To: Edward Hanlon/DC/USEPA/US@EPA
Date: 04/07/2010 10:06 AM
Subject: Risks to water from the shale gas industry

Dear Dr. Hanlon,

Please allow me to introduce myself: My name is Stephen Penningroth, and I am writing to you as a private citizen concerned about the shale gas industry, in general, and hydraulic fracturing, in particular. I currently serve as the Executive Director of the Community Science Institute, a nonprofit organization that includes a certified water quality testing laboratory in Ithaca, New York. Previously I was an Associate Professor of Pharmacology at the University of Medicine and Dentistry of New Jersey and a Senior Lecturer in Toxicology at Cornell University in Ithaca. I recently authored a textbook entitled "Essentials of Toxic Chemical Risk: Science and Society," which is being published by Taylor & Francis this month.

It has come to my attention that EPA is soliciting public input on the scope of EPA's review of hydraulic fracturing in relation to risks to groundwater.

I would like to urge EPA to study risks to surface water as well as groundwater from the shale gas industry. There are many opportunities for accidental spills of hydraulic fracturing fluids and flowback from pipes, hoses, valves, overflowing pits and trucks. Indeed, while I am not aware of any formal risk assessments, it seems possible that risks to surface water from accidental spills may be as great or greater than risks to groundwater from hydraulic fracturing. Further, surface water is ultimately impacted by contaminated groundwater feeding streams and lakes.

Surface water is also impacted by the disposal of gas well waste fluids by POTWs. The screens in place for detecting and pre-treating toxic chemicals are based on the PPL of 126 chemicals and are inadequate to the task of screening for the 250 to 400 chemicals that might be found in fracking fluid, according to the draft Supplemental Generic Environmental Impact Statement prepared by the NYSDEC as well as information obtained by Theo Colborn's Endocrine Exchange. This means that disposal of flowback by POTWs creates a substantial risk of contaminating surface waters with toxic chemicals that go undetected by the screening process. Even if contaminants are diluted to levels that are currently considered acceptable with respect to human health, there is a risk of ecosystem impacts due to bioaccumulation and biomagnification through the aquatic food web over the long term. The NYSDEC's draft Supplemental Generic Environmental Impact Statement proposes using toxicity bioassays as an additional screen for hazardous chemicals, however, the implementation of the bioassay screen is inadequate as proposed.

I would like to urge EPA to also consider air pollution, which is an inevitable consequence of shale gas extraction as currently practiced.

I am attaching the comments I submitted to the NYSDEC on the draft Supplemental Generic Environmental Impact Statement in December, 2009. The overall thrust of my comments is that flowback is hazardous chemical waste as defined by NYSDEC regulations, and that while an exemption for waste from old-style vertical wells might have made at least some sense in the 1980s, the scale of the modern shale gas industry is so much greater that continuing the exemption no longer makes any sense today.

I would greatly appreciate it if you would consider my input in the scoping process despite its tardiness.

Thank you.

Sincerely,   Steve Penningroth

Stephen Penningroth, Ph.D., Executive Director
Community Science Institute

Stephen Penningroth

December 27, 2009

Attn: dSGEIS Comments
Bureau of Oil & Gas Regulation
NYSDEC Division of Mineral Resources
625 Broadway, Third Floor
Albany, NY 12233-6500

To Whom it may concern:

I wish to submit the following comments on the draft Supplemental Generic Environmental Impact Statement for the Marcellus Shale:

<u>General comments</u>

1. The Commissioner of the NYSDEC should exercise his authority under existing NYSDEC regulations to classify flowback as hazardous waste on the basis of its

toxicity, radioactivity and quantity so that it can be handled and disposed of in ways that minimize risks to human health and the environment.

2. Flowback qualifies as hazardous chemical waste based on its toxicity characteristic, as defined by existing NYSDEC regulations.
3. Flowback contains alpha particle radioactivity up to 2,000 times higher than the concentration that can be safely discharged by Publicly Owned Treatment Works (POTWs) (sewage treatment plants) under existing NYSDEC regulations, further classifying it as hazardous chemical waste.
4. In addition to its demonstrated toxicity characteristic and its dangerously high radioactivity, both of which are documented by information presented in the dSGEIS, flowback is reasonably suspected to contain one or more other chemicals that exhibit acute and/or chronic toxicity, such as carcinogens, endocrine disruptors, teratogens, developmental toxicants, neurotoxins and/or toxicants that may bioaccumulate and biomagnify in the environment. Systematic chemical analyses should be performed in order to characterize the full range of toxic and radioactive chemicals in flowback and the risks they present to human health and the environment.
5. Flowback should be analyzed for the radioactive gas Radon-222. If present in flowback, Radon-222 could volatilize, increasing the risk of lung cancer to those who inhale it.
6. Flowback should not be stored in surface impoundments either at the drill pad or at a central location that serves several drill pads.
7. Flowback should not be accepted for pre-treatment and processing by POTWs, because it is impossible for pre-treatment analyses to identify all of the toxic and radioactive chemicals in flowback. The reason is that pretreatment is based on an antiquated list of 126 chemicals called the Priority Pollutant list. The dSGEIS lists 259 hydrofracturing chemical additives that could be present in flowback, many of which are not on the Priority Pollutant list; moreover, in addition to the 259 hydrofracturing chemical additives listed in the dSGEIS, toxic chemicals can be leached from shale, and new chemicals can be generated by reactions among the many chemicals in flowback as well as by the metabolic activities of microorganisms in flowback.
8. NYSDEC regulations identify 450 chemicals that qualify waste as hazardous; many NYSDEC toxic chemicals are missing from the list of 126 Priority Pollutants used to screen waste for pre-treatment and processing by POTWs.
9. The risks to human health and the environment from the toxicity and radioactivity of flowback are magnified by the unprecedented quantities of contaminated liquid that are generated as a byproduct of the modern gas industry.
10. The dSGEIS fails to provide either an effective system for monitoring surface water and groundwater quality, a set of criteria that define contamination from gas well waste fluids, or a list of steps that gas companies will be required to take to address and mitigate contamination if it occurs.

<u>Specific comments</u>

1. Appendix 22, NYSDEC – Division of Water, Hydrofracturing Chemical (HFC) Evaluation Requirements for POTWs: This comment is directed at unacceptable

risks presented by two categories of hazardous chemicals documented in return water, or flowback. The purpose of Appendix 22 is to prescribe conditions for the disposal of Marcellus Shale flowback by modifying SPDES permits and processing flowback in Publicly Owned Treatment Works (POTW), i.e., in conventional sewage treatment plants. The disposal of flowback through POTWs should be prohibited. The reason is that flowback is very likely to contain toxic and radioactive chemicals that may go undetected. If detected, the large quantities of toxic or radioactive chemicals are likely to overwhelm the capacity of POTWs to remove them effectively.

Two examples illustrate the risks that would be involved in modifying SPDES permits to allow POTWs to accept return water. In the first example, 4-nitroquinoline-1-oxide (4-NQO) was documented in 24 out of 24 samples of return water at a maximum concentration of 48,336 mg/L (dSGEIS Tables 5-9 and 6-2). Note that it seems likely there is a typographical error, and the correct units are probably ug/L, not mg/L, because the solubility of 4-NQO in water is known to be less than 1,000 mg/L. Nevertheless, even at concentrations that are 1,000 times lower than those stated in the dSGEIS, the presence of 4-NQO makes return water toxic. 4-NQO is listed as a hazardous chemical in NYSDEC regulations, Chapter IV, Subchapter B, Part 371, Identification and Listing of Hazardous Wastes, Appendix 23 (http://www.dec.ny.gov/regs/14899.html) (accessed 12/26/09). The 50% lethal dose of 4-NQO is 12 mg/kg (subcutaneous, rat) (http://msds.chem.ox.ac.uk/NI/4-nitroquinoline-N-oxide.html) (accessed 12/26/09). 4-NQO is also a known carcinogen. While I have been unable to find a formal risk assessment for 4-NQO, a related chemical, quinoline, is listed in the U.S. EPA's Integrated Risk Information System (IRIS) as posing a cancer risk of 1 in 10,000 at a concentration of 1 ug/L in drinking water (http://www.epa.gov/NCEA/iris/subst/1004.htm#carc) (accessed 12/26/09).

If flowback containing 48,336 ug/L 4-NQO were accepted for processing at a sewage treatment plant, there would be two predictable consequences. First, a large percentage if not all of the bacteria that the plant depends on to digest sewage would likely be killed. Second, the effluent from the plant would be carcinogenic. The degree of carcinogenicity would depend on how much the flowback was diluted in the plant; the dilution factor would depend, in turn, on the percentage of flowback relative to the total volume of liquid processed by the plant. If the volume of return water equaled 1% of the total volume of liquid, then the cancer potency of the effluent would be approximately 1 in 10,000 divided by (48,336/100) or 1 in 21. In other words, the risk of cancer from drinking the effluent would be roughly 5%. The effluent from the sewage treatment plant would need to be diluted by an additional factor of 500 by the receiving water in order to lower the cancer risk to roughly 1 in 10,000 (1 in ten thousand). The effluent would probably have a greater impact on the ecosystem of the receiving water than on human health. Please note that 4-NQO is not listed as a hydrofracturing chemical in dSGEIS Table 5-6. Therefore, it is probably generated as a result of chemical and/or biotransformation reactions that take place in the flowback itself (see below).

Release of gross alpha radioactivity to receiving waters is the second example of an unacceptable risk that would result from processing flowback in POTWs. Public health is protected by limiting the concentrations of radionuclides that may be legally discharged to water and air. Concentration limits for all radionuclides are listed in existing NYSDEC regulations, Chapter IV, Subchapter C, Section 380-11.7, Tables of Concentrations (http://www.dec.ny.gov/docs/administration_pdf/380table.pdf) (accessed 12/26/09). For example, the concentration of Radium-226 in the effluent of sewage treatment plants is limited to 6×10^{-8} uCi/ml, or 60 pCi/L. The concentration of Radon-222 with daughters present (i.e., when it is likely that a mixture of radon and its decay products is present, as would be the case with return water) is limited to 1×10^{-10} uCi/ml, or 0.1 pCi/L.

dSGEIS Appendix 13 reports radionuclide analyses of flowback samples from 13 wells drilled in the Marcellus Shale formation in New York The highest concentration of gross alpha particle radioactivity was 123,000 pCi/L, and the highest Radium-226 concentration was 16,030 pCi/L. The return water from this well (Webster T1 in Schuyler County) would need to be diluted by a factor of 267 (16,030/60) in order to meet the concentration requirements for discharge of Radium-226 by a POTW. In other words, the return water could comprise no more than 0.37% of the total volume of waste processed by the POTW. If a POTW processed 10 million gallons of waste per day, it could accept no more than 37,000 gallons of return water containing 16,030 pCi/L of radium-226.

dSGEIS Appendix 13 reports higher gross alpha radioactivity than alpha radioactivity from Radium-226 in 12 out of 13 Marcellus Shale wells in NewYork. In other words, Radium-226 accounted for only part of the total alpha radioactivity in flowback ("return water"). The concentrations of other radioactive materials such as uranium were much lower than Radium-226. In the case of the Webster T1 well, alpha radioactivity that was not accounted for by Radium-226 and other alpha emitters was about 106,000 pCi/L.

There are at least two possible sources of the unidentified alpha radiation: a) It is due to a radioactive metal which was not included in the analyses reported in Appendix 13; or b) It was due to the gas Radon-222 dissolved in water. Assuming the source was dissolved Radon-222 and applying the limit of 0.1 pCi/L in Section 380-11.7, Table 2, the return water from Webster T1 would need to be diluted by a factor of 1,060,000 (1 million and 60 thousand) (106,000/0.1) before it could be discharged to a receiving water. In other words, if a POTW processed 10 million gallons of waste per day, it could accept no more than about 10 gallons of return water a day from Webster T1, assuming the unidentified alpha radiation was due to Radon-222.

A final concern is that if the unidentified alpha radiation reported in dSGEIS Appendix 13 were due wholly or partially to Radon-222, the health risks to gas industry workers and POTW staff would be considerable. Dissolved Radon-222 would be predicted to volatilize, and the pathway of exposure would be inhalation of air in the vicinity of return water. Due to the potential increased risk of lung cancer from exposure to Radon-222, the sources of the unidentified alpha radioactivity reported by dSGEIS Appendix 13 in return water from Marcellus Shale wells should be determined.

Appendix 22 (cont'd): The following comments are intended to illustrate the inadequacy of Appendix 22 as a basis for characterizing flowback ("return water") for pre-treatment and processing by POTWs and to strengthen the argument that POTWs should be prohibited from accepting flowback.

a) The term "Hydrofracturing Chemical (HFC)" refers to a commercial product that contains a mixture of chemicals, not to individual chemical additives. To reflect that fact, the title of Appendix 22 would need to be changed to "Hydrofracturing Chemical Product Mixture (HFCPM)."
b) Item 9, HFC Composition: A column would need to be added stating whether the ingredient is or is not one of the approximately 450 chemicals listed as a Hazardous Constituent in NYSDEC regulations, Chapter IV, Subchapter B, Part 371, Identification and Listing of Hazardous Wastes, Appendix 23 (http://www.dec.ny.gov/regs/14899.html).
c) Item 9, HFC Composition: A column would need to be added stating whether an HFC ingredient is known to be bioaccumulative. At least two references should be provided from the toxicological literature. If no information is available on bioaccumulativeness, the applicant should be required to determine the bioconcentration factor (BCF) for each HFC ingredient in at least two species of aquatic organisms.
d) Item 10, HFC Toxicity Info: Values for LC50, EC50, Chronic NOEC and Chronic LOEC would need to be determined and reported for the HFC product mixture as a whole in addition to reporting toxicity values for individual chemical ingredients in the HFC product mixture. The reason is that the toxicities of individual ingredients may not reflect the toxicity of the HFC product mixture as a whole. To clarify that toxicity results apply to the HFC product mixture as a whole, toxicity values for the HFC product mixture should be reported in terms of the dilution factor of the product mixture, e.g., 10x (10% HFC), 33x (3% HFC), 100x (1% HFC), etc., as well as in concentration units of mg/L.
e) Item 16, Return Water Toxicity: Return water can be expected to contain, in addition to the ingredients of the original HFC product mixture: Chemicals leached from the shale, new chemicals that may be formed by spontaneous chemical reactions among the many chemical constituents in return water, and new chemicals that may be formed as a result of the biotransformation of chemical constituents by microbial organisms in flowback. To clarify that toxicity results apply to flowback as a whole and not to any one individual constituent, toxicity values should be reported in

terms of the dilution factor of the flowback, e.g., 10x (10% HFC), 100x (1% HFC), 1,000x (0.1%), etc., as well as in concentration units of mg/L.

f) Item 16, Return Water Toxicity: Instructions for completing Items 10 and 16 state: "In general, submissions which do not include any toxicity information will not be authorized. Submissions containing incomplete toxicity information will be reviewed using conservative safety factors that may prevent authorization or result in the permit being modified to include routine whole effluent toxicity testing or other monitoring." Submissions containing partial toxicity information for return water should be rejected without exception. The application of conservative safety factors cannot replace actual toxicity testing, because the toxicities of individual chemical constituents in return water are unknown, and their combined toxicity is also unknown. Application of conservative safety factors would amount to making poorly informed "guesstimates" of return water toxicity. The use of routine whole effluent toxicity testing is also an inadequate strategy for protecting the receiving water. "Routine" generally means monthly, quarterly or annually. Moreover, effluent toxicity testing is not random, rather, POTW operators are generally free to choose the time at which effluent testing is performed. Thus, while it is believed that POTW operators would never falsify results, they nevertheless have an opportunity to bias results by testing non-randomly at times when toxicity may be lower than at other times. Even assuming whole effluent toxicity testing were conducted randomly, toxic effluent could go undetected between routine tests, because the composition of flowback is known to vary from well to well and within each well. The phrase "or other monitoring" should be eliminated from the instructions for item 16, because it opens the door for *ad hoc*, make-shift monitoring criteria that are even less protective than the application of "conservative safety factors" or "routine whole effluent toxicity testing."

g) Item 17, Return Water Analysis: The federal Clean Water Act prohibits POTWs from accepting waste that will result in interference with the sewage treatment process, in the pass through of toxic chemicals and their discharge to the receiving water, or in contamination of sewage sludge that prevents its use or disposal (http://www.dec.ny.gov/chemical/8728.html) (accessed 12/26/09). To prevent interference, pass through, and sludge contamination, POTW operators are required to screen waste for the 126 chemicals on the EPA's Priority Pollutants list (http://www.epa.gov/waterscience/methods/pollutants.htm). The quantities of waste a POTW can accept are determined in a so-called headworks analysis, which is based squarely on the results of the Priority Pollutant screen. The higher the concentrations of Priority Pollutants, the smaller the quantities of waste a POTW can accept.

As a tool for screening flowback from gas wells, the Priority Pollutant list should be discarded as antiquated and insufficient and replaced with a more extensive and relevant set of chemical analyses. The new chemical screen for flowback should include any and all of the 259 hydraulic fracturing fluid additives listed in Table 5-6 of the dSGEIS that are known or suspected of being toxic or for which no toxicity data are available. The new screen should also include any and all of the 450 chemicals in NYSDEC regulations Section 371.1, Appendix 23, that are listed as hazardous due to their toxicity. Finally, the new screening tool for flowback toxicity should include an explicit requirement to characterize any and all chemicals that are neither hydraulic fracturing fluid additives nor New York State hazardous chemicals but that may be generated as a result of spontaneous chemical reactions or microbial metabolism of chemicals in flowback. An apparent "poster child" for the concept that new toxic chemicals can be generated in flowback is the ubiquitous presence of large quantities of the potent carcinogen 4-nitro-quinoline-1-oxide (see above and dSGEIS Tables 5-9 and 6-2). In addition to the potential for flowback to act as a "breeding ground" for new toxic chemicals, heavy metals and naturally occurring radioactive material (NORM) have been shown to leach from shale into flowback. The chemistry, radiochemistry and toxicity of flowback can be safely predicted to be varied and complex and to exceed the capacity of the Priority Pollutant list to characterize.

Item 17 proposes four chemical scans: GC/MS Volatile, GC/MS Base/Neutral, GC/MS Acid and GFAA Metals scans. Each and every one of the individual chemicals covered by these four scans and their CAS numbers should be added to item 17 in order to provide the public with a complete list of the chemicals that can be detected by the proposed pre-treatment screen. However, these four scans do not cover all of the hydrofracturing fluid additives (dSGEIS Table 5-6) nor all New York State hazardous chemicals considered to be toxic (see Part 371.1, Appendix 23). Any and all hydrofracturing fluid additives and New York State toxic chemicals not covered by these four scans should also be added to item 17. Further, Radon-222 should be added to item 17. Finally, item 17 should provide additional space for listing new chemicals that may be generated by chemical reactions and/or microbial metabolism in flowback.

2. Section 5.11.1.1, Subsurface mobility of fracturing fluids: "Any flow of fracturing fluid toward an aquifer through open fractures or an unplugged wellbore would be reversed during flowback, with any residual fluid further flushed by flow from the aquifer to the production zone as pressures decline in the reservoir during production." Over the past century, thousands of old-style vertical gas wells have been abandoned without being properly plugged. Given the extremely high pressures involved in hydraulic fracturing, these abandoned wells present a pathway for fracturing fluids to move quickly into groundwater aquifers and contaminate them. Contamination could readily occur before pressure is reduced and flowback begins. Operators should be required to document, as a condition of

their permit, the absence of unplugged wells in the entire area under which new horizontal wells will be drilled and fractured from a multi-well pad. For example, if wells will be drilled in all directions for distances of up to a mile, then operators should be required, first, to document the presence of every abandoned well in a 1-mile radius from the drill pad, and second, to certify that every abandoned well has been properly plugged; alternatively, operators should be required to certify the absence of any abandoned gas wells, plugged or unplugged. Undiscovered open fractures are a wild card in hydraulic fracturing technology. It is impossible to rule out natural vertical fractures, or a series of interconnected vertical fractures, that could act as a conduit for hydraulic fracturing fluid to move from the shale formation up into a groundwater aquifer under the high pressures that prevail during the hydraulic fracturing process. Instead of creating a perception of low risk of groundwater contamination by emphasizing flow reversal during flowback, the dSGEIS should acknowledge that the risks of groundwater contamination from open fractures and unplugged wellbores are significant, and that operators will be required to address these risks explicitly and to mitigate them in specific, enforceable ways.

3. Section 5.11.2, Flowback water handling at the wellsite: “Operators could… retain flowback water in an onsite lined pit for longer than 45 days, until the next well or well pad is ready for fracturing operations.” Flowback water is, by definition, toxic chemical waste according to existing New York State regulations (see below). As such, it should not be stored in open pits for any length of time, because open pit storage of hazardous chemical waste poses unacceptable risks to human health and the environment. Flowback should be kept in closed containers at all times.
4. Section 5.4.3, Composition of fracturing fluids. Table 5-6 lists 259 chemicals that industry has self-reported as additives in hydraulic fracturing fluid. Some additives are known to be toxic, some are known to be non-toxic, and many have not been characterized with respect to their toxicity. The self-reported list of chemical additives is fully consistent with the conclusion that flowback derived from hydraulic fracturing fluid is hazardous chemical waste.
5. Section 5.11.3, Flowback water characteristics: “The following description of flowback water characteristics was provided by URS Corporation… based on a limited number of analyses from out-of-state operations, without corresponding complete compositional information on the fracturing additives that were used at the source wells… Most fracturing fluid components are not included in standard chemical scans of flowback samples that were provided to DEC, so little information is available to document whether and at what concentrations most fracturing chemicals occur in flowback water.”

    a) The cited passage from the dSGEIS makes it clear that relatively few details are known about the chemical composition of flowback from gas wells in the Marcellus Shale in New York. To reiterate: a) Chemical analyses reported in the dSGEIS are from wells in West Virginia and Pennsylvania, not New York; b) Standard sets of chemical analyses that are used to screen wastewater cannot detect many of the chemical additives in hydraulic fracturing fluids for the simple reason that many chemical additives are not included in the standard scans; c) As noted earlier, in addition to the chemical additives that are automatically omitted from standard chemical scans, flowback may also contain new chemicals that are generated by chemical reactions among various flowback constituents or as a result of microbial metabolism.

b) Despite the extremely sketchy characterization of flowback in the dSGEIS, the data that are available show clearly that flowback exhibits characteristics of hazardous chemical waste as defined by New York State regulations (http://www.dec.ny.gov/regs/14897.html). Section 5.11.3, Table 5-9, lists the concentrations of 69 chemical constitutents in flowback from West Virginia and Pennsylvania wells. (The same list is repeated in dSGEIS Table 6-2). Of these 69 constituents, 18 are identified as hazardous chemical waste in NYSDEC regulations, Chapter IV, Subchapter B, Part 371, Identification and Listing of Hazardous Wastes, Appendix 23 (http://www.dec.ny.gov/regs/14899.html) based on their toxicity. The 18 New York State hazardous waste chemicals and their detection frequencies and maximum concentrations are shown in Comment Table A, below, for the small number of haphazardly analyzed wells in West Virginia and Pennsylvania reported in the dSGEIS:

Comment Table A

NYS Listed Hazardous Chemical reported in dSGEIS Table 5-8 and Appendix 13	Detection frequency, dSGEIS Table 5-9 and Appendix 13	Max. Concentration, dSGEIS Table 5-9 and Appendix 13
4-Nitroquinoline-1-oxide	24/24 (100%)	48,336 mg/L*
Antimony	1/29 (3%)	0.26 mg/L
Arsenic	2/29 (7%)	0.123 mg/L
Barium	34/34 (100%)	15,700 mg/L
Benzene	14/29 (48%)	1,950 ug/L
Bis(2-ethylhexyl)phthalate	2/23 (9%)	21.5 ug/L
Cadmium	5/29 (17%)	1.2 mg/L
Chromium	3/29 (10%)	5.9 mg/L
Lead	2/29 (7%)	0.46 mg/L
Naphthalene	1/26 (4%)	11.3 ug/L
Nickel	6/29 (21%)	0.137 mg/L
Phenol	1/23 (4%)	459 ug/L
Selenium	1/29 (3%)	0.058 mg/L
Silver	3/29 (10%)	6.3 mg/L
Tetrachloroethylene	1/29 (3%)	5.10 ug/L

Thallium	1/29 (3%)	0.1	mg/L
Toluene	15/29 (52%)	3,190	ug/L
Nitrobenzene	Frequency and concentration not reported		
Gross alpha particle radioactivity**	13/13 (100%)	123,000	pCi/L
Gross beta particle radioactivity**	13/13 (100%)	12,000	pCi/L

*Possible typographical error that should read ug/L not mg/L; solubility of 4-nitroquinoline-1-oxide is less than 1,000 mg/L in water.
**Radioactivity is regulated under Part 380, whereas hazardous chemicals are regulated under Part 371. For an analysis of health risks from gross alpha particle radioactivity, see comments on dSGEIS Appendix 22, above.

c) The chemical hazard of greatest concern from flowback is its toxicity. Toxicity is defined in New York State regulations paragraph 371.3 (e) Toxicity characteristic: "A solid waste exhibits the characteristic of toxicity if, using the Toxicity Characteristic Leaching Procedure… the extract from a representative sample of the waste contains any of the contaminants listed in Table 1 at a concentration equal to or greater than the respective value given in that Table. Where the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering… is considered to be the extract for the purpose of this subdivision" (http://www.dec.ny.gov/regs/14897.html#14901). In the case of flowback, the concentration of filterable solids is reported to be 0.191 percent or less (see Total Suspended Solids, dSGEIS Table 5-9). This makes flowback itself the "extract" for purposes of characterizing toxicity.

Five New York State hazardous waste chemicals: a) Are reported in dSGEIS Table 5-9 (see Comment Table A, above); and b) Exceed the toxicity characteristic concentrations listed in paragraph 371.3 (e) Table 1 (Table 1 limits shown in parentheses) (http://www.dec.ny.gov/regs/14897.html#14901): Barium, 15,700 mg/L (100 mg/L); benzene, 1,950 ug/L (500 ug/L); cadmium, 1.2 mg/L (1.0) mg/L); chromium, 5.9 mg/L (5.0 mg/L); and silver, 6.3 mg/L (5.0 mg/L). Based on the maximum concentrations of these five chemicals, flowback from Marcellus Shale wells in West Virginia and Pennsylvania is, by definition, toxic, according to NYSDEC regulations, paragraph 371.3 (e). Therefore, flowback should be classified as hazardous waste unless it is granted an exemption.

Note that 371.3 (e) Table 1 lists just 40 chemicals as a basis for defining the toxicity characteristic. These 40 chemicals are heavily weighted toward chlorinated hydrocarbons. This bias may be a consequence of the 1970s era when the Toxicity Characteristic Leaching Procedure was developed, because chlorinated solvents and pesticides were a principal focus of environmental toxicology at that time. It is clear that the list in paragraph 371.3 Table 1 is in need of updating. More of the 450 New York State hazardous chemicals in section 371, Appendix 23, need to be included, particularly endocrine disruptors, carcinogens, reproductive and developmental toxicants and environmentally persistent and bioaccumulative chemicals that have emerged in the last 30 years.

Thus, flowback has been shown to contain at least four New York State hazardous chemicals that are known to be toxic but are not used to define the toxicity characteristic of waste at the present time: 4-nitroquinoline-1-oxide, bis(2-ethylhexyl)phthalate, phenol(s) and toluene. Further, seven chemicals identified in flowback are known to be toxic but are not listed in Appendix 23: Cyanide, ethylbenzene, fluoride, iron, manganese, strontium and xylenes.

To summarize the evidence that flowback constitutes hazardous chemical waste, haphazard analyses of a small number of samples of flowback from Marcellus Shale wells in West Virginia, Pennsylvania and New York reveal the presence of toxic chemicals and radioactivity at concentrations that exceed regulatory thresholds by significant factors, in some cases up to several thousand-fold. Given the limited state of current knowledge about the chemical composition of flowback, it is likely that this is just the tip of the toxic iceberg. More comprehensive analyses are virtually assured of identifying additional toxic chemicals in flowback.

d) To facilitate flowback analyses by third parties, gas companies should be required to disclose the chemical identities and CAS numbers of the additives in each batch of hydraulic fracturing fluid. This will also make it possible to perform mass balance calculations to estimate how much of each chemical additive is recovered in the flowback from each well, how much may be consumed in chemical and biotransformation reactions, and which new reaction products are generated in various hydrofracturing mixtures.

e) Even with the limited evidence at hand, it is clear, without any further testing, that flowback qualifies as hazardous chemical waste based on the toxicity characteristic alone. In addition to listed toxic chemicals at excessive concentrations, flowback also contains radioactive material, particularly alpha emitters, at concentrations hundreds to thousands of times greater than are regulated by NYSDEC as safe.

f) The huge quantities of flowback represent a third criterion, in addition to toxicity and radioactivity, for classifying flowback as hazardous waste. Indeed, paragraph 371.2 (b) Criteria for listing hazardous waste, refers specifically, in subparagraph (‘h’), to “the quantities of the waste generated at individual generation sites or on a regional or national basis” as one criterion for listing waste as hazardous (http://www.dec.ny.gov/regs/14897.html#14902). To summarize, flowback qualifies as hazardous waste under NYSDEC regulations because of its toxicity, its radioactivity and the quantities in which it is produced.

g) While flowback qualifies as hazardous waste on a scientific basis, is it exempted? Section 371.1 (e) (2) Solid wastes which are not hazardous wastes, describes specific types of waste which are exempted from regulation as hazardous waste. The general purpose of the exemptions is to refrain from interfering unnecessarily with industrial activities, provided the volume of hazardous waste is relatively small and that it can be managed within a given industrial process in such a way as effectively to negate release to the environment. The exemptions balance society’s concern for human health and the environment, on the one hand, against society’s need to encourage entrepreneurship, business and industry, on the other.

The exemptions are not absolute, however. The Commissioner of the NYSDEC is authorized, under Section 371.2 (b) 2, to "list classes or types of solid wastes as hazardous wastes if the commissioner has reason to believe that individual wastes, within the class or type of waste, typically or frequently are hazardous under the definition of hazardous waste found in Article 27, Title 9 of the Environmental Conservation Law." In other words, the Commissioner of the NYSDEC has the responsibility, under existing law, to classify waste as hazardous waste if the classification becomes warranted on the basis of available evidence.

h) Paragraph 371.1 (e) (2) (v) exempts "drilling fluids, produced waters, and other wastes associated with the exploration, development, or production of crude oil, natural gas or geothermal energy" from classification as hazardous waste. On its face, this paragraph seems to exclude flowback water because it is a "waste associated with the… production of natural gas." Upon reflection, however, it is readily apparent that the exemption was not intended to apply to the vast quantities of flowback water generated by the hydraulic fracturing of horizontal wells, for several reasons:

- First, this exemption was created before the advent of horizontal drilling and high-volume hydraulic fracturing of shale formations. Given when it was written, its intent could only have been to exempt wastes associated with old-style vertical wells. According to the 1992 GEIS, old-style vertical wells require about 50,000 gallons of hydraulic fracturing fluid, and the toxicity of flowback is primarily due to two chemical characteristics: High concentrations of total dissolved solids (TDS) (i.e., brine) and high biological oxygen demand (BOD). Neither of these constituents is listed by New York State as hazardous waste, and so it is not clear why the State decided that gas well production wastes needed to be exempted. Possibly the toxicity of brine to vegetation, the toxicity of BOD to streams, the probable presence of other toxic chemicals (e.g., fracturing fluid additives, metals leached into flowback water) combined with the practice of on-site storage in open pits led regulators to view flowback from conventional vertical gas wells as waste that might be classified as hazardous and that therefore should be explicitly exempted. Indeed, the exemption in paragraph 371.1 (e) (2) (v) is not altogether unreasonable, because the volumes of flowback from old-style vertical gas wells are relatively small, and consequently the risk to the environment could be considered manageable, assuming adequate resources.
- The exemption was also created prior to the federal Energy Policy Act of 2005. This Act currently shields the oil and gas industry from major provisions of the Safe Drinking Water Act, the Clean Water Act, the Clean Air Act, the Comprehensive Environmental Response, Compensation and Liability Act (Superfund) and other federal environmental laws -- laws which, prior to 2005, New York State could count on to provide an additional level of federal protection from flowback in the event the exemption granted in 371.1 (e) (2) (v) was abused. As a result of the Energy Policy Act of 2005, many federal protections from gas well wastes no longer exist. The absence of federal protections places a greater responsibility on NewYork State to address risks from flowback.

- In summary, the exemption in paragraph 371.1 (e) (2) (v) is reasonable in the context of the conventional gas well technology and the safety net of federal environmental laws within which the exemption was created some three decades ago. However, it is not now reasonable to apply the old exemption to the new gas well technology. The old exemption no longer applies because of the greatly increased toxicity, radioactivity and volume of flowback. Due to exemptions granted to the oil and gas industry in the federal Energy Policy Act of 2005, the Commissioner of the New York State Department of Environmental Conservation as well as his counterparts in other states now have increased responsibility to classify waste as hazardous and to ensure it is regulated accordingly.

6) Section 7.1.4, Ground water impacts associated with well drilling and construction: There should be a discussion of the relationship between groundwater contamination and surface water contamination and the need to monitor surface water quality as well as groundwater quality for possible impacts from gas wells. Under base flow conditions, water in streams and lakes comes mostly from groundwater due to the earth’s hydrologic cycle. Because surface water is derived mainly from groundwater, contamination of groundwater inevitably leads to contamination of streams and lakes. The groundwater entering streams may be augmented by surface runoff following rainfall and snowmelt, and surface runoff can impact water quality by loading pollutants into streams and lakes. However, groundwater also has a decisive impact on surface water quality.

7) Section 7.1.4.1, Private water well testing: Gas companies should be required to sample and test all private drinking water wells and all surface water bodies such as streams, ponds and lakes for as far as horizontal well holes extend out from a multi-well drill pad. Depending on how individual wells are drilled from a multi-well pad, gas companies should be responsible for monitoring groundwater and surface water quality for a mile or more in all directions.

   The testing both of private water supplies and of water in streams, ponds and lakes should be directed at obtaining a “chemical signature” of contamination from gas well activities. As a practical matter, a “chemical signature” should: a) Be cost-effective and affordable, particularly for homeowners who may not qualify to have their testing paid by gas companies; and b) Be directed at detecting elevated concentrations of one or more substances that are found in high concentrations and at high frequencies in flowback. The reason for focusing on flowback is that flowback is the waste that is produced in the largest quantities by the new gas well technology and that therefore presents the greatest overall risk of contamination. While information is currently limited on the composition of flowback, enough is known to design an affordable “chemical signature” with a high probability of detecting contamination. The signature chemicals can be modified as appropriate as more information becomes available on flowback composition. Based on dSGEIS Table 5-9 (repeated in Table 6-2) and Appendix 13, an affordable “chemical signature” might contain the following ELAP-certifiable analytes: Methane, pH, alkalinity, color, uv absorbance, total dissolved solids, chloride, conductivity, ammonia-nitrogen, chemical oxygen demand, turbidity, total suspended solids, total hardness, barium, strontium, bromide, potassium, gross alpha radioactivity, and gross beta radioactivity.

Section 7.1.4.1 (cont'd), Schedule: It should be stated clearly that water quality varies little over time, and that baseline testing can be performed five years or more in advance of drilling. Sampling and analysis every three months while wells are being drilled and fractured at a multi-well pad seems reasonable. However, if sampling and analysis are discontinued one year after completion of the last well on a multi-well pad, contamination of groundwater and/or surface water that may occur later in the life of a gas well (20 to 50 years) will go undetected. Sampling and analysis should be repeated at least every two years for the life of the gas well or every time hydraulic fracturing is repeated on one of the wells on a multi-well pad, whichever comes first. Biannual sampling and analysis should be continued for ten years after the well is abandoned and plugged.

Section 7.1.4.1 (cont'd), Parameters: Table 7.3 – NYSDOW Water Well Testing Recommendations: This table should be eliminated, because many if not most of the parameters of interest in a newly drilled well are irrelevant to a "chemical signature" of gas well contamination, specifically coliform bacteria, lead, nitrate, nitrite, iron, manganese, and iron plus manganese. Their lack of relevance is indicated by the composition of flowback samples reported in dSGEIS Tables 5-9 and 6-2. Most of the additional parameters identified on dSGEIS page 7-41 are consistent with flowback composition reported in Tables 5-9 and 6-2 and Appendix 13; however, the following parameters on the list do not correspond to ELAP-certifiable tests and should be eliminated: Static water level, carbonates, and bicarbonates.

Instead of a list of parameters that might be tested for, the dSGEIS should provide a list of parameters that gas companies are required to test for. If a specific set of tests is not mandated, then each gas company is free to negotiate a different set of tests with each landowner. The potential result is a hodge-podge of baseline water quality data with diverse "chemical signatures" that may not be sufficiently clear to detect contamination and protect the landowner.

Section 7.1.4.1 (cont'd), Complaints: It is unfair to place the burden of detecting gas well contamination on the individual landowner. The NYSDEC should assume full responsibility for detecting and addressing contamination by: a) Requiring gas companies to test for a specific set of analytes as a "chemical signature" of contamination due to gas well activities (see above) and reporting test results directly to NYSDEC while providing copies of test results to the landowner and the County Health Department; and b) Specifying the limits of normal variability of each signature analyte in groundwater and surface water. The limits of variability can be estimated from regional water quality monitoring data collected over the past 30 years under section 305(b) of the federal Clean

Water Act. Depending on the uncertainty of the estimates, it may be reasonable to add a safety factor. If one or more of the analytes exceeds its estimated limit of natural variability (or its estimated limit plus a safety factor), it should automatically trigger the following actions by the NYSDEC: A shutdown of the gas well, provision of the landowner with bottled water for household use, and an investigation into the cause of the elevated analyte concentration(s). If the investigation confirms that the drinking water supply and/or a surface water body is contaminated due to gas well activities, NYSDEC should require the gas company to do the following: a) Disclose the exact chemical composition of the hydraulic fracturing fluid used on the well; b) Disclose the exact chemical composition of flowback from the well; c) Test the landowner's drinking water and/or surface water body for the presence of each and every chemical in hydraulic fracturing fluid and flowback that was not tested as part of the initial "chemical signature" of contamination; d) Perform a detailed human health risk assessment and a detailed ecological risk assessment for submission, respectively, to NYSDOH and NYSDEC; and e) Pay for all measures to mitigate the risks and attain the goals described in the human health risk assessment and the ecological risk assessment.

Thank you for considering these comments.

Sincerely,

Stephen M. Penningroth