution (EIA 2, 2011).

While the United States has several large shale formations, the Marcellus shale is the largest, covering approximately 140,000 square miles and reaching 7,000 feet underground (NYSDEC 1, 2011). The shale formation extends into Maryland, Ohio, Pennsylvania, West Virginia, and across the Southern Tier and Finger Lakes regions of New York State (EPA 2, 2012). With several large urban centers close in proximity, the Marcellus shale is geographically positioned to be a convenient energy source for millions of consumers (NYSDEC 1,

2011).

The Marcellus shale is estimated to possess between 141 trillion cubic feet (TCF)² and 489 TCF of recoverable natural gas (Engelder, 2009; EIA 4, 2012). The low estimate equates to approximately six years of total U.S. demand for natural gas (EIA 4, 2012). The DEC estimates that New York alone could develop 1,600 new wells per year, with each well remaining active for up to 30 years (NYSDEC 1, 2011). With similar developments in shale-containing states, the U.S. has the potential to increase unconventional natural gas production by more than 60% by 2035 (IEA, 2011). If the moratorium on hydraulic fracturing is lifted, New York would see an influx of jobs in the natural gas industry, significant industrial investments, and increases in tax revenue (NGSA, 2012). In Pennsylvania, where there has not been a moratorium over the past five years, the natural gas industry employs over 111,000 workers and generates approximately 10 billion dollars through job creation and tax revenue (Considine, Watson, & Blumsack, 2010).

The U.S. has the potential to increase unconventional natural gas production by more than 60% by 2035

In addition to the economic advantages and utility of hydraulic fracturing, natural gas extraction also offers environmental benefits over other fossil fuels. Natural gas generation creates 47% less greenhouse gas emissions than coal generation from source to use and has been referred to by energy

Natural gas generation creates 47% fewer greenhouse gas emissions than coal generation

experts as a 'transition fuel' to replace coal until renewable energy becomes more accessible and economical (Worldwatch Institute, 2012). Research by Cornell University calculated that replacing all coal and some oil with natural gas could result in a 40% decrease of total carbon emissions in the United States (Cathles, 2012). However, it is important to note that leaks or spills during extraction and transportation of natural gas can result in the emission of methane, a greenhouse gas with a higher warming potential than carbon dioxide, into the air (EPA 1, 2012). In addition, there is public concern of hydraulic fracturing fluid leaking into nearby water sources, particularly drinking water supplies.

² The 141 TCF estimate by the U.S. Energy Information Administration (EIA) is a 65% reduction from estimates in 2011 due to new survey methodologies (EIA 4, 2012; WEC, 2012).

In 2009, a well in Dimock, Pennsylvania leaked 8,000 gallons of hydraulic fracturing fluid into a nearby stream, killing fish and contaminating water supplies. After this incident, residents reported experiencing dizziness, headaches, and skin sores after showering (Zukowski, 2012). In 2010, another well in Clearfield County, Pennsylvania accidentally blew out and released over one million gallons of hydraulic fracturing fluid into the surrounding environment (Zukowski, 2012).

To minimize the likelihood of hydraulic fracturing fluid leakage and methane emission from future hydraulic fracturing operations, the government must enforce policies such as those described in Senate Bill 6892. These policies aim to ensure well operators implement the proper practices during production and that waste is monitored and tracked (Bill 6892, 2011).

Support and Opposition to Hydraulic Fracturing and Senate Bill 6892

Hydraulic fracturing in New York is a highly contentious issue with substantial support on both sides of the debate. The largest supporter of hydraulic fracturing development in New York State is the natural gas industry. Given that New York is the fifth largest consumer of natural gas in the United States and that the Marcellus shale contains an estimated two trillion dollars worth of extractable gas, the natural gas industry has a huge economic incentive to see the moratorium lifted (EIA 1, 2012; ANGA, 2012). Public opinion towards hydraulic fracturing remains largely divided. A survey conducted by Quinnipiac University found that residents of upstate New York living near potential drilling sites supported hydraulic fracturing development by a narrow four point margin (DeWitt, 2012). Citizens supporting hydraulic fracturing development in New York claim that the economic benefits, particularly job creation, outweigh potential environmental and health effects (DeWitt, 2012). Those opposed to hydraulic fracturing believe that such benefits are not worth the known and unknown environmental and human health risks (Esch, 2012).



Figure 3. (Left) Pro-fracking group *Friends of Natural Gas NY* rallying for the lifting of the moratorium on fracking (Kozak, G., 2012), **(Right)** Anti-fracking rally in Albany on August 27, 2012 (Van Buren, 2012).

In its aim to regulate high-volume³ hydraulic fracturing waste disposal, Senate Bill 6892 therefore faces both support and opposition from the New York community. Introduced in 2011, the bill would require the creation of a new tracking system to monitor chemicals used in the hydraulic fracturing process from “cradle to grave”; i.e. from the point of creation to disposal (Bill 6892, 2011). Supporters of the bill argue that an effective waste tracking system is necessary to minimize the potential health and environmental risks resulting from hydraulic fracturing if New York intends to lift its moratorium (J. Erdman, 2012). Proponents of the bill include the Natural Resources Defense Council, Environmental Advocates of New York, Citizens Campaign for the Environment, and Earth Justice (J. Erdman, personal communication, June 5, 2012). Opponents of the bill are divided; pro-environment groups argue the proposed regulations are not stringent enough, while some pro-fracking groups argue the bill is entirely unnecessary. The Sierra Club opposes S6892 because they advocate the complete ban of hydraulic fracturing in New York and believe the adoption of S6892 would prompt New York State to lift the hydraulic fracturing moratorium prematurely, before studies on the risks have been concluded (Erdman, 2012). On the other hand, the Independent Oil and Gas Association of New York and the American Petroleum Institute oppose the bill because they contend the “fluid disposal plan” outlined in the DEC’s draft Supplemental Generic Environmental Impact Statement (SGEIS) is already sufficient in ensuring that hydraulic fracturing waste is properly disposed (IOGNY, 2012).

A new tracking system to monitor chemicals used in the hydraulic fracturing process from “cradle to grave”, which is from the point of creation to disposal

³ High volume hydraulic fracturing is defined as hydraulic fracturing operations using greater than 300,000 gallons of water (NYDEC 1, 2011).

Senate Bill 6892 - Stipulations and Discretionary Components

New York State Senate Bill 6892 is an amendment to Article 23 of New York's Environmental Conservation Law (ECL), a body of law establishing the DEC and authorizing its programs (DEC, 2012). S6892 aims to minimize the potential environmental and health risks associated with hydraulic fracturing drilling processes by ensuring the proper containment and disposal of the generated waste through the establishment of a waste tracking program (S6892, 2011). S6892 stipulates the DEC track the transport and disposal of all solid and liquid waste⁴ generated by high-volume hydraulic fracturing from its point of generation to its point of ultimate disposal (S6892, 2012). Owners or operators of an oil or gas well will be required to deliver a uniform manifest to the DEC that identifies the quantity, composition, origin, routing, and destination of all waste produced (S6892, 2012). The DEC then must create an online database on its main website that is accessible to the public and contains all information from the manifests (S6892, 2011). Therefore, by mandating a manifest tracking system, S6892 facilitates strict oversight over the management

of hydraulic fracturing waste and establishes public transparency (S6892, 2011).

The bill stipulates that the waste tracking program shall:

- a) Provide for the tracking of the transportation of liquid and solid waste associated with the production of natural gas where high-volume hydraulic fracturing is utilized;
- b) Include a system for providing the generator with assurance that the materials were treated or received by the receiving facility;
- c) Use a uniform form or forms for tracking;
- d) Require the generator to deliver a copy of the manifest form to the department when the shipment leaves their facility site;
- e) Require receiving facility to deliver a copy of the manifest form to the department when the shipment arrives at the receiving facility;
- f) Use a computer system to maintain a record of data from the manifests and track the movement of liquid and solid waste; and
- g) Display data records on the department's website.

Senate Bill 6892 clearly outlines the basic requirements of the waste tracking system but the implementation is left to the discretion of the DEC. The DEC will be responsible for deciding the maximum time hydraulic fracturing waste can be stored on-site before requiring relocation for disposal, where the waste will be treated and disposed, and creating a process of permitting and inspecting by which the DEC will grant oil and gas companies permission to conduct hydraulic

fracturing operations and ensure proper conduct on sites. Other issues unmentioned by the S6892 are

⁴ Solid and liquid waste are defined as, but not limited to, production brine, produced water, flowback fluid, and drill cuttings from oil and gas production (NYSDEC 1, 2011).

addressed in the DEC's 2011 Supplemental Generic Environmental Impact Statement (SGEIS) and therefore are not left to discretion. For example, although the specific method of well site waste containment is not addressed in S6892, the SGEIS mandates that the waste be stored in closed-loop storage tanks (NYSDEC 1, 2011).

A New Waste Tracking and Permitting System

After thoroughly analyzing the social, political, environmental, and economic aspects of hydraulic fracturing, we created a plan to successfully implement Senate Bill 6892. It was important that the plan be effective in implementing the mandates of S6892 but also be economically and logistically feasible. The implementation plan has five key components:

1. The establishment of a waste permit
2. A 30 day maximum duration for the storage of waste on-site
3. Regular compliance inspections
4. Electronic manifest forms
5. Disincentives in the form of fees and fines

We also prescribe a reorganization of the DEC in order to ensure that the DEC has sufficient organizational and administrative capacity to manage the new tracking program.

DEC Organizational Changes

In order to build the necessary capacity to implement the hydraulic fracturing waste program, the DEC will be required to make temporary work assignments, create additional staff positions, and hire contractors. Under the current DEC organizational structure, the Division of Environmental Remediation manages the tracking and regulation of hazardous waste. The Division of Materials Management manages the tracking and regulation of non-hazardous waste (NYSDEC 3, 2012). Although S6892 mandates that hydraulic fracturing waste be tracked in a manner similar to hazardous waste, the bill does not classify hydraulic fracturing waste as hazardous waste (S6892, 2011). For this reason, the Division of Mineral Resources and Division of Materials Management will collaborate in administering the waste tracking program (See Table 1).

Program Element	Organizational Unit	Responsibility	Reports to	Skills and Experience
Waste Permitting	Division of Mineral Resources, Oil and Gas Regional Minerals Managers	Section Staff	Section Chief	Training from Division of Materials Mgmt. 3-5 years Minerals Mgmt. experience
Storage Duration	Division of Mineral Resources, Regional Mined Lands	Regional Staff	Regional Supervisor	Well permitting 3-5 years Minerals Mgmt. experience
Reporting	Division of Materials Management, Bureau of Permitting and Planning, Compliance and Resource Management Section	Section Manager	Bureau Director	Waste permitting, reporting and database management 1-3 years Materials Mgmt. experience
Inspections and Auditing	Division of Materials Management, Regional Materials Management	Regional Staff	Regional Supervisor	Waste permitting 1-3 years Materials Mgmt. experience

Table 1. Proposed task distribution within DEC Division of Mineral Resources and Division of Materials Management to administer recommended plan.

While we recommend that temporary work assignments and additional staff positions be integrated into the DEC's organizational structure, large scale change in the DEC's organizational structure is unnecessary because existing departments and staff positions can be utilized in the implementation of the hydraulic fracturing waste tracking program. The addition of nine new staff positions, as well as temporary work assignments and contractors, will supply the needed capacity with minimal impact on the Department's financial and physical resources. Additional staffing changes may need to be considered should the proposed organizational structure prove insufficient.

Waste Permitting

A permit to generate waste, in addition to the already-mandated permit to drill on a well site, will be required for all oil and gas companies wishing to establish hydraulic fracturing operations in New York (NYSDEC 1, 2011). In order to be eligible for the permit, operators must have their well sites inspected and

approved by DEC regulators before commencing hydraulic fracturing operations and must pay the annual permit fee of \$500. This permitting system will ensure that well site operators adhere to proper standards on site and are able to manage waste safely and efficiently.



Figure 4. Worker in Texas handling hydraulic fracturing waste (Janik, 2012).

Under the current DEC structure, regional staff from Mineral Resources are responsible for issuing drilling permits (NYSDEC 4, 2012). In order to maintain efficiency, the same staff will be trained by the Division of Materials Management and outside contractors to issue waste permits. Five new staff positions within the Division of Mineral Resources and four new staff positions within the Division of Materials Management will be created to ensure sufficient capacity exists within the DEC to implement the waste permitting system⁵. In addition to issuing permits, all new staff positions will also be required to inspect sites and will focus on regions 7, 8, and 9, namely, Central New

York, Western Finger Lakes area, and Western New York (NYSDEC 5, 2012). These areas within New York State are expected to experience the largest number of hydraulic fracturing operations once the statewide moratorium on drilling is lifted (NYSDEC 5, 2012). Within the Division of Mineral Resources, three of the new positions will report to the Regional Mined Land Supervisors and two of the new positions will report to the Oil and Gas Regional Minerals Managers. Three positions will be added to the Section on Regional Material Management within the Division of Materials Management and the final position will be responsible for overseeing the following new departments within the Division of Materials Management:



Figure 5. DEC designated regions within New York (NYSDEC 5, 2012)

⁵ See Appendix 1 for a diagram depicting the proposed expansion of DEC.

Hydraulic Fracturing Permitting and Compliance, Permitting and Planning, and Compliance and Resource Management.

Storage Duration

Our plan will propose that waste can be stored on site for a maximum of 30 days. In the 30 day time period, the waste will be required to be transported from the well site to a treatment facility. This timeline will prevent the accumulation of waste on site and decrease the risk and severity of potential accidents. It will also promote efficiency by ensuring that well operators are managing and attending to waste in a timely manner. We propose that failure to transport the waste from site within 30 days of its generation would result in a penalty of \$25,000.



Figure 6. Closed-loop storage containers for hydraulic fracturing waste (VE Enterprises, Inc 2010).

Compliance Inspections

The implementation plan will require regular inspections of hydraulic fracturing operations within New York State to ensure that they are in compliance with the stipulations of Senate Bill 6892, the DEC SGEIS, and our proposed implementation plan. Specifically, inspectors will need to verify that operators possess

both a waste and drilling permit issued by the DEC, that waste on site is stored in closed-loop containers for no longer than 30 days after its generation, and that operators are accurately reporting the transport of waste using the waste tracking manifest (see page 17). Inspection will occur twice annually for each hydraulic fracturing well in New York State. One inspection will be scheduled and one inspection will be unannounced and at random. In addition to annual inspections, a preliminary inspection will be a prerequisite to obtaining a waste permit and therefore required prior to the commencement of any hydraulic fracturing operations within New York. The DEC Division of Mineral Resources will be responsible for issuing waste permits and conducting preliminary inspections while the DEC Division of Materials Management will conduct the subsequent annual inspections. During the initial development period, temporary contractors as well as staff from the Division of Materials Management will assist with preliminary inspections in order to accommodate the large number of permit applications that the DEC expects to receive once the moratorium lifted. University partnerships, such as with Cornell University's Department of Earth and Atmospheric Sciences or Columbia University's Lamont Doherty Earth Observatory, could also provide added capacity for field inspections and expertise for program implementation.



Figure 7. Staff inspection of hydraulic fracturing well sites (Schubert & Scott, 2011).

Tracking, Reporting, and Auditing

To successfully implement the tracking manifest system mandated by Senate Bill 6892, our program design will utilize an electronic manifest to efficiently track hydraulic fracturing waste from point of generation to point of disposal. The content of each manifest will be collected and organized in an online public database. The online database will improve DEC's ability to oversee the handling of hydraulic fracturing waste and will increase industry transparency. The manifest requires that well operators report the waste composition, volume, and location of origin and disposal. A hard-copy version of the manifest will travel with the waste until it reaches a waste treatment facility for disposal. The manifest will have an electronic barcode that will be scanned at the point of origin (the well site) and the point of disposal (waste treatment facility). The DEC Division of Materials Management will be responsible for maintaining and auditing the online database in order to verify the accuracy of the waste tracking records and to inspect for any sign of noncompliance.



Figure 8. Truck carrying hydraulic fracturing waste and manifest from well site to disposal site (VE Enterprises, Inc 2010).

Enforcement: Fees, Fines, and Penalties

Under the proposed implementation plan, fines and penalties will be enforced upon operators who do not comply with the regulations mandated by the Senate Bill 6892, DEC SGEIS, and our proposed implementation plan. The penalty system is established with the hope that it will incentivize hydraulic fracturing well operators to achieve a high standard of efficiency and safety. In addition, every operator will need to pay the annual permit fee of \$500 to operate hydraulic fracturing wells in New York State. Assuming that 13,827 wells⁶ exist within New York, \$6,913,500 can be expected annually from permit fees alone. Possible fines for noncompliance include a \$50,000 fee for operating a well without a waste permit and a \$25,000 fine for storing waste on well site for over 30 days, documenting inaccurate information on tracking manifests, or repeating past infractions. Assuming a 2% noncompliance rate for every 6,000 hydraulic fracturing wells, the total value of fines collected by the DEC would amount to \$5,761,250⁷. If an operator demonstrates consistent or severe noncompliant behavior, their permit may be suspended and their hydraulic fracturing operation terminated.



Figure 9. Open-air pit in Susquehanna County containing hydraulic fracturing waste (un-natural gas, 2011).

⁶ 13,827 is the number of hydraulic fracturing wells that existed within New York State in 2011.

⁷ See Appendix 2 for detailed breakdown of revenue estimates.

Budget

Funding will be required to implement the following tasks: waste permitting, inspections, auditing, and reporting. This will cover salaries and benefits for DEC staff and contracted labor, costs of supplies, equipment, transportation, and overhead for each task. The projected operating cost of the plan in its first year is approximately \$1,892,984.94 (see Figure 12). Assuming a conservative estimate of a 2% noncompliance rate, the total revenue from the program's fees, fines, and penalties within the first year is estimated to reach \$12,674,750.00⁸. Therefore, in the first year the DEC will experience a revenue of \$10,781,765.06. After the first year of development, total operating cost is estimated to decrease to \$674,000, resulting in an estimated annual budget of \$1,218,984.94 from the second year onwards (see Figure 13). Detailed budgets for individual aspects of our recommended plan can be found in Appendix 3.

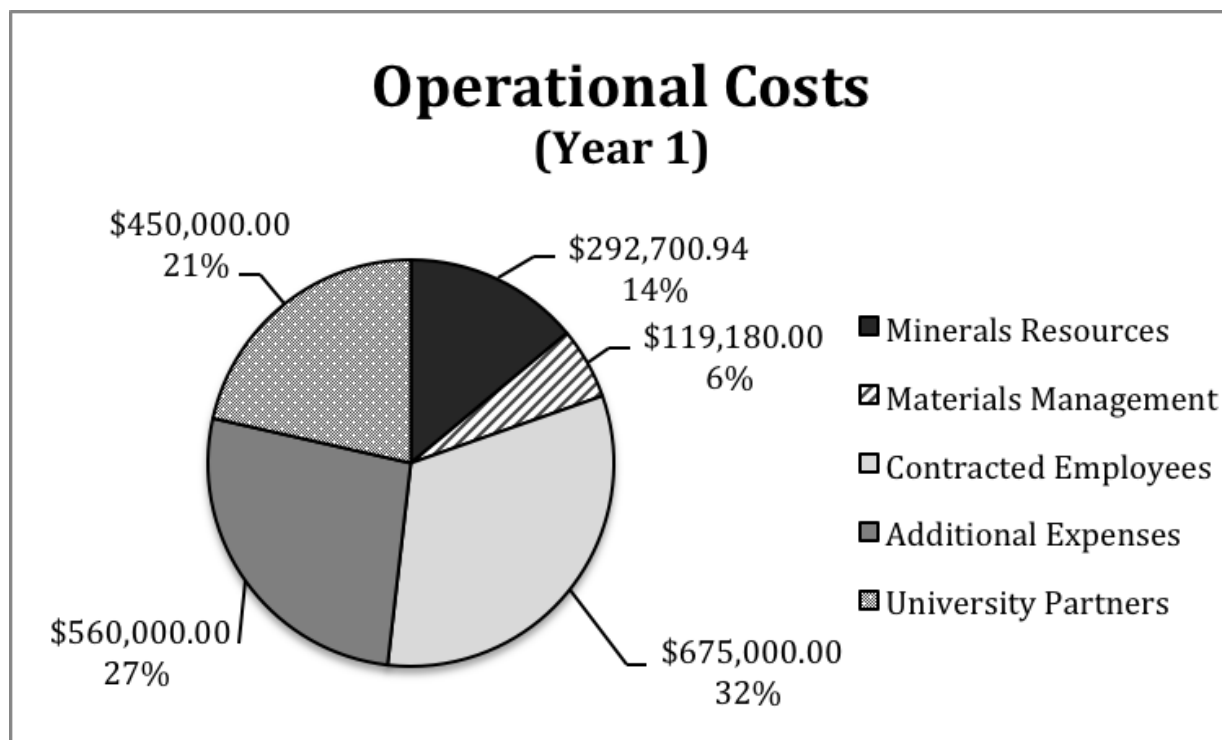


Figure 10. Distribution of operational costs within the first year of plan implementation.

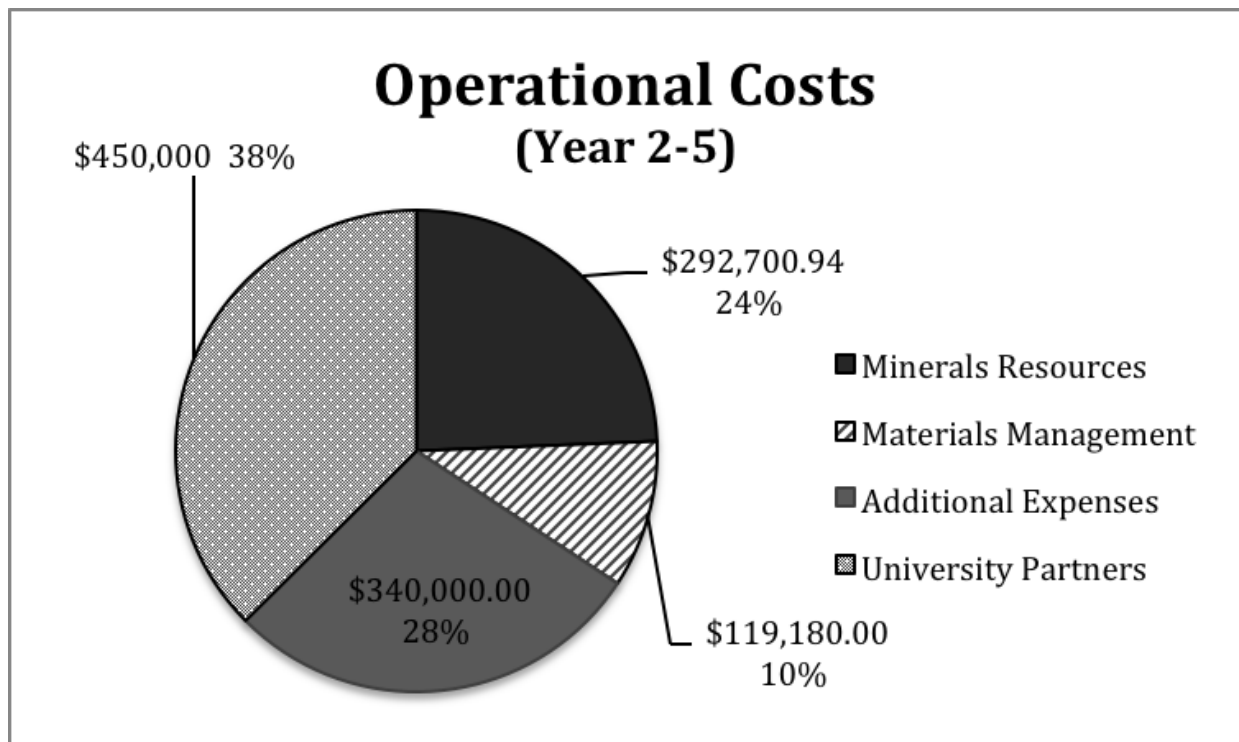


Figure 11. Distribution of operational costs after first year of plan implementation.

Calendar

The calendar serves as an operational plan delineating timeframes and staffing needs within the first year of execution. The calendar was designed under the following key assumptions: that the current moratorium on hydraulic fracturing in New York has been lifted, that half of the wells that operated prior to the moratorium will be active by January 2013, that all wells will be active by March 2013, and that external contractors will be hired to expedite implementation. The calendar aims to aid the DEC in achieving its first year goals, namely, to issue permits to drilling operators, ensure proper tracking of waste using the electronic manifest, conduct compliance inspections, and establish the public database. The recommended plan will commence in January 2013 with a rapid development period of hiring and training staff within the first four to five months. Following this initial phase, the implementation period will begin with the DEC issuing permits, monitoring waste tracking, conducting inspections, and maintaining the online manifest database.

2013	J	F	M	A	M	J	J	A	S	O	N	D
Permit Implementation												
Hiring/Staffing												
Training												
Implementation												
Monitor Permitting Process												
Waste Tracking Implementation												
Hiring Process												
Training												
Track Progress												
Implementation												
Monitoring/Reporting												
Compliance Inspections												
Hiring Process												
Train Regional Staff												
Inspection Implementation												
Track Progress												
Quarterly Reports												
Database Management												
Hiring Process												
Training												
Database Launch												
Maintenance of Database												
Report Site Traffic												

Figure 12. Calendar of first year of implementation.

Conclusion

Technological advancements have made hydraulic fracturing a “game changer” in the United States energy market (IEA, 2011). Natural gas from the Marcellus shale can help the United States meet local energy demands and create hundreds of new jobs in the natural gas industry. In addition, natural gas is a “cleaner” alternative to coal, which creates larger amounts of greenhouse gases [and other pollutants such as heavy metals and sulfur] when burned for energy. However, hydraulic fracturing does pose environmental and health risks that remain largely unknown. It is imperative that regulations such as New York State Senate Bill 6892 are implemented successfully to minimize these risks and protect the environment and health of local communities.

Our recommended plan would allow the DEC to successfully implement the High-volume Hydraulic Fracturing Waste Tracking Program mandated by S6892. Specifically, this plan requires that all oil and gas companies obtain a waste permit before drilling, waste generated from hydraulic fracturing operations are transported from well site within 30 days, all hydraulic fracturing operations undergo regular compliance inspections, electronic manifest forms are utilized to track waste, and fees and penalties are enforced. In addition, the plan will incorporate temporary work assignments and additional job positions within the DEC to ensure sufficient organizational and administrative capacity. We are confident that this plan will enable the DEC to efficiently manage waste and minimize risk once the moratorium is lifted and natural gas development commences within New York.



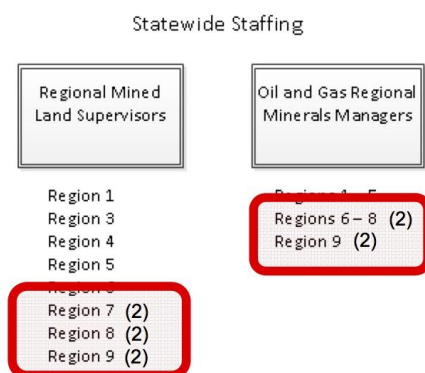
Figure 13. Hydraulic fracturing drill site.

Appendices

Appendix 1. Proposed expansion of DEC.

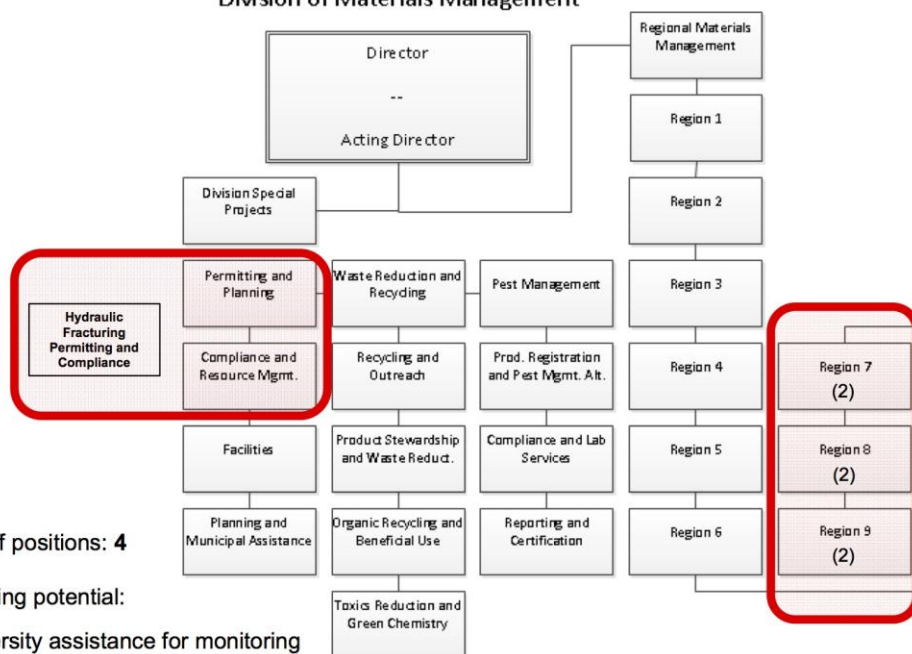
(Diagrams produced using information retrieved from <http://www.dec.ny.gov/about/34315.html> and http://www.dec.ny.gov/docs/materials_minerals_pdf/dmmorgchart.pdf)

New York State Department of Environmental Conservation Office of Remediation & Materials Management Division of Mineral Resources



New staff positions: 5

New York State Department of Environmental Conservation Office of Remediation & Materials Management Division of Materials Management



New staff positions: 4

Contracting potential:

- University assistance for monitoring

Appendix 2. Revenue made from fines, penalties and fees in the first year.

Enforce Fines, Penalties and Fees					Amounts
	Fines (Conditions)		Per Instance	Estimated Incidence (per 6,000 sites)	
	Operating Without a Permit		50,000	2%	2,304,500
	Exceeding 30 Day Storage Duration		25,000	2%	1,152,250
	Inaccurate Documentation		25,000	2%	1,152,250
	Repeated Infractions		25,000	2%	1,152,250
			Total Estimated Fines		5,761,250
	Operating Permit Fee				
	Fee Per Well Per Annum	Number of Wells, 2011	Total Estimated Fee Revenue		
	500	13,827			6,913,500
			Total Estimated Fees, Assuming 2% Noncompliance Across Conditions		12,674,750

Appendix 3. Detailed budgets for individual aspects of the recommended plan.

Program Budget for Waste Permitting

Waste Permitting					Amounts
	Personnel Services	Duration	Salary		
	Oil & Gas Regional Manager (G-23)	(6 months)	66,375		33,187
	Oil & Gas Regional Manager (G-23)	(6 months)	66,375		33,187
	Hydraulic Fracturing Permit and Compliance Officer (G-25)	(50%)	73,768		36,884
			Base Salaries		103,259
			Fringe Benefits (25%)		25,814.75
			Duration Rate		
	Expert Level Contracted Specialist	(Divided evenly amongst actions)	50 weeks, 40 hours/week	60/hour	90,000
	Skilled Contracted Specialist	(Divided evenly amongst actions)	3 months, 40 hours/week	45/hour	78,750
			Total Personnel Services		297,822.75
	Other Than Personnel Services				
	Supplies				4,000
	Equipment and Furniture				25,000
	Transportation				
		Vehicles	2012 Toyota		

				Prius		
				24,000	(2)	48,000
			Fuel	2,000	(2)	4,000
		Overhead				15,500
				Total OTPS		96,500
				Total Waste Permitting		394,322.75

Program Budget for Inspections

Conduct Inspections						Amounts
	Personnel Services	Duration		Salary		
	Regional Mined Land Supervisor (G-23)	(8 months)		66,375		49,781.25
	Regional Mined Land Supervisor (G-23)	(8 months)		66,375		49,781.25
	Regional Mined Land Supervisor (G-23)	(8 months)		66,375		49,781.25
				Base Salaries		149,343.75
				Fringe Benefits	(25%)	37,335.94
	University Partner Testing and Quality Assurance			Per Annum		450,000
	Expert Level Contracted Specialist	(Divided evenly amongst actions)		50 weeks, 40 hours/week	60/hour	90,000
	Skilled Contracted Specialist	(Divided evenly amongst actions)		3 months, 40 hours/week	45/hour	78,750
				Total Personnel Services		805,429.69
	Other Than Personnel Services					
	Supplies					6,000
	Equipment and Furniture					25,000
	Transportation					
		Vehicles		2012 Toyota Prius		
				24,000	(3)	72,000
		Fuel		2,000	(3)	6,000
	Overhead					15,500
				Total OTPS		124,500
				Total Conduct Inspections		929,929.70

Program Budget for Auditing

Auditing						Amounts
	Personnel Services	Duration	Salary			
	Hydraulic Fracturing Permitting and Compliance Officer (G-25)	(50%)	73,768			36,884
			Base Salary			36,884
			Fringe Benefits	(25%)		9,221
	Expert Level Contracted Specialist	(Divided evenly amongst actions)	50 weeks, 40 hours/week	60/hour		90,000
	Skilled Contracted Specialist	(Divided evenly amongst actions)	3 months, 40 hours/week	45/hour		78,750
			Total Personnel Services			214,855
	Other Than Personnel Services					
	Supplies					2,000
	Equipment and Furniture					25,000
	Overhead					15,500
			Total OTPS			42,500
			Total Auditing			257,355

Program Budget for Reporting

Reporting						Amounts
	Personnel Services	Duration	Salary			
	Materials Management Specialist (G-18)	(6 months)	51,268			25,634
	Materials Management Specialist (G-18)	(6 months)	51,268			25,634
	Materials Management Specialist (G-18)	(6 months)	51,268			25,634
			Base Salaries			76,902
			Fringe Benefits	(25%)		19,225.50
	Expert Level Contracted Specialist	(Divided evenly amongst actions)	50 weeks, 40 hours/week	60/hour		90,000
	Skilled Contracted Specialist	(Divided evenly amongst actions)	3 months, 40 hours/week	45/hour		78,750
			Total Personnel Services			264,877.50
	Other Than Personnel Services					
	Supplies					6,000
	Equipment and Furniture					25,000
	Benefits					15,500
			Total OTPS			46,500
			Total Reporting			311,378

Compiled Program Budget

<u>Line-Item Budget</u>				
Waste Permitting				
			Total	\$394,322.75
Conduct Inspections				
			Total	\$929,929.69
Auditing				
			Total	\$257,355.00
Reporting				
			Total	\$311,378.00
			Total Operation Costs	\$1,892,984.94
Estimated Well Permitting Revenue				
\$500/well/year			13,827 wells	\$(5,761,250.00)
Estimated Fines Revenue Assuming 2% Noncompliance Across All Conditions for approximately 2,000 Sites				\$(6,913,500.00)
			Total Estimated Revenue	\$(12,674,750.00)
			Total Plan Budget	\$(10,781,765.06)

Works Cited

- ANGA. (2012). Hydraulic Fracturing 101. Retrieved August 02, 2012, from American Natural Gas Alliance:
<http://anga.us/media/41084/hydraulic%20fracturing%20101.pdf>
- Bill 6892, 2011. Create the High-Volume Hydraulic Fracturing Waste Tracking Program.
<http://open.nysenate.gov/legislation/bill/S6892-2011>
- Cathles, L. M. (2012). *Assessing the greenhouse impact of natural gas*. Informally published manuscript, Cornell University, Ithaca, New York, Available from Geochemistry, Geophysics and Geosystems. Retrieved from
<http://www.pressoffice.cornell.edu/releases/release.cfm?r=67426&y=2012&m=7>
- Considine, T., Watson, R., & Blumsack, S. (2010). The Economic Impacts of the Pennsylvania Marcellus Shale Natural Gas Play: An Update. University Park, PA: The Pennsylvania State University College of Earth and Mineral Sciences Department of Energy and Mineral Engineering.
- Cornell. (2012, March 21). Gas Wells: Waste Management of Cuttings, Drilling Fluids, Hydrofrack Water and Produced Water. Retrieved 08 05, 2012, from Cornell: http://wri.eas.cornell.edu/gas_wells_waste.html
- DeWitt, K. (Performer) (2012). Poll shows increased support for fracking [Radio series episode]. In *Regional News*. Albany, NY: NCPR. Retrieved from
<http://www.northcountrypublicradio.org/news/story/20474/20120913/poll-shows-increased-support-for-fracking>
- EIA 1. (2012). New York Dry Natural Gas Production. Retrieved August 4, 2012, from Energy Information Administration: http://www.eia.gov/dnav/ng/hist/na1160_sny_2m.htm
- EIA 2. (2011). [Graphic of Lower 48 states shale plays]. Maps: Exploration, Resources, Reserves, and Production. Natural Gas. Retrieved Nov. 27 from http://www.eia.gov/oil_gas/rpd/shale_gas.pdf
- EIA 3. (2011). [Graphic of Marcellus Shale Play, Appalachian Basin]. Maps: Exploration, Resources, Reserves, and Production. Natural Gas. Retrieved Nov. 27 from http://www.eia.gov/oil_gas/rpd/shaleusa5.pdf
- EIA 4. (2012). *Annual Energy Outlook 2012: With Projections to 2035*. Washington D.C.: U.S. Energy Information Administration.

- Engelder, T. (2009). Marcellus 2008: Report card on the breakout year for gas production in the Appalachian basin. Fort Worth Basin Oil & Gas Magazine 20, 18–22.
- EPA 1. (2012). Natural Gas. Clean Energy. Retrieved Oct. 27, 2012, from United States Environmental Protection Agency: <http://www.epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html>
- EPA 2. (2012). Background. Key Documents About Mid-Atlantic Oil and Gas Extraction. Retrieved Nov. 24, 2012, from United States Environmental Protection Agency: http://www.epa.gov/region3/marcellus_shale/#background
- Esch, M. (2012, Sept. 30). Rulemaking will likely delay lifting NY moratorium on gas drilling by fracking. *The Republic*. Retrieved from <http://www.therepublic.com/view/story/9338b890dda8431887aa0daf6ff1b191/NY--Gas-Drilling-NY-Regulations>
- Geny, F. (2010). Can Unconventional Gas be a Game Changer in European Gas Markets? Oxford: The Oxford Institute for Energy Studies.
- IEA. (2011). World Energy Outlook 2011 Special Report: Are we Entering a Golden Age of Gas? Paris: International Energy Agency.
- IEA. (2012). World Energy Outlook 2012 Special Report on Unconventional Gas: Golden Rules for a Golden Age of Gas. Paris: Energy Information Agency.
- IOGANY. (2012, April 23). Memorandum in Opposition. Retrieved from <http://www.marcellusfacts.com/blog/wp-content/uploads/2012/05/MIOS6892Grisanti.pdf>
- Janik, J. (2012). [Photograph of worker in Texas handling fracking liquid]. International Agency Call for Action on Natural Gas Safety. National Geographic Daily News. Retrieved Nov 27, 2012 from <http://news.nationalgeographic.com/news/energy/2012/05/120530-iea-report-on-natural-gas-safety/>
- Kozak, G. (2012, March 13). [Photograph of pro-fracking activists]. Fracking Facts. *The Michigan View*. Retrieved Nov. 27 from <http://apps.detroitnews.com/apps/blogs/watercooler/index.php?blogid=4462>
- Nelson, S. A. (2012). *Energy resources*. Unpublished manuscript, Physical Geology, Tulane University, Tulane, New Orleans, Retrieved from <http://www.tulane.edu/~sanelson/eens1110/energy.htm>

- NYSDEC 1. (2011). *Supplemental Generic Environmental Impact Statement On The Oil, Gas and Solution Mining Regulatory Program*. Albany: New York State Department of Environmental Conservation. Retrived from <http://www.dec.ny.gov/regulations/40195.html>
- NYSDEC 2. (2012). About DEC - NYS Dept. of Environmental Conservation. *About DEC*. Retrieved October 12, 2012, from <http://www.dec.ny.gov/24.html>
- NYSDEC 3. (2012). Division of Materials Management - NYS Dept. of Environmental Conservation. *Division of Materials Management*. Retrieved October 12, 2012, from <http://www.dec.ny.gov/about/638.html>
- NYSDEC 4. (2012). Division of Mineral Resources - NYS Dept. of Environmental Conservation. *Division of Mineral Resources*. Retrieved October 12, 2012, from <http://www.dec.ny.gov/about/636.html>
- NYSDEC 5. (2012). Regions – Dept. Of Environmental Conservation. *About DEC*. Retrieved October 28, 2012, from <http://www.dec.ny.gov/about/50230.html>
- NYSDEC 6. (2012). The Marcellus Shale. *Oil and Gas*. Retrieved Nov 24, 2012, from <http://www.dec.ny.gov/energy/46288.html>
- NGSA. (2012). *Focus on jobs* . Retrieved from <http://www.naturalgas.org/jobs/jobs-home.asp>
- NRDC. (2012, July). State Hydraulic Fracturing Disclosure Rules and Enforcement: A Comparison. Retrieved October 27, 2012, from NRDC: <http://www.nrdc.org/energy/files/Fracking-Disclosure-IB.pdf>
- The Ozone Hole Inc. (2012). [Graphic illustration of hydraulic fracturing]. Retrieved Nov. 27 from <http://www.earthlyissues.com/gasdrill.htm>
- Pless, J. (2012). Natural gas development and hydraulic fracturing a policymaker’s guide. Washington D.C.: National Conference of State Legislatures.
- Schubert, P. and Scott, D. (2011). [Photograph of well site inspection]. Streamlining Inspection of Oil & Gas Well Sites & Facilities. *Energy Digital: Energy Portal*. Retrieved on Nov 27 from http://www.energydigital.com/oil_gas/streamlining-inspection-of-upstream-oil-gas-well-sites-processing-facilities
- Un-natural gas. (2011). [Photograph of open-air pit in Susquehanna County]. Image Gallery. Un-naturalgas.org. Retrieved Nov 27, 2012 from http://www.un-naturalgas.org/image_gallery.htm

Van Buren, L. (2012). [Photograph of anti-fracking march in Albany on Aug. 27, 2012]. Retrieved Nov.27 from <http://www.timesunion.com/local/article/Hundreds-march-in-opposition-to-fracking-3819540.php>

VE Enterprises, Inc 1. (2012). [Photograph of closed-loop storage containers]. Home. VE Enterprises, Inc.. Retrieved Nov 27, 2012 from <http://www.veenterprises.com/>

VE Enterprises, Inc 1. (2012). [Photograph of truck carrying waste]. Home. VE Enterprises, Inc.. Retrieved Nov 27, 2012 from <http://www.veenterprises.com/>

Vine, J.D. and Tourtelot, E.B. (1970). "Geochemistry of black shale deposits – A summary report". *Economic Geology* 65: 253–273.

WEC. (2012). *Survey of Energy Resources: Shale Gas - What's New*. London: World Energy Council.

Worldwatch Institute. (2012). *Despite methane emissions upstream, natural gas is cleaner than coal on a life-cycle basis* . Retrieved from website: <http://www.worldwatch.org/despite-methane-emissions-upstream-natural-gas-cleaner-coal-life-cycle-basis>

YSI Environmental. (2011). *Network Monitors Water Quality in Shale Gas*. Yellow Springs: YSI Environmental.

Zukowski, A. (2012). *Fracking Disaster: Ban Horizontal Fracking in Michigan*. Friends of the Jordan Watershed Inc, East Jordan, MI.

Lead Author:

Amy Burns

Contributing Editors:

Fernando Arias, Elizabeth Engoren

Cover Design:

Fernando Arias

Workshop Manager:

Katherine Hoffmaster

Deputy Manager:

Dan Robicheaux

Workshop Members:

Fernando Arias, Elizabeth Engoren, Sarah Finn, Mary Flannelly, Katherine Hoffmaster, Olivia Kemp, Max Litt, Robicheaux, James Spencer, Claire van Zuiden, Karl Wasmuth

Faculty Advisor:

Steve Cohen, Ph. D.



Columbia University in the City of New York

School of International and Public Affairs | The Earth Institute
MPA in Environmental Science and Policy | Fall Workshop 2012