Grassroots Environmental Education

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Delaware River Basin Commission
P.O. Box 7360
25 State Police Drive East
West Trenton, New Jersey 08628-0360

Re: Comments to the Delaware River Basin Commission on the Draft Regulations Addressing Hydraulic Fracturing.

Thank you for the opportunity to comment on the Draft Regulations on Hydraulic Fracturing.

Grassroots Environmental Education is a science based environmental health nonprofit providing public education on environmental health issues and practical solutions for local and state governments, health care providers, school systems, environmental and health organizations nationwide. Grassroots works directly with a network of leading medical and scientific experts in the field of environmental health to bridge the gap between emerging science and public understanding through evidence-based tools and educational programs.

Grassroots Environmental Education strongly urges the Delaware River Basin Commission to ban the drilling, extraction and production of fossil fuels in the Basin and all other activities associated with hydraulic fracturing including water withdrawals and the acceptance, disposal, application, handling and treatment of waste from oil and gas drilling extraction, production, storage, and waste management operations. The Commission's most fundamental responsibility is to provide robust protection of the Basin, the precious drinking water supply for nearly seventeen million residents.

We strongly support the Commission's determination to prohibit drilling in the Basin. The assessment by the NYS DOH served as the basis for the New York State Department of Environmental Conservation (NYS DEC) to conclude that HVHF entailed significant adverse public health and environmental impacts. The growing body of peer-reviewed studies continues to demonstrate adverse public health impacts and degradation of natural resources. The ban on HVHF in New York State was based on recommendations by the DEC and the DOH, informed by extensive health and scientific reviews conducted by both the NYS DEC and DOH. This decision placed particular emphasis on the right and responsibility of the Executive along with state agencies to first and foremost safeguard public health and safety.

It is well understood that "HVHF activities", as the term was used in the NYS DOH Health Review, refers to the entire complex lifecycle of shale gas development, production and distribution which includes, clearance and preparation of the well pad, drilling, shattering the shale to extract the gas or oil, extraction, drilling waste management, and distribution of the oil or gas via pipelines, compressor stations, and other infrastructure components. In his opening remarks regarding the State's decision to prohibit HVHF, Commissioner Zucker stated, "The public health impacts from HVHF activities could be significantly broader than just those geographic locations where the activity actually occurs, thus expanding the potential risk to a large population of New Yorkers." [1]

[1] http://www.health.ny.gov/press/reports/docs/high_volume_hydraulic_fracturing.pdf

Indeed, the 2016 review [2] by Physicians, Scientists and Engineers for Healthy Energy of the peer reviewed science of the potential impacts of unconventional natural gas development (UNGD) on public health, air and water quality revealed that the science has grown significantly in recent years. Of more than 685 peer-reviewed scientific studies that are relevant to assessing the impacts of fracking and its related activities. 84% of public health studies contain findings that indicate public health hazards, elevated risks, or adverse health outcomes; 69% of water quality studies contain findings that indicate potential association with or actual incidence of water contamination; and 87% of air quality studies contain findings that indicate elevated levels of air pollutants and/or atmospheric concentrations. Overall, the weight of the findings in the scientific literature demonstrates hazards and elevated risks to human health as well as possible adverse health outcomes associated with hydraulic fracturing and related activities.

Furthermore, The Compendium of Scientific, Medical and Media Findings Demonstrating Risks and Harms of Fracking [3] compiled by Concerned Health Professionals of New York and Physicians for Social Responsibility, now in its fifth edition, reveals the links between HVHF and related activities and adverse public health impacts as well as significant air and water pollution.

Interestingly, by its own admission, the Commission states that "withdrawals from surface and ground waters in the amounts required for HVHF may adversely affect aquatic ecosystems, river channel, and riparian resources downstream, including wetlands, and may diminish the quantity of water stored in an aquifer or a stream's capacity to assimilate pollutants…HVHF operations may significantly increase the volume of water withdrawn in a localized area, they may ultimately upset the balance between the demand on water resources and the availability of those resources for uses protected by the Commission's comprehensive plan, particularly during periods of low precipitation or drought."

Severe droughts in the west and southwest forewarn of more extreme and frequent events consistent with climate change. Stringent protections, conservation and planning are imperative to maintain precious water resources and its infrastructure essential to meeting the needs of the communities that are served by the Delaware River Basin.

Water withdrawals for HVHF can impact groundwater supplies and could negatively impact groundwater feeds to local wetlands, wells, agriculture and other critical needs in the watershed. Water withdrawals for fracking are known to permanently remove water from the supply and hydrologic cycle. The millions of gallons of water used per fracking well would result in intensive diminishment of water supplies for vast populations. The risks associated with water withdrawal and potential contamination from fracking waste disposal in the Basin could have significant economic implications.

Fracking waste and its constituents should be prohibited from the Delaware River Basin and should be classified as hazardous waste as it exceeds criteria. Although the Commission discourages importation of fracking waste in the Basin, it outlines requirements for approval to grant permits for its treatment. Processing, handling, disposal, storage or application of fracking waste in the Basin poses serious risks to the watershed and health risks to the millions of residents who rely on the Basin's water resources. There is simply no safe plan for handling fracking waste in any of its forms.

Radioactive materials including Radium and its decay product, Radon, are known to be significantly higher in the Marcellus Shale and are well documented by the USGS. [4] Radium, Radon and other decay products are an integral part of the entire life cycle of hydraulic fracturing from extraction, production, treatment, storage, waste management, and its infrastructure to end users.

Hydraulic fracturing is a technology used for oil and gas extraction from shale formations involving the

[2] https://www.psehealthyenergy.org/wp-content/uploads/2017/04/Literature-Review-2009-2015.pdf
[3] http://concernedhealthny.org/wp-content/uploads/2018/03/Fracking_Science_Compendium_5FINAL.pdf
[4] Radium Content of Oil and Gas Field Produced Waters in the Northern Appalachian Basin, Rowan, E., Engle, M. USGS 2011-1135

injection of millions of gallons of fresh water mixed with hundreds of chemicals and sand forced under high pressure into the well bores to crack open the shale. The fissures created by the fracturing of the shale are held open by the sand particles so that oil or gas can be released. The extraction process produces two types of wastewater. Flowback water is chemically treated fracking fluid that returns to the surface following shortly after a fracking operation. Produced water or fracking brine is the fluid that comes out of the shale formation along with the oil or gas and contains high levels of chlorides and bromides as well as toxic heavy metals. Produced water and semi-solids including drill cuttings, sludge and drilling muds, can contain high levels of Radium-226 and Radium-228, which are water soluble.

As much as forty percent of this highly toxic chemical mixture is returned to the surface with the oil or gas and naturally occurring radioactive materials, including volatile organic compounds, heavy metals and radioactive elements including Radium-226 and Radium-228 and its decay product, Radon, a known carcinogen. Radon is the leading cause of lung cancer in non-smokers with no safe level of exposure. Radium-226 has a half-life of 1600 years and is linked to anemia, cataracts, bone, liver and breast cancers and death.[5] It also emits gamma radiation that can travel fairly long distances through air, raising risks for cancer in communities.

Radon is an odorless, tasteless and colorless gas formed by the radioactive decay of Radium, Uranium and Thorium and has a half-life of 3.8 days. Polonium and Lead, the decay products of Radon, have a half-life of 138 days and 22.3 years respectively and are solids known to attach to dust particles. Lead is a neurotoxin with no safe threshold level of exposure and is linked with cognitive deficits and attention deficit/hyperactivity disorder in children and low birth weight. It is also linked to elevated blood pressure in adults and is an important risk factor for renal failure. [6] U.S. EPA classifies Lead as a probable human carcinogen while Polonium is considered a radioactive carcinogen. Radon absorbed by the lungs decays further into Polonium and Lead damaging lung tissue. Lead and Polonium can also damage DNA and RNA. [7] The exposure pathway of all three of these radioactive materials is through inhalation, ingestion and absorption.

In its own report, the Pennsylvania Department of Environmental Protection (DEP) refers to these waste byproducts as TENORM and indicates significant radioactivity levels in waste associated with gas development and production exceeding EPA's maximum contaminant levels by more than several thousand times. The report indicates Radium-226 levels in flowback samples were measured between 551 pCi/L and 25,5000 pCi/L while Radium-228 levels were measured between 248 pCi/L and 1,740pCi/L. Radium-226 levels in produced water or brine samples were measured between 40 pCi/L and 26,600 pCi/L while Radium-228 concentrations were measured between 26 pCi/L and 1,900 pCi/L. [8]

Recent experts' analyses of leachate from the Hakes landfill in upstate New York reveals very high levels of radionuclides resulting from Radium decay, known to be present in drill cuttings from the Marcellus Shale. [9] [10] [11] Radon continues its decay process emitting Polonium 210 and Lead 210, which are easily mobilized in the environment and bio-accumulate in plants and animals.

In the analysis, the operating requirements and radioactive detection plan incorporating a fixed radiation detection device at a monitoring location for all incoming waste was grossly inadequate and does not ensure detection and accurate measurement of all radioactive material present in waste including alpha, beta and gamma emitters. Such a detection device fails to take into account and identify radioactive progeny, which will continue to propagate for hundreds of years to come. Synergistic effects of combinations of radionuclides

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[5] http://www.atsdr.cdc.gov/toxprofiles/
[6] Textbook of Children's Environmental Health, Edited by P. Landrigan, R. Etzel, Oxford University Press, 2014
[7] Ibid.
[8] http://www.depweb.state.pa.us/portal/server.pt/community/dep_home/5968
[9] Raymond C. Vaughan, PhD, Affidavit: http://treichlerlawoffice.com/waste/hakes/E2017-1384CV_Vaughanaff_011818.pdf
[10] Dustin M. May Affidavit: http://treichlerlawoffice.com/waste/hakes/E2017-1384CV_May_Affidavit_011718.pdf
[11] David O. Carpenter, M.D. Affidavit: http://treichlerlawoffice.com/waste/hakes/E2017-1384CV%20Carpenter%20Affidavit_011718.pdf

are not considered or addressed. Truckloads of waste with up to 60 fold variations in their Radium-226 concentrations may demonstrate the same or similar monitor readings. [12]

The Air and Particulate Items Report and Monitoring Plan also failed to address Radon emissions from the landfill surface or the gas collection system. This is a glaring gap as Radon gas is released through the stack during the venting of landfill gas and can adversely impact downwind communities. Dust particulates are also not considered and expose workers at the facility and residents in the surrounding communities.

Of major concern are high concentrations of Lead-214 and Bismuth-214 found in some of the leachate samples [13] exceeding 1000 pCi/L and as high as 6000 pCi/L. Results indicated major potential enrichment of leachate with Radon-222 gas; the half-lives of Lead-214 and Bismuth-214, are too short for these radionuclides to exist independently during the time period between collection and analysis, they would have decayed away entirely. In order for these two radionuclides to be detectable in the samples weeks after collection, they would have to be supported and exist in an equilibrium state with Radon-222 gas or Radium-226.

Hence, either Radium-226 in landfill's leachate is substantially underreported or Radon-222 in landfill's leachate is high and not recognized as such. [14] Given the high activities reported for Lead-214 and Bismuth-214 in the landfills' leachate, either the actual Radium-226 activities have ranged up to 6000 pCi/L in Hakes' leachate, or the actual Radon-222 activities have ranged up to 270,000 pCi/L in Hakes' leachate.

Dr. David Carpenter stated in his signed affidavit [15] : "Accepting radioactive fracking waste in the landfills will lead to human exposure to ionizing radiation by various routes. The greatest concern is inhalation of radon. The levels of radon in air above the leachate may potentially be as high as 1.05 million pCi/L and poses a clear hazard to anyone in the vicinity of leachate. Radon will also be released into the air over the landfill. The leachate will migrate into ground water, where radon will be transported and will appear in the drinking water of people on wells and be ingested. A major hazard will come from hot water showers, where the radon is released from the water by the heat and will fill the shower stall and be inhaled. The radon will also migrate up from the ground water in basements of homes, where it will be inhaled by occupants. When ground water is used as drinking water for those persons with wells they will be ingesting radon, radium and lower concentrations of the other less soluble radionuclides that are dissolved in the water as well particulates containing bound radionuclides coming from the fracking drill cuttings and de-watered mud."

In his conclusion, Dr. Carpenter stated,[16] "As made clear by the reports of Dr. Vaughan and Mr. May and the leachate analyses, there is a significant amount of radioactivity contained in and coming from the Hakes C&D Disposal Site as the result of the deposits of drill cuttings and de-watered mud coming from fracking sites in Pennsylvania. The net effect of New York accepting drill cuttings and de-watered mud from Pennsylvania fracking sites will be that New Yorkers will have an increased risk of cancer, especially lung and gastrointestinal cancers, and increased risk of birth defects coming from DNA damage and increased risk of a shortened life span. There is reason to believe the DEC is underestimating the amount of radioactivity deposited in and being released from the landfill. The statement made in the Memorandum of 18, September 2015 that "drilling wastes such as drill cuttings do not display elevated radioactivity above naturally occurring background levels" is simply untrue. The peer-reviewed scientific evidence available to anyone indicates that the carcinogenic material found in fracking waste poses a real hazard to human health. Any increase in exposure to ionizing radiation beyond that which is unavoidable should not be tolerated."

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[12] Raymond C. Vaughan, PhD, Affidavit: http://treichlerlawoffice.com/waste/hakes/E2017-1384CV_Vaughanaff_011818.pdf
[13] Dustin M. May Affidavit: http://treichlerlawoffice.com/waste/hakes/E2017-1384CV_May_Affidavit_011718.pdf
[14] Raymond C. Vaughan, PhD, Affidavit: http://treichlerlawoffice.com/waste/hakes/E2017-1384CV_Vaughanaff_011818.pdf
[15] David O. Carpenter, MD, Affidavit: http://treichlerlawoffice.com/waste/hakes/E2017-1384CV%20Carpenter%20Affidavit_011718.pdf
[16] Ibid.

Other relevant scientific documentation concerning hazardous chemicals and radioactivity in fracking waste and its byproducts include the report, **Consideration of Radiation in Hazardous Waste Produced from Horizontal Hydrofracking**, [17] by Ivan White, a staff scientist for the congressionally commissioned National Council on Radiation Protection charged with the protection of military and civilian populations, expressed concern regarding the cavalier attitude toward human exposure to radioactive material and stated that radioactivity should never be released into the environment in an uncontrolled manner because of the potential for exposure from the many potential pathways that exist. [18] Radioactive materials can migrate through air exposing crops and plants, soil, animals, livestock, food supplies and humans. Radioactive contaminants can also migrate through soil and surface or groundwater exposing sand and sediment, aquatic animals and plants, fish, irrigation water, vegetation, animals, livestock, food supplies and humans. He further stated that the type of radioactive material found in the Marcellus Shale formation and brought to the surface by hydrofracking is the type that has a long half-life and could easily bio-accumulate over time delivering a dangerous radiation dose to potentially millions of people long after the drilling is over. [19]

In a 2011 review of federal, state and company records, the New York Times reported that in a sampling of wells studied in Pennsylvania and West Virginia, reported levels of Radium or other radioactive elements exceeded EPA's maximum contaminant level for drinking water by 100 times to more than 1,000 times. [20]

The term NORM (Naturally Occurring Radioactive Materials) is misused when applied to radioactive material introduced into human environments by oil and gas operations and must be correctly classified as TENORM with special disposal requirements. [21] Naturally Occurring Radioactive Materials (NORM) are distributed throughout geologic formations and exist undisturbed in nature whether at the earth's surface or below the surface. However, when NORM are disturbed and transported by human activity to human environments they are considered Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) increasing potential of exposure that may result in concentration levels above background levels. [22]

The U.S. EPA defines TENORM as "Naturally Occurring Radioactive Materials (NORM) that have been concentrated or exposed to the accessible environment as a result of human activities such as manufacturing, mineral extraction, or water processing, with technologically enhanced meaning that the radiological, physical, and chemical properties of the radioactive material have been concentrated or further altered by having been processed, or beneficiated, or disturbed in a way that increases the potential for human and/or environmental exposures." [23]

In a peer-reviewed study at University of Texas and University of North Texas Health Science Center, School of Public Health, Department of Environmental and Occupational Health, [24] soil and water (sludge) obtained from reserve pits used in unconventional natural gas activities were analyzed for the presence of technologically enhanced naturally occurring radioactive material (TENORM). Samples were analyzed for total gamma, alpha, and beta radiation, and specific radionuclides. Laboratory analysis confirmed elevated beta readings. Specific radionuclides present included Thorium-232 and Radium-226 radionuclides. According to the authors, many of the radionuclides found in oil and gas drilling waste and their constituents are not addressed by regulatory guidance documents and negligible information is provided in determining potential

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[17] http://www.grassrootsinfo.org/pdf/whitereport.pdf
[18] Ibid.
[19] Ibid.
[20] NYT Drilling Down Series: http://www.nytimes.com/2011/02/27/us/27gas.html?pagewanted=1&ref=drillingdown
[21] http://www.ncbi.nlm.nih.gov/pubmed/23552651
[22] Analysis of reserve pit sludge from unconventional natural gas hydraulic fracturing and drilling operations for the presence of technologically enhanced naturally occurring radioactive material (TENORM), Rich, A. Crosby, E., 2013;23(1):117-35. https://www.ncbi.nlm.nih.gov/pubmed/23552651
[23] U.S. EPA Radiation Protection, TENORM: Oil and Gas Production Wastes https://www.epa.gov/radiation/tenorm-oil-and-gas-production-wastes

[24] Ibid.

of cumulative effects of simultaneous exposure to several radionuclides or potential human and animal health impacts. The study also indicated that the Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC) do not have established federal regulations that directly govern NORM waste from the oil and gas industry. [25]

The authors describe synergistic catalysis, a relatively new field of chemical study concerned with the ability of synthetic chemicals to spontaneously form new chemical bonds when exposed to sunlight, water, air and radionuclides or other chemical catalysts. [26] The potential health risks of resulting compounds are unknown and pose a public health threat as mixtures of hydrofracking chemicals, interaction of chemicals with radioactive materials and reaction of chemicals with other contaminants under heat and pressure cause unknown synergistic reactions. [27]

Regulators and operators may be grossly underestimating radioactivity levels in oil and gas waste by using improper methods to detect radiation. Dr. Michael Schultz and his colleagues at the University of Iowa, in their peer-reviewed study, [28] tested the accuracy of the Radium measurement technique used and recommended by the U.S. EPA for analyzing radioactivity in drinking water since studies have shown that the drinking water method is unsuitable for solutions with high radioactive concentrations characteristic of fracking waste byproducts. Several methods were used to assess Radium isotopes in a sample of gas drilling waste from the Marcellus Shale. One method, the co-precipitation technique used by the EPA recovered less than 1 % of Radium-226, the most abundant Radium isotope in the gas drilling waste byproduct sample. Another method known as gamma-ray spectroscopy, the gold standard for Radium analysis, detected 91% of the Radium. [29] The authors' findings indicated that the EPA method is ineffective for analyzing oil and gas drilling waste byproducts. Their subsequent study calls attention to the use of radium alone to predict radioactivity concentrations can greatly underestimate total radioactivity levels and that uranium and thorium decay series require scrutiny as well.[30]

The EPA's 2014 study, Development of Rapid Radiochemical Method for Gross Alpha and Gross Beta Activity Concentration in Flowback and Produced Waters from Hydraulic Fracturing Operations, further highlights the complexity of accurately measuring detection levels of alpha and beta emitters in the field and by other outdated methods. [31]

As borne out by the Hakes' leachate analysis, radiation sensors at the landfill are grossly inadequate for the detection of radiation from wastes from conventional and unconventional oil and gas activities. Landfill disposal of radioactive waste from oil and gas extraction, production and storage operations could contaminate them for thousands of years. All landfill membranes fail eventually and leaching or flooding could result in contamination of nearby ponds, streams, or groundwater.

Leachate from landfills is a frequent cause of groundwater contamination and is of particular concern from landfills that accept oil and gas wastes from conventional and unconventional oil and gas operations. Its disposal cannot be safely handled by wastewater treatment facilities or via applications on farmland or other real property. Fifty-nine scientists attested to the fact that wastewater treatment facilities are not designed to treat chemicals, contaminants and highly radioactive materials produced from hydrofracking operations. [32] High bromide levels in oil and gas waste byproducts are highly corrosive to equipment and can react during

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[25] Ibid.
[26] Ibid.
[27] Ibid.
[28] http://pubs.acs.org/doi/abs/10.1021/ez5000379?source=cen
[29] Ibid.
[30] http://ehp.niehs.nih.gov/wp-content/uploads/advpub/2015/4/ehp.1408855.acco.pdf
[31] Development of Rapid Radiochemical Method for Gross Alpha and Gross Beta Activity Concentration in Flowback and Produced Waters from Hydraulic Fracturing Operations, U.S. EPA July 2014,
[32] http://www.psehealthyenergy.org/site/view/1035

water treatment to form brominated trihalomethanes linked to bladder and colon cancers and are associated with birth defects. Once added to drinking water supplies, trihalomethanes are difficult to eliminate. [33]

According to another study conducted at Duke University, authors examined water quality and radioactivity of discharged effluents, surface waters, and stream sediments associated with a treatment facility site in western Pennsylvania. [34] Downstream from the treatment facility, concentrations of chloride and bromide were above background levels and Radium-226 levels in stream sediments at the point of discharge were 200 times greater than upstream and background sediments and above radioactive waste disposal threshold regulations posing potential public health and environmental risks of Radium bioaccumulation in areas of shale gas waste byproduct disposal. [35]

Agricultural areas are especially vulnerable to the immediate threat posed by radioactive oil and gas waste byproducts and their constituents. Mounting evidence reveals livestock illness and death from acute toxicity poisoning from harmful exposures to oil and gas drilling waste byproducts. Reproductive problems in cows and higher rates of stillborn and deformed calves have also been reported. [36] Presence of highly radioactive materials and other contaminants on farmland and in food products can cause irreparable damage and serious financial impacts. Protection of the quality and safety of food production is imperative for the health and safety of residents and to ensure consumer confidence in food production.

Vehicles transporting radioactive fracking waste byproducts increase the risk of human and animal exposure and contamination of water, air, soil and farmland when accidents, leaks, and spills occur. Due to lack of proper hazardous classification and tracking requirements, trucks hauling the waste have no special hazardous waste warning signs or emergency instructions placing first responders and residents at risk.

Truck accidents, spills, leaks and road spreading applications can expose drivers, passengers, pedestrians, animals and livestock to radioactive materials while contaminating nearby surface waters, residential areas, school properties and cropland. Radioactive particles may become airborne as trucks and passenger vehicles travel along roads and can be tracked on tires into driveways and garages and ultimately tracked in on shoes into homes. Rain and snowmelt carrying radioactive materials can run off road surfaces where it can migrate onto nearby property, farms and into streams, ponds and irrigation systems, leach into soil or seep into groundwater. These numerous pathways of exposure pose increased risk for human and livestock inhalation and ingestion of highly radioactive materials, and carcinogenic and endocrine disrupting chemicals.

Finally, potential exposure to toxic chemicals and radioactive contaminants has significant implications for human health and the economy. An analysis of the costs of environmentally mediated diseases in children nationwide by Dr. Leo Trasande, Associate Professor in the Department of Pediatric Environmental Medicine and Population Health at NYU Medical Center, found that the costs of childhood cancer, asthma, and neurological disorders had escalated from $54.9 billion in the 2002 analysis to $76.6 billion in 2008. Dr. Trasande states that the analysis reemphasizes for policy makers the implications of failing to prevent toxic exposures not only for the health of children but also for the health of the economy. [37]

Emphasis must be placed on primary prevention, eliminating hazards BEFORE children and adults are exposed. Disease and dysfunction triggered by toxins can be prevented and it is imperative that strong measures be taken to prevent harmful exposures to hazardous materials from the oil and gas industry.

In closing, the sound science supports our recommendation to the Delaware River Basin Commission, in the strongest possible terms, to ban drilling, extraction and production in the Basin and to also ban all activities

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[33] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1566350/
[34] http://pubs.acs.org/doi/abs/10.1021/es402165b
[35] Ibid.
[36] http://www.psehealthyenergy.org/data/Bamberger_Oswald_NS22_in_press.pdf
[37] http://content.healthaffairs.org/content/30/5/863.abstract

associated with hydraulic fracturing including water withdrawals from the Basin and the importation of fracking waste and its constituents from the oil and gas industry.

Respectfully submitted by,

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