Analysis of Air Monitoring at the Shaw Well Incident

Beaver Run Reservoir

Westmoreland Marcellus Citizens' Group and Protect PT

November 22, 2019

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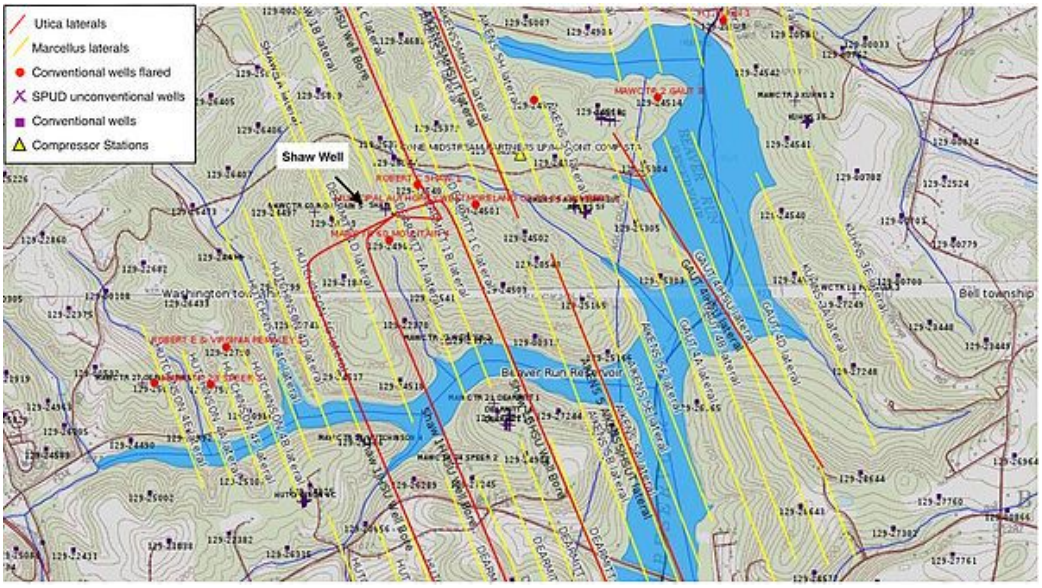

Flared wells (red dots) around Beaver Run Reservoir after catastrophic loss of containment of the Shaw well.

The Shaw Well Pad and a flare at a conventional gas well two weeks after Shaw well loss of containment. Eight other more distant wells were also flared.

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Executive Summary

Objective

Westmoreland Marcellus Citizens' Group, Protect PT, and partners collaborated in order to analyze reports from consultants of CNX Gas Company LLC (CNX) and the Municipal Authority of Westmoreland County (MAWC) on air quality associated with the January Shaw well casing failure event that resulted in the flaring of nine conventional natural gas wells near the Beaver Run Reservoir (BRR). We formulated recommendations for future actions by MAWC, CNX Gas Company LLC, and the PA Department of Environmental Protection (PA DEP).

Approach

Air quality information was obtained from a presentation by MAWC's contracted air monitoring consultant from Indiana University of Pennsylvania (IUP) and a report by SLR International Corporation (SLR), a consultant engaged by gas well operator, CNX Gas Company LLC (CNX). The SLR report was released by PA DEP following an Informal File Review request. The authors and organizational partners completed desktop reviews and used peer-reviewed research and government documents on air quality standards. The analysis was reviewed by Karl Koerner, engineering/technical coordinator at Clean Air Council (cleanair.org), and Beth Weinberger, MPH, Ph.D. – Research and Communications Specialist at Southwestern Pennsylvania Environmental Health Project (www.environmentalhealthproject.org).

Conclusions

Based on our analysis, we conclude that no meaningful evaluation of impacts on public health from the Shaw Well Incident was possible because of several flaws in air analysis, as listed below.

1. Testing began too late to measure important pollutants released before conventional wells were flared.
2. Background sites were inadequate in number and location.
3. Limits for pollutants were evaluated using inappropriate standards, e.g., OSHA limits used in the SLR report apply specifically to adult worker exposures and are not applicable to populations such as children and pregnant women.
4. The study did not consider the persistent nature of certain pollutants and impacts of chronic, low concentrations.
5. Peak values for serious pollutants were improperly omitted, despite their importance for public health.
6. Chlorofluorocarbons and methylene chloride observed in samples were erroneously dismissed as not related to gas operations, despite numerous reports of these substances in similar gas operations.
7. Particulate matter (PM) air pollution data was omitted in reporting, but methods indicate PM instruments were used.

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Introduction

On January 26, 2019, the Shaw 1G unconventional gas well near the Beaver Run Reservoir, Westmoreland County, PA, experienced a loss of pressure. Beaver Run Reservoir is the public water source for Westmoreland County as well as portions of Allegheny, Indiana and Armstrong Counties. This source is managed by the Municipal Authority of Westmoreland County (MAWC). While completing hydraulic fracturing activities at the Shaw 1G Well, CNX identified a pressure anomaly and subsequently observed increasing pressures at multiple shallow gas wells within a mile in each direction south-west to north-east of the Shaw Pad. As these pressure anomalies were detected, CNX deployed temporary flares to the conventional shallow gas wells in order to combust excess gas in those systems and avoid an emergency blowout situation.

On January 30, 2019, CNX began monitoring the area surrounding the Shaw Pad for potential changes to ambient air quality resulting from well flaring activity at the nearby shallow gas wells.

The March 2019 *Shaw Pad Ambient Monitoring Report* by SLR International Corporation, a professional air consulting group contracted by CNX, concludes that "no ambient air concentrations were detected at any time that would be of concern with respect to the public's welfare" and that "no elevated levels of pollutants were caused by the Shaw Pad Event and the ambient air around the area of concern never exceeded any of the OSHA Permissible Exposure Limits or would have adversely affected the surrounding community." In the CNX report to the DEP, citing SLR's findings, CNX concluded that there were no impacts to ambient air quality. For example, the introduction of the SLR report includes summary statements such as the following: "Data collected from each monitoring location over the monitoring period show no ambient concentrations of concern detected above OSHA Exposure Limits," and "Each location's analysis over the monitoring period show no ambient air concentrations detected above OSHA Exposure Limits." [1]

CNX's claim of no impact to ambient air quality, no elevated levels of pollutants, and no adverse effects on the surrounding community ignore several factors and shed doubt on the reliability of these findings, leaving ongoing concerns about air quality impacts from the Shaw Pad event. The following sections provide details regarding several major flaws in air testing procedures and the interpretation of air quality information.

Timing: Testing Was Too Late

a. No testing occurred prior to flaring which combusted many of the gases released by the Shaw incident.

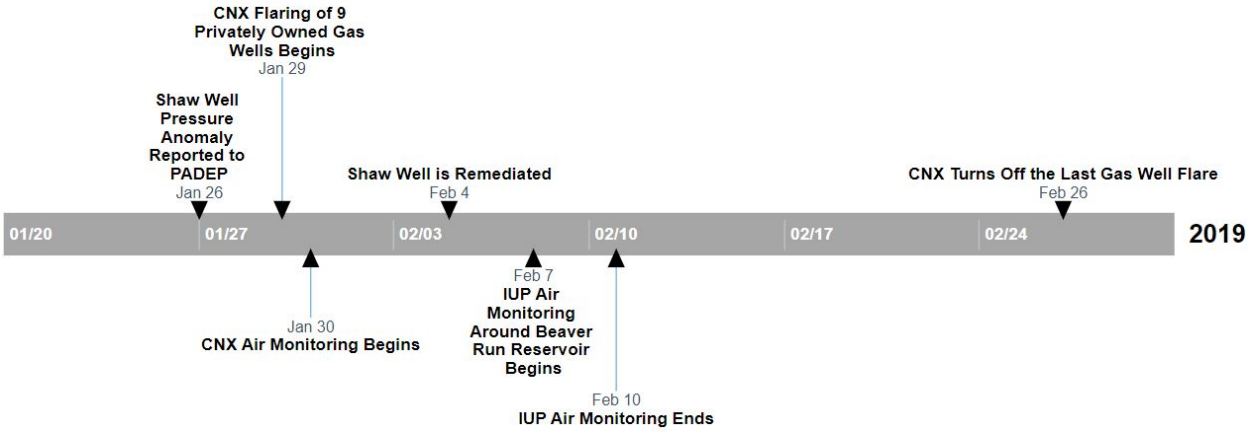
b. Most testing by the CNX contractor occurred after the Shaw well was killed, which reduced pressure, and consequently reduced flaring intensity at the conventional wells.

c. CNX monitoring did not begin until January 30, after flaring was likely decreasing as a result of the Shaw well being killed.

d. Testing by the MAWC contractor began even later than testing by the CNX contractor.

MAWC did not request air testing until Feb 6. On that date, MAWC manager, Mark Stoner, contacted John Bradshaw, Ph.D., professor of Physics at Indiana University of Pennsylvania (IUP) who was previously contracted to conduct air monitoring under normal operations at the Mamont Compressor Station and the Kuhns, DeArmitt, Hutchinson and Mamont (KDHM) pad sites. Dr. Bradshaw's schedule and inclement weather limited his testing to Feb 7 and Feb 10 at a few sites. He was not informed by the operator as to whether the compressor was operational during his testing period.

Shaw events and monitoring were as follows according to the April 17, 2019, CNX letter to the PA Department of Environmental Protection:



Flare Location

Name	API	Lat/Long	First Date Flared*	Last Date Flared*
Gaut 3	37-129-24514	40.509372, -79.555531	2/4/2019	2/5/2019
Gaut 1	37-129-24509	40.509302, -79.563689	2/3/2019	2/6/2019
Germroth 1	37-129-25011	40.495673, -79.589051	2/1/2019	2/6/2019
Gumbert 3	37-129-24501	40.504189, -79.567579	1/29/2019	2/8/2019
APC Remaly 1	37-129-22790	40.498132, -79.584377	2/3/2019	2/11/2019
HJ Kuhns 1	37-129-23518	40.513394, -79.550826	2/2/2019	2/12/2019
Speer 3	37-129-27539	40.495631, -79.584626	1/29/2019	2/13/2019
Shaw Robert 1	37-129-27540	40.505268, -79.571201	2/3/2019	2/15/2019
Mountain 4	37-129-24903	40.502566, -79.573027	2/1/2019	2/26/2019

Table 1.2.B

Monitoring Locations

Name	Sampling Equipment	Lat/Long	First Date Deployed	Last Date Collected
Background	Summa Canister	40.504126, -79.577458	2/03/19	3/02/19
Aikens 5	Aeroqual, MET, Summa, Sorbent Tubes	40.503839, -79.560302	1/30/19 2/03/19	3/02/19 2/17/19*
Khuns	MET, Summa, Sorbent Tubes	40.508161, -79.545850	2/03/19	3/02/19 2/17/19*
Dearmitt	MET, Summa, Sorbent Tubes	40.493891, -79.565377	2/03/19	3/02/19 2/17/19*
"Pad 4"	MET, Summa, Sorbent Tubes	40.496833, -79.559100	2/03/19	3/02/19 2/17/19*

Table 1.2.A *Sorbent tubes were collected on 2-17-2019

The Location of the Shaw Pad is 40.503824° -79.572814°

Tables taken from the *Shaw Pad Ambient Monitoring Report* by SLR. [1]

Summary and Recommendations: CNX and MAWC should have begun testing immediately on Jan 26. The testing devices employed by the air testing service take only minutes to initiate the sample collection and are commonly available. These air testing devices could have been stored by MAWC and deployed immediately when excess pressure at Shaw or at private wells was detected. Deployment of a Summa Canister or Sorbent Tube requires minimal training and these items require <$100/yr. to maintain ready for use. Therefore, these devices should be available on-site in case of a fugitive release that would cause concern to public health.

Background Sites Were Inadequate

a. Only one background location was utilized for reference; at least three reference stations should have been used. The reference site was in close proximity to other gas wells, just 1200 feet northwest of the Shaw pad and northeast of flares, which could have affected values used as background data. The distance between the Shaw well and the

reference site is within the distance used by researchers to analyze the effects of fracking on health because contaminants are known to be present within that range. In addition, the wind was not reliably and consistently strong from the southwest to discount contamination of the background sampling.

b. The CNX contractor deployed air sampling equipment only near the surface. No samples were collected above 2 meters above ground, but a professional air sampling contractor is capable of collecting samples at a wide range of heights.

c. The CNX contractor did not extend sample points to include ridges downwind from flaring locations. The need to sample air at such locations is well established among professionals when tracking air pollution in hilly terrain. The steady direction of wind during the sampling period would have made such measures especially relevant.

d. The IUP researcher was under contract by MAWC for monitoring during normal operations using ground level equipment and sampling site designs specific for certain CNX wells and the compressor at BRR. The researcher was contacted after the Shaw well failure and during flaring of several wells on private property and asked to sample air in the area. His limitations or time, weather and site accessibility severely limited the sampling.

Summary and Recommendations: Samples should have been obtained in a wider array of sites and heights to obtain more relevant data. Both CNX and MAWC should have utilized multiple reference sites to collect values for background data that were not impacted by emissions from other gas wells. The availability of portable, moderate cost air sampling devices makes such sampling feasible. Emergency planning should include the identification of sites for reference and impacted areas under a variety of scenarios.

Inadequate Interpretation of Air Quality Data and Health

1. **The OSHA limits used apply solely to the workplace and are not applicable to the evaluation of rural, residential air.**

In reference to chemical concentrations found during monitoring, the report notes that the levels were “below OSHA’s permissible and occupational exposure limits.” But, OSHA standards were designed for 40-hour week exposure for adults in the workplace, not areas where families reside, especially young children, and where exposure may be continuous. Some chemicals are so toxic there is no safe level of exposure, or they have been found to be harmful at very low levels, even at levels below government limits.

Examples:

Benzene

"OSHA set a standard for benzene, but the National Cancer Institute evaluates benzene as so toxic that it concludes there is no safe level. In 1997, a National Cancer Institute (NCI) study showed that benzene exposure, even within OSHA's legal limit, could cause non-Hodgkin lymphoma and myelodysplastic syndrome, a common precursor to leukemia." [2]

The World Health Organization concluded, "There is no safe level of benzene exposure that can be recommended." [3]

"Benzene is a known human carcinogen. Chronic exposure to benzene increases the risk of leukemia. The increased risk occurs at low levels of exposure with no evidence of a threshold level. Benzene exposure increases risk of birth defects, including neural tube and other defects found near natural gas development. Respiratory effects include pulmonary edema, acute granular tracheitis, laryngitis, and bronchitis. UOG *(Unconventional Oil and Gas)* fields present multiple sources and exposure routes for benzene. Benzene occurs naturally in shale and other hydrocarbon deposits, and is vented, flared, or released as fugitive emissions along numerous points of production, such as wells, production tanks, compressors, and pipelines. It can volatilize and disperse from flowback and produced water at drilling sites and remain in the air for several days. It was among the first pollutants found in air samples near shale gas operations. Previous studies found benzene to be the largest contributor to excess lifetime cancer risk near gas fields. Residents exposed to VOCs (*Volatile Organic Compounds*), including benzene, experience immediate health symptoms and illness. Within days after a flaring event at a Texas City refinery, children exhibited altered blood profiles, liver enzymes, and somatic symptoms. Future research is needed to determine whether the concentrations of benzene we measured are due to continuous releases or flaring, fugitive emissions, or facility upsets." [4]

"A toxicological review of benzene produced for the American Petroleum Institute in 1948 states that, in general, the chemical is considered so potent that there is no safe exposure level. In an undated litigation defense guide from a senior attorney with Shell Oil Company, it cautions colleagues to avoid 'inadvertent disclosure' of benzene documents." [2]

Non-Methane Hydrocarbons

"At concentrations *far less than government safety standards*, a literature search of the health effects of Non-Methane Hydrocarbons revealed that many had multiple health effects, including 30 that affect the endocrine system, which is susceptible to chemical impacts at very low concentrations." [5]

Toluene

Toluene may be a carcinogen in humans. NIOSH has re-evaluated cancer policies and now advises that there may be no safe level of exposure to a carcinogen. [6]

Methylene Chloride

"There is no national standard for acceptable levels of airborne methylene chloride." [5]

2. There was no consideration of the persistent nature of some pollutants in concluding there was no impact on ambient air quality or concern for public welfare.

Although *average* values were below minimal risk levels, some chemicals were consistently present at low doses, leading to concerns of sub-acute or sub-chronic health effects.

"On average, Non-Methane Hydrocarbons account for 18 percent of the unprocessed gas and are released into the air at various stages of production. The NMHCs in the study were detected at levels of parts per million, parts per billion and parts per trillion, but the endocrine system is so sensitive that even tiny doses can lead to large health effects. Federal safety standards rarely consider the impacts of low dosage testing, an omission that scientists say should be addressed**."** [5]

"Hundreds of studies have examined people from the general population and found associations between low levels of hormone-altering compounds and infertility, cardiovascular disease, obesity, abnormal bone health, cancer, and other diseases… We should never assume that because an exposure is tiny that it is safe." [7]

"Current epidemiology studies linking low-dose EDC [endocrine disrupting chemical] exposures to a myriad of health problems, diseases, and disorders suggests that the costs of current low-dose exposures are likely to be substantial." In other words, small exposures to endocrine disrupting chemicals can have large health consequences. Also, the health effects of a small dose of an EDC can be different than the health effects of a large dose of EDC. Current regulations to test and evaluate chemical safety must be updated. [8]

3. Pollution peaks were not considered in assessing emission impacts on health

The SLR report noted: *"no elevated levels of pollutants were caused by the Shaw Pad Event, and the ambient air around the area of concern never exceeded any of the OSHA Permissible Exposure Limits or would have adversely affected the surrounding community."* [1]

The previous conclusion is flawed because peak emission levels were not considered in assessing effects on public health or in stating there were no elevated levels of pollutants as a result of the Shaw Pad event. Chemical concentrations were averaged for 24-hour periods; more frequent measures such as spikes, fifteen-minute averages or one-hour measurements were not reported or analyzed. Spikes in air pollutants are known to impact human health even if averages appear normal.

"Natural gas facilities have sporadic emission spikes that last just a few hours or minutes. These fleeting events, which release particulate matter, volatile organic compounds and other harmful toxins into the air, can quickly lead to localized health effects. When averaged over 24 hours, however, the spikes can easily be ignored." [9]

"EHP researchers found that peaks of PM 2.5 at all five houses in Penn Township were high enough to potentially cause upper respiratory problems in sensitive populations including children, the elderly and people with asthma. However, the baseline levels of PM 2.5 recorded at each house stayed below the daily 24-hour threshold set by the U.S. Environmental Protection Agency." [10]

"Researchers have demonstrated the wisdom of looking at peak exposures as compared to averages over longer periods of time. Darrow et al (2011) write that sometimes peak exposures better capture relevant biological processes. This is the case for health effects that are triggered by, short-term, high doses. They write, 'Temporal metrics that reflect peak pollution levels (e.g., 1-hour maximum) may be the most biologically relevant if the health effect is triggered by a high, short-term dose rather than a steady dose throughout the day. Peak concentrations … are frequently associated with episodic, local emission events, resulting in spatially heterogeneous concentrations….'" [11]

Delfino et al (2002) posited that maxima of hourly data, not 24-hour averages, better captured the risks to asthmatic children, stating, "it is expected that biologic responses may intensify with high peak excursions that overwhelm lung defense mechanisms." Additionally, they suggest that "one-hour peaks may be more influenced by local point sources near the monitoring station that are not representative of regional exposures…." [12]

"The National Ambient Air Quality Standards (NAAQS) used as a benchmark for air quality were not created to assess the air quality and safety in a small geographic area with fluctuating emissions. NAAQS effectively address regional air quality concerns. But these standards do not adequately assess risk to human health for residents living in close proximity to polluting sources such as unconventional natural gas development (UNGD) sites, where emissions can be highly variable." [13]

Peak exposures cause the most harm. Short, high levels of exposure can cause damage to health and repeated exposure increases damage. For these reasons, among others, health findings and air monitoring reports have been in conflict. Environmental Health Project recommends that a 1-hour average is a more accurate health standard, rather than the EPA's 24-hour standard in order that peak exposures be recognized**.** There are no health-based standards for very short exposures. [14]

Summary & Recommendations: Research indicates that air quality reports are insufficient to evaluate public health impacts from emissions if they conclude "no impact on ambient air quality" while using 24-hour averages without the inclusion of data on peak values. In other words, people can become ill because of peak exposures which are not revealed in 24-hour averaged emissions reports. Results of air testing should have at least included peak values, 15-minute averages, and one-hour averages in addition to 24-hour averages. Furthermore, the analysis of health impacts should have used research more relevant to residential populations than studies of OSHA standards and adult workers.

Chlorofluorocarbons Were Erroneously Dismissed As Not Related To Gas Operations.

The SLR report states that a number of organic compounds detected are *"actually classified as Chlorofluorocarbons (CFCs) refrigerants such as chloromethane, dichlorodifluoromethane, and trichlorofluoromethane likely remaining from past use."*
"A number of organic compounds detected are actually classified as Chlorofluorocarbons (CFCs) refrigerants such as ***chloromethane****,* ***dichlorodifluoromethane****, and* ***trichlorofluoromethane****. These were commonly used as refrigerants and/or consumer product propellants/solvents in the past. They can remain in the atmosphere for long periods of time and are likely from past use and/or are global background. Additionally, methylene chloride was detected as being present in detectable quantities at all locations. However, since methylene chloride has not been found within the natural gas streams being flared we would expect it to also be a result of consumer use propellants and/or paint stripping operations. These compounds are not listed as chemicals used in hydraulic fracturing fluids by EPA or thought to be a byproduct of any of the oil and gas production operations that were present during the monitoring event*. [1]

Chlorofluorocarbons were therefore dismissed as not related to gas operations. In contrast, government agencies and researchers report that Chlorofluorocarbons are often detected in air monitoring conducted near gas operations, as shown in the following five examples.

Example A.

In 2011 and 2013, Earthworks, collected air samples within 0.33 miles of two compressor stations: Springhill compressor in Fayette County and the Cumberland/Henderson compressor station in Greene County, Pennsylvania. Results from samples collected included: 1,1,2-Trichloro-1,2,2-trifluoroethane, 1,2-dichlorobenzene, 2-butanone, benzene, carbon tetrachloride, **chloromethane**, **dichlorodifluoromethane**, ethylbenzene, methane, methylene chloride, tetrachloroethylene, toluene, trichloroethylene, and **trichlorofluoromethane**. [15]

Example B.

A report issued by Earthworks and based on the largest health survey to-date is a cause for alarm. Similar conclusions were reported in the same week by the US Governmental Accounting Office, and earlier by German researchers.

"The results from Washington County, PA, showed the highest measured concentrations of 5 VOCs that were measured and the highest concentrations of 3 VOCs measured of 9 counties in the study. All 9 samples from Washington County and 6 samples from Butler contained —**1,1,2-Trichloro-1,2,2-trifluoroethane**, Carbon tetrachloride, **Chloromethane**, Toluene, and **Trichlorofluoromethane**."

“Think about what it’s like to live when you have ongoing emissions from the gas operations as well as these odor events inflicting health impacts on you on a daily basis,” said Wilma Subra, prominent environmentalist and co-author of the report. [16]

Example C.

“This study goes beyond previous Barnett Shale field studies by encompassing a wider variety of production equipment (wells, tanks, compressors, and separators) and a wider geographical region. The principal components analysis, unique to this study, provides valuable information regarding the ability to anticipate associated shale gas chemical constituents.” … “Air sampling confirmed the presence of methane and 101 other chemicals in the atmosphere in and around sampled residential sites in the DFW Metroplex where unconventional shale gas extraction and production was the predominant emission activity. Approximately 20 of the 101 (20%) chemicals identified are listed as HAPs according to the EPA, including benzene, 1,3-butadiene, carbon disulfide, carbonyl sulfide, **chloromethane**, **tetrachloroethane**, toluene, and xylene. Emissions are not limited to well completion period but also strongly associated with compressor stations.” [17]

Example D.

“We analyzed drinking water samples from 66 Ohio households for 13 UO&G-related volatile organic compounds (VOCs) (e.g., benzene, disinfection byproducts [DBPs]), gasoline-range organics (GRO), and diesel-range organics). We interviewed participants about health symptoms and calculated metrics capturing proximity to UO&G [Unconventional Oil and Gas] wells. Based on multivariable logistic regression, odds of detection of bromoform and **dibromochloromethane** in surface water decreased significantly as distance to nearest UO&G well increased (odds ratios [OR]: 0.28–0.29 per km). Similarly, the distance to the nearest well was significantly negatively correlated with concentrations of GRO and toluene in ground water (rSpearman: −0.40 to −0.44) and with concentrations of **bromoform[chloromethane]** and **dibromochloromethane** in surface water (rSpearman: −0.48 to −0.50).” [18]

Example E.

“Fracking contaminates nearby water wells with a variety of heavy metals and toxic chemicals that fluctuate over time. Industry can't always control the direction of the fractures. As more unconventional wells were drilled and stimulated, more drilling-related contaminants were found in the groundwater, "**Dichloromethane**, an industry chemical and potential human carcinogen, was found in quantities above safe drinking water levels in water wells on highly fracked landscapes. The EPA says the chemical "poses health risks to anyone who breathes the air when this compound is present." The pH of the water also changed while **dichloromethane**, a degreaser used on well pads, appeared in the water as well.” [18]

Summary and Recommendations: Chlorofluorocarbons are found near gas operations and do impact public health. Therefore, detected chlorofluorocarbon levels should not have been dismissed as being unrelated to gas operations.

Methylene Chloride Was Erroneously Dismissed As Not Related To Gas Operations

The SLR report states: "*However, since methylene chloride has not been found within the natural gas streams being flared we would expect it to also be a result of consumer use propellants and/or paint stripping operations. These compounds are not listed as chemicals used in hydraulic fracturing fluids by EPA or thought to be a byproduct of any of the oil and gas production operations that were present during the monitoring event."* [1]

The claims in the above statements are flawed in several ways. They are based on several untested assumptions, such as methylene chloride was coming from consumer use of propellants or paint stripping in the area, but no evidence is provided. Also, the authors assume that the EPA listing of all chemicals in gas operations is complete, but no evidence to that effect is provided, and confidentiality of gas operation substances makes such lists always incomplete. In contrast to the SLR claim, several research studies report methylene chloride being detected regularly at gas operations, and often at high concentrations, as seen in the following seven examples.

Example A.

Colburn and colleagues collected weekly air samples in Garfield County, Colorado, within 1 mile of 130 shale gas wells, reporting 61 airborne chemicals. "**Methylene chloride**, a toxic solvent not reported in products used in drilling or hydraulic fracturing, was detected 73% of the time; several times in high concentrations. A literature search of the health effects of the NMHCs [Non-methane hydrocarbons] revealed that many had multiple health effects, including 30 that affect the endocrine system, which is susceptible to chemical impacts at very low concentrations, far less than government safety standards." ….. "[**Methylene chloride**] is not a component in drilling or fracturing fluids. It does not appear on two extensive lists of more than 750 chemicals that companies admit they use during either operation and it does not appear on the voluntary fracturing chemical disclosure registry for the well pad of interest in this study. However, residents and gas field workers have reported that methylene chloride is stored on well pads for cleaning purposes." ... "The human and environmental health impacts of the NMHCs, which are ozone precursors, should be examined further given that the natural gas industry is now operating in close proximity to human residences and public lands." [5]

"One of the most concerning was **methylene chloride**, which may be a carcinogen, according to the Environmental Protection Agency. Acute inhalation can be fatal, while chronic exposure can cause memory loss, nausea and respiratory symptoms. This high-powered cleaning solvent was detected in 73% of the weekly air samples, at times spiking above 563 parts per billion by volume (ppbv). There is no national standard for acceptable levels of airborne **methylene chloride**, but the Wisconsin Department of Natural Resources says action should be taken if indoor methylene chloride levels are above 15 ppbv." [20]

“On average, NMHCs account for 18 percent of the unprocessed gas and are released into the air at various stages of production.” … “The NMHCs in the study were detected at levels of parts per million, parts per billion and parts per trillion, but the endocrine system is so sensitive that even tiny doses can lead to large health effects. Federal safety standards rarely consider the impacts of low dosage testing, an omission that scientists say should be addressed.” … “The study's authors detected thirty NMHCs that affect the endocrine system. Several belong to a class of compounds called polycyclic aromatic hydrocarbons (PAHs) and were detected at levels that other scientists have found are high enough to impact child development. In those studies, clinical researchers gave pregnant women living in cities personal air monitors, then tracked their children's development. Women exposed to a certain level of PAHs were more likely to have children with lower birth weight and lower IQ scores.” … “Robert Howarth, a Cornell University scientist who wasn't involved in the study, said the presence of **methylene chloride** points to a need for better chemical disclosure laws. "**Methylene chloride** is a surprise...We need a lot more information on what's used at drilling sites overall.**"** [19]

Example B.

“The literature suggests that shale gas development processes emit hazardous air pollutants including, but not limited to benzene, toluene, ethylbenzene, and xylene (BTEX compounds), formaldehyde, hydrogen sulfide, acrylonitrile**, methylene chloride,** sulfuric oxide, nitrogen oxides, volatile organic compounds (VOCs), trimethylbenzenes, aliphatic hydrocarbons, diesel particulate matter, and radon gas (McKenzie et al. 2012; Pétron et al. 2012; Roy et al. 2013). These emissions can result in elevated air pollution concentrations that exceed US EPA guidelines for both carcinogenic and non-carcinogenic health risks.” [21]

Example C.

The Center for Environmental Health (CEH) outlines the health risks to pregnant women and young children from harmful chemicals used in fracking.

“Just some of the harmful substances commonly used in fracking include methane, BTEX (benzene, toluene, ethylbenzene and xylenes), arsenic, radium, ozone, formaldehyde, radium, radon, nitrogen oxides, **methylene chloride** and silica sand. These substances are associated with low birth weight, birth defects, respiratory problems, cancer and fertility problems. Exposure to industrial chemicals and to ionizing radiation cause greater injury during development and early life. This may result in greater likelihood of birth defects, cognitive and behavioral development and lifelong disabilities.” [22]

Example D.

"Another substance that is detected near compressor stations is **methylene chloride**. According to the EPA: The acute (short-term) effects of **methylene chloride** inhalation in humans consist mainly of nervous system effects including decreased visual, auditory, and motor functions, but these effects are reversible once exposure ceases. The effects of chronic (long-term) exposure to **methylene chloride** suggest that the central nervous system (CNS) is a potential target in humans and animals. Human data are inconclusive regarding methylene chloride and cancer. Animal studies have shown increases in liver and lung cancer and benign mammary gland tumors following the inhalation of methylene chloride." [15]

Example E.

In May 2014, Susquehanna, PA, DEP found chemicals in drinking water including **methylene chloride** and tetrachloroethene that were consistent with the surfactant used to drill a gas well 1500 feet away. [23]

Example F.

Rex Energy tested the water of Kim McElvoy, Connoquenessing Township, Butler County, and found elevated levels of arsenic and **methylene chloride**, a possible carcinogen, after two gas wells were drilled near her home. She was provided with a water buffalo but Rex denies responsibility. [24]

Example G.

"Two Cancer causing chemicals, acrylonitrile and **methylene chloride**, were detected at high levels near gas operations. Neither is associated with gas deposits but both seem to be associated with the use of fracking products. Resins acrylonitrile, 1,3 butadiene and styrene are suspected to be present in fracking additives." [25]

Summary and Recommendations: In summary, in studies of gas industry operations including those in SW Pennsylvania, methylene chloride has been found near gas operations and is related to serious health problems. The presence of this substance in air test results should not have been interpreted as not related to gas industry operations at the reservoir and solely attributed to consumer use of propellants and/or paint stripping operations, especially since no evidence was provided regarding those activities during the testing period. Analysis of non-methane hydrocarbons such as methylene chloride should reflect updated research on their association with gas operations and harm to public health.

Particulate Matter Results Were Omitted from the Report

Air sampling methods used by SLR included the Aeroqual Dust Sentry Sampler which tested for particulate matter, but those results were not included in the final report. The SLR

report noted an error in a reference source in Appendix A which may be related to the lack of data on the Aeroqual Dust Sentry Sampler.

Hundreds of scientific articles indicate that particulate matter poses serious adverse health risks. Without specific information on the timing and locations of the samplers, and the results of particulate matter information, no evaluation can be completed.

Definitions

Types of Exposure include Acute, which is exposure to a chemical for 24 hours or less; Chronic, which is exposure to a chemical for more than 3 months; Sub-acute, which is exposure to a chemical for 1 month or less; Sub-chronic, which is exposure to a chemical between 1 to 3 months.

TWA is the employee's average airborne exposure in any 8-hour work shift of a 40-hour work week which shall not be exceeded. The 8-hour TWA PEL is the level of exposure established as the highest level of exposure an employee may be exposed to without incurring the risk of adverse health effects.

REL is an occupational exposure limit *recommended by NIOSH to OSHA* to adopt as the “new” permissible exposure limit (PEL). The REL is a level that NIOSH believes would be protective of workplace safety and employee health over a working lifetime.

Threshold level is the lowest concentration of a pollutant that might produce a harmful effect. The threshold level for a chemical may differ from person to person.

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