**Fact Sheet on Fracking Waste**

**1. What is fracking?**

 The term “fracking” is a nickname for hydraulic fracturing. The process of hydraulic fracturing is injecting large volumes of various mixtures of water, sand, and chemicals deep underground at extreme pressures to create fractures in rock formations that hold bubbles of gas or oil. As commonly practiced, a well is drilled about a mile into the rock, and then a tunnel is drilled horizontally for thousands of feet perpendicular to the well. Hundreds of thousands of gallons of water, tons of sand, and thousands of gallons of chemicals are injected at high pressure to open tiny fissures in the rock so that gas or oil can flow to the surface.

 A typical fracking well for gas will use two million to eight million gallons of water in repeated injections over the seven and one-half year lifetime of a well. About six percent of this total is a mix of chemicals to act as lubricants, lower the viscosity of the water, and other purposes. Oil and gas companies are allowed to keep the names of most of these chemicals secret as proprietary information, but some of them are known to be carcinogens including benzene

**2. What is fracking waste?**

 After the well operator has injected the fracking fluid, the pressure is released, and about ten to forty percent of the water that is injected returns to surface mixed with natural gas and contaminants from the ground. (The rest of this article will only be concerned with fracking for gas.) The water that returns immediately after injection is called “flowback”.

 During the period between injections when the gas is being extracted, water also returns to the surface. This water is called “produced water”, “formation water”, or “fracking brine”. Of course, most of the toxic mixture of chemicals that were injected returns. The contaminants from the ground contain heavy metals, arsenic, mercury, corrosive salts, and radioactive elements of uranium, thorium, radium, radon, polonium, and lead. The drilling and extraction process also produces tons of semi-solid waste in the form of sludge, drilling muds, and cuttings.

 Over 64% of the natural gas in the United States is produced by fracking in the Marcellus Shale in Pennsylvania. In 2014, the flowback water from the Marcellus Shale wells was over one billion gallons.a The flowback and produced water from the Marcellus Shale is the second saltiestb and most radioactivec of all the states where fracking occurs. Disposing of this much water contaminated with carcinogens and radioactive materials are a huge problem for the oil and gas companies.

a. Lutz, B.D, Lewis, A.N., and Doyle, M.W., “Generation, transport, and disposal of wastewater associated with Marcellus Shale gas development,” *Water Resourc. Res.* **49**, 647-656 (2013).

b. US DOE, “Cost-Effective Recovery of Low-TDS Frac Flowback Water for Re-use” (U.S. Department of Energy, www.netl.doe.gov, 2011).

c. E. L. Rowan, M. A. Engle, C. S. Kirby, T. F. Kraemer, “Radium content of oil- and gas-field produced waters in the Northern Appalachian Basin (USA): Summary and discussion of data” (U.S. Geological Survey, Scientific Investigation Report 2011-5135, 2011).

**3. What happens to flowback water and produced water?**

 Three methods are used for disposing of the contaminated water: Reuse for fracking, injection into dry wells, and returning it to the surrounding environment. In Pennsylvania, the Department of Environmental Protection (DEP) ruled that dumping the contaminated water into streams and rivers would be safe because the amount of fresh water in the stream or river would dilute the contaminants to safe levels. This was a very cheap method for disposal. After a few years of this disposal, scientific studies showed that waters surrounding the dumping sites were becoming highly contaminated. The Pennsylvania DEP then decided that the contaminated water could be treated at sewage treatment plants before being discharged into rivers. This increased the cost of disposal, but it was still relatively inexpensive. However, further scientific studies revealed that even after treatment, the amount of salts, especially bromides, in the rivers had increased beyond the point that the water was safe to use.a, b Another scientific study found radium contamination 200 times background downstream of a treatment plant in Pennsylvania.c The DEP then introduced discharge limits that eliminated the disposal of Marcellus Shale waste water in sewage treatment plants.

 The oil and gas companies turned to two other methods for disposing of the waste water. First, they began recycling the flow back water for use in further fracking. This requires treating the flowback water to remove some of the contaminants and mixing it with fresh water. This method is more expensive than the other two methods. Supposedly 75% of the flowback water is now being reused for fracking in Pennsylvania. However, the produced water is too contaminated to be reused.

 The second method was to send the rest of the flowback water and the produced water to other states, primarily Ohio, for injection into dry wells. A magnitude 4.0 earthquake on December 31, 2011 near Youngstown, PA appears to have been caused by injection of waste water into a deep well.d Earthquakes have also been linked to the injection of waste water into deep wells in Texas, Oklahoma, Colorado, and Arkansas.e, f Because of the public’s concerns about huge quantity of small earthquakes close to injection wells, states have either banned or put strict controls on injecting waste water into dry wells.

a. K. J. Ferrar et al., Environmental Science & Technology, dx.doi.org/10.1021/es301411q (2013).

b. D. J. Rozell, S. J. Reaven, “Water pollution risk associated with natural gas extraction from the Marcellus Shale,” *Risk Anal*. **32**, 1382 (2012). doi: 10.1111/j.1539-6924.2011.01757.x; pmid: 22211399.

c. Warner, N. R.; Christie, C. A.; Jackson, R. B.; Vengosh, A, “Impacts of Shale Gas Wastewater Disposal on Water Quality in Western Pennsylvania,” *Environ. Sci. Technol*. **47** (20), 11849−11857 (2013).

d. W.-Y. Kim, “Induced seismicity associated with fluid injection into a deep well in Youngstown, Ohio,”

*J. Geophys. Res*. 10.1002/jgrb.50247 (2013).

e. W.L. Ellsworth, “Injection-Induced Earthquakes,” *Science* **341**, 1225942-1 (2013).

f. F.W. Walsh III and M.D. Zoback, “Oklahoma’s recent earthquakes and saltwater disposal,” *Science Advance* **1**, e1500195 (2015).

**4. How about other forms of fracking waste?**

 The solid forms of fracking waste are rock cuttings removed by the drilling, sludges, and muds. Currently these forms of fracking waste are disposed of in landfills. This practice is very controversial. Some attempts at trucks entering landfills for disposal have triggered radiation alarms.a Recently the Pennsylvania DEP has issued a report stating that while the cuttings, sludges, and muds have some radioactivity associated with them that the level of activity is too low to be a threat to the public.b

a. A. Litvak, “Marcellus Shale waste triggers more radioactive alarms than other products left at landfills,” Pittsburgh Post-Gazette, August 22, 2013, <http://www.post-gazette.com/marcellusshale/2013/08/22/Marcellus-Shale-waste-trips-more-radioactivity-alarms-than-other-products-left-at-landfills/stories/201308220367>.

b. Pennsylvania Department of Environmental Protection, “Technologically Enhanced Normal Occurring Radioactive Materials (TENORM) Study Report,” January 2015.

**5. Why should Connecticut be concerned about fracking waste?**

From the above paragraphs, it should be obvious that an enormous amount of fracking waste is being generated in Pennsylvania, and the cheapest methods of disposal have been eliminated. Even reusing 75% of the flowback water leaves at least 250 million gallons of flowback water to be disposed of each year. There is also another 250 million gallons of produced water to dispose of. The oil and gas companies are seeking the cheapest way to do this. If Connecticut waste companies bid low, they can get this business. However, Connecticut companies cannot seek this business until 2018. Last year the General Assembly passed a moratorium on receiving fracking waste for three years. In the meantime, the law authorizes the Commissioner of DEEP (Department of Energy and Environmental Protection) to formulate regulations under which fracking waste could be accepted. The best regulation would be an outright ban on any fracking waste coming into the state.

 Even though New York has banned fracking , its citizens are having a much harder time banning fracking waste entering the state. In 2014, 460,000 tons of fracking cuttings, sludges, and muds were dumped in their landfills, 4286 gallons of waste water was sent to their landfills for storage in barrels, and 42,546 gallons of produced water was spread on their roadsa.

 Even if the Pennsylvania DEP report is accepted at face value, it does not consider the build up of radiation that could occur if fracking solids are continuously dumped in the same landfills. The main radioactive contamination on solids is radium with a half-life of 1600 years. Radium is soluble in water and can form a leachate that could reach ground water sources. From the water it could enter into plants and animals that might be eventually eaten by us.b, c

 If safe disposal sites for fracking waste could be found, there is always the threat of improper disposal by bad actors. In 2013,two different fracking waste water haulers in Ohio were charged with illegal dumping of untreated drilling sludge and produced water into surface water.d,e Similar charges were brought against a Pennsylvania wastewater treatment facilityf. Previously, more than 1,000 incidents of illegal dumping of fracking wastewater in farmland and waterways were reported in North Dakotag. Illegal dumping is of particular concern because cows and other grazing farm animals are continually exposed to soil and water; a 2012 study found a link between illegal dumping of fracking wastewater and farm animal deaths and birth defectsh. Another fear is that contamination could migrate into the human food chain through meat and dairy products.

a. PA Unconventional Drilling Waste Disposal in NYS 2011-2014. <http://www.arcgis.com/home/item.html?id=8bd41c4a84e446269b8e4b136aa5b633>.

b. Pennsylvania Department of Environmental Protection, “Technologically Enhanced Normal Occurring Radioactive Materials (TENORM) Study Report,” January 2015.

c. E.I. White, “Consideration of Radiation in Hazardous Waste Produced from Horizontal Hydrofracking,” Grassroots Environmental Education, October 2012.

d. Ecowatch, “Feds charge man in fracking wastewater dumping case,” February 5, 2013, [www.ecowatch.com/2013/fracking-wastewater-dumping-case/](http://www.ecowatch.com/2013/fracking-wastewater-dumping-case/).

e. S. Hunt, “Hauler illegally dumped fracking waste, state says,” *The Columbus Dispatch*, June 5, 2013, [*http://www.dispatch.com/content/stories/local/2013/06/05/hauler-illegally-dumped-fracking-waste-state-says.html*](http://www.dispatch.com/content/stories/local/2013/06/05/hauler-illegally-dumped-fracking-waste-state-says.html).

f. S. Kelly, “Another Pennsylvania wastewater treatment plant accused of illegally disposing radioactive fracking waste,” DeSmogBlog.com, July18, 2013, [*www.desmogblog.com/2013/07/17/another-pennsylvaniawastewater-treatment-plant-accused-illegally-disposing-fracking-radioactive-waste*](http://www.desmogblog.com/2013/07/17/another-pennsylvaniawastewater-treatment-plant-accused-illegally-disposing-fracking-radioactive-waste)*.*

g.N. Kusnetz, “North Dakota turns blind eye to dumping of fracking waste in waterways and farmland,” *InsideClimate News.* June 8, 2012,*insideclimatenews.org/news/20120608/oil-campanies-north-dakota-boom-gas-drilling-fracking-wastewater-waterways-pollution-dumping-grounds*.

h. M. Bamberger and R.E. Oswald, “Impact of gas drilling on human and animal health,” *New Solutions* **22**, 51-77 (2012).

**6. Is there such a thing as safe disposal of fracking waste?**

 Ordinary municipal and industrial treatment plants are not equipped to remove high salinity, radioactivity, or other components of flowback or produced waste water.a,b.c, d Special facilities will be needed. To treat the flowback water and produced water waste, the steps needed are:e

1. De-oiling – removal of free and disperse oil and grease.

2. Soluble organics removal – needed to remove benzene and other chemicals added for fracking.

3. Disinfection – removal of bacteria, microorganisms, algae, etc.

4.Suspended particles removal – sand, turbidity etc.

5. Dissolved gas removal – removal of light hydrocarbon gases, carbon dioxide, hydrogen sulfide, etc.

6. Desalinization and demineralization – removal of dissolved salts, sulfates, nitrates, contaminants, scaling agents, etc.

7. Softening – removal excess water hardness.

8. Sodium Adsorption Ratio adjustment.

9. Removal of naturally occurring radioactive materials.

 Step 6 is especially important for produced water that has a high level of dissolved salts in it. Several standard desalinization methods are not adequate for the Marcellus Shale produced water. Thus this becomes a step that requires intensive treatment at a higher cost than other types of waste water. Obviously, all these steps mean that the cost of treatment will be expensive to produce clean water. There is still a problem though because the treatment leaves behind concentrated salts in solid form and concentrated radioactive material. These solids need to be disposed of. Any waste water delivered for treatment should be monitored before treatment and monitored after cleaning before being discharged or reused.

 One possibility is centralized waste treatment plants (CWT). The EPA has guidelines and standards for CWT plants.f The guidelines and standards were developed before fracking waste water became an issue. They are supposedly working on standards for CWT plants to accept fracking waste water. The Pennsylvania DEP has stringent requirements for CWT plants to receive fracking waste water since 2012. There are only a few Pennsylvania CWT plants qualified to receive the waste water. In 2012, only 6,615 gallons of fracking waste water was treated at CWT plants out of 854 million gallons of fracking waste water produced.g

 The cost of treating waste water at a CWT plant that meets Pennsylvania standards is about five times greater than injecting into dry wells which is why so little waste water is treated that way.h The bottom line is that a CWT plant with the technology to produce clean water from waste water is an expensive method. For Connecticut companies to accept waste water and be competitive, the DEEP regulations may not be stringent enough to guarantee that our water supply is safe. **The best regulation is a ban on any fracking waste being accepted for any purpose in Connecticut.**

a.B.G. Rahm and S.J. Riha,. “Toward strategic management of shale gas development: Regional, collective impacts on water resources,” *Environmental* *Science & Policy* **17**,12–23 (2011), *cce100.cornell.edu/Energy*

*ClimateChange/NaturalGasDev/Documents/PDFs/ESP%20Strategic%20*

*Management%202012.pdf*.

b. B.D Lutz, A.N. Lewis, and M.W. Doyle, “Generation, transport, and disposal of wastewater associated with Marcellus Shale gas development,” *Water Resources Research* **49**, 647–656, *http://onlinelibrary.wiley.*

*com/doi/10.1002/wrcr.20096/abstract?deniedAccessCustomisedMessage=&userIs Authenticated=false*.

c. S.M. Olmstead, L.A. Nuehlenbachs, J.S. Shih, Z. Chu, and A.J. Krupnick, “Shale gas development impacts on surface water quality in Pennsylvania.,” *Proceedings of the National Academy of Sciences* **110**, 4962–4967 (2013), doi:10.1073/pnas.1213871110, [*http://www.pnas.org/content/early/2013/03/06/1213871110.full.pdf+html*](http://www.pnas.org/content/early/2013/03/06/1213871110.full.pdf%2Bhtml)

d. K.B. Gregory, R.D. Vidic, and D.A. Dzombak, “Water management challenges associated with the production of shale gas by hydraulic fracturing,” *Elements* **7**, 181–186 (2011), Mineralogical Society of America. doi:10.2113/gselements.7.3.181, [*http://elements.geoscienceworld.org/content/7/3/181.abstract*](http://elements.geoscienceworld.org/content/7/3/181.abstract).

e. J.D. Arthur, B.G. Langus, and C. Patel, “Technical Summary of Oil and Gas Produced Water Treatment Technologies,” All Consulting LLC, Tulsa, OK, March 2005.

f. <http://water.epa.gov/scitech/wastetech/guide/cwt/#study>.

g. J. Veil, “U.S. Produced Water Volumes and Management Practices in 2012,” Veil Environmental, LLC, prepared for the Ground Water Protection Council, April 2015.

h. National Energy Technology Laboratory, “Fact Sheet – Off Site Commercial Disposal,” <http://www.netl.doe.gov/research/coal/crosscutting/pwmis/tech-desc/offsite>.