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Citizen Investigation of Toxic Air Pollution from Natural Gas Development

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ANNIVERSARY

Global Community Monitor
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Background on Global Community Monitor

Global Community Monitor, founded in 2001, trains and supports communities internationally in the use of environmental monitoring tools to understand and address industrial toxic pollution threats to their health and the environment.

GCM, best known as the innovator of the “Bucket Brigade”, incubates community-based groups to develop the skills, expertise, and experience to win demands around environmental health and justice. Since GCM’s approach is extremely replicable and effective, we have been invited to work with more than 40 communities in 27 countries. GCM collaborates with an established network of environmental health experts in the US and internationally to leverage resources for the communities.

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Executive Summary

Over the past decade, oil and natural gas exploration and production have grown at an unprecedented rate in the United States. Since necessary environmental and health regulations are not in place for this industry, residents living near oil and natural gas sites may be exposed to highly toxic chemicals on a regular basis, with their health at risk.

During 2010-11, Global Community Monitor (GCM), responding to citizen odor and health complaints, launched a community-based pilot environmental monitoring program in northwest New Mexico, southwest Colorado and western Colorado to document and measure air pollution from natural gas facilities. Through the course of this pilot study, residents, armed with their own air monitors, documented a potent mix of chemicals in nine air samples from different locations. The sites in this program are all natural gas production and processing sites, although production of oil presents similar risks. Air sampling for this project targeted many aspects of natural gas development.

Through the course of this study, several serious issues emerged:

Citizen samples exposed alarming levels of toxins in the air.

A total of *22 toxic chemicals* were detected in the nine air samples, including *four known carcinogens*, toxins known to damage the nervous system, and respiratory irritants. The levels detected were in many cases significantly higher than what is considered safe by state and federal agencies. The levels of chemicals, including benzene and acrylonitrile, ranged from three to 3,000 times higher than levels established to estimate increased risk of serious health effects and cancer based on long-term exposure.

These air samples confirm the observations, experiences and first-hand complaints of residents. Odors and health effects that have been reported for years were consistent with exposure to the chemicals found in the samples. These results underscore the need of regulatory agencies to take such complaints seriously, given the close proximity between the industry and its residential neighbors.

At least two cancer-causing chemicals, acrylonitrile and methylene chloride, were detected at high levels near natural gas operations. Neither chemical is associated with natural gas or oil deposits, but both seem to be associated with the use of hydraulic fracturing (fracking) products. Resins acrylonitrile, 1, 3 butadiene and styrene (ABS) are suspected to be present in fracking additives.

Air emissions from natural gas production are largely unregulated and unmonitored, despite being a significant source of air pollution. State and Federal air monitoring devices are located several miles from production sites, and test for criteria air pollutants rather than specific volatile organic compounds associated with natural gas exploration and production.

Oil and gas exploration and production operations are exempt from two key provisions of the Clean Air Act's National Emissions Standards for Hazardous Air Pollutants, designed to protect

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public health. Because of these exemptions, the industry avoids complying with standards that are applied to other industries.

Based on the data gathered in this pilot study, highly toxic chemicals are permeating the air near homes, farms, schools, playgrounds, and town centers. Due to the lack of regulation and standards, key information about chemicals being used in the production process, including hydraulic fracturing is widely unavailable. Combined with the lack of appropriate air monitoring near production sites, **citizen right-to-know is virtually non-existent.**

Without registration of the chemicals by industry, neighbors of gas wells have no way of knowing what chemicals are stored on site, used during the industrial processes, vented to the air, water or land, or disposed nearby.

Recommendations

1. Given the proximity of residential and public property, any new sites –whether drilling, fracking, refining, or disposal – should be located at least one-quarter mile from homes, farms, schools, playgrounds, and businesses. This space would provide a **buffer zone** for industry to continue its operations while reducing community exposure to chemical contaminants.
2. The U.S. Environmental Protection Agency (EPA) should update air quality standards for oil and gas development, including the New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants, based on the principles of comprehensiveness, effectiveness, full health protection, forward looking, and enforceability.
3. Until strong new rules are in place, the oil and natural gas industry can and should **voluntarily invest in equipment that reduces pollution escaping to the air.** Such equipment is readily available and financially profitable for companies. These investments would increase efficiency and production and reduce cancer-causing chemicals from being emitted into the air in communities near production facilities – saving lives and protecting the health of neighboring families.
4. Current natural gas production and processing sites should **have air monitors near all operations and equipment. All data should be made available to the public.**
5. **EPA and state agencies must enforce the current laws** on the books vigorously and impose the maximum penalties available to create a culture that prioritizes public health. Regulators should be accessible and fully funded to ensure their ability to protect public health and the environment.

As the natural gas industry continues to grow, so will the number of families neighboring and affected by the emissions. Industry and government leaders have a unique opportunity to address public health and environmental issues by implementing all of these recommendations. For

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coexistence between communities and industry to be possible, chemical exposure has to be immediately addressed.

Oil and Natural Gas Development and Air Pollution

There are a variety of chemicals used and released during the drilling, fracking, and production phases of oil and gas development. In addition, different types of wastes are produced throughout the development process. Air pollution is generated at all stages of oil and gas development including wellpad construction and drilling, workovers, fracking and completion, gas compression, evaporation of chemicals from produced water and frack flowback, dehydration, separation, waste treatment and disposal, transmission and processing.

The following is a brief glossary of the life cycle of natural gas development:

Construction activity

Even prior to producing natural gas, air pollution is generated by heavy construction activity including trucks and other equipment that emit air pollutants at well pads, pipelines, roads and compressor stations.

Drilling

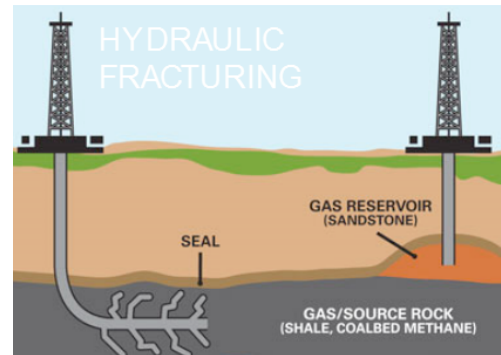
During the drilling of a well, air pollution is generated by diesel engines powering the drill rig, as well as by any natural gas emissions being vented from the hole in the ground. These emissions could include various toxic gases, including volatile organic compounds.

Hydraulic fracturing (fracking) and completion¹

Image from Stark Political Report

While oil and gas have always been extractable from the natural fissures in certain rock formations, some of these deposits are too diffuse to be economically feasible to exploit using traditional drilling methods.

Increasing demand, however, has spurred the evolving development of fracturing technology. Pioneered in west Texas, fracking is being used to increase the productivity of drill sites in shale, coalbed methane, and tight sands formations that previously were too expensive to drill.



Fracking is dependent on fracturing fluid, typically comprised of water-based concoctions riddled with assortments of chemicals and proppants like sand. The chemical makeup of the fluid varies from company to company and site to site. The process of fracking involves perforating oil and gas wells and then pumping chemical fluid into the earth. By pumping fracturing fluid deep into the rock formation fissures under the earth at very high pressure, the cracks are expanded and then propped open with the proppant. These expanded cracks allow a single well to tap into multiple diffuse deposits.

¹ "Hydraulic Fracturing Research Study," US EPA. Office of Research and Development. 24 May 2011. <http://www.epa.gov/safewater/uic/pdfs/hfresearchstudyfs.pdf>

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Though fracking enables cost effective production of natural gas for the gas companies, it also comes with risks to public health and the environment. One of the least documented risks has been from air pollution caused by fracking compounds during their use, storage, or waste disposal.

Pits

Waste from drilling, fracking, or production may be dumped into open air pits to allow some of the toxic material to evaporate into the air. This can result in significant air pollution.

Land application (including land farming)

Waste from drilling, fracking, or production may be spread on the ground or otherwise applied to the land. This can result in significant air pollution.

Compressor station

Gas from wells is collected at central locations and compressed into smaller volumes at stations. Another type of compressor is located on the well site. Both types of compressors can leak and release a variety of toxic gases.

Condensate tanks

Some well sites produce semi-liquid gases along with natural gas that are stored in tanks, which can leak various toxic gases into the air.

Dehydrators

These systems are needed to remove water from natural gas and can release toxic gases in the process.

Flaring

Unwanted gases in the production process may be burned off in the open air through flares, which can produce other toxic gases as a result.

Fugitive emissions

Leaks in equipment such as pumps, valves, compressors, pipes and tanks can result in significant air pollution releases because of the number of components in gas processing.

Venting

During various stages of gas exploration, production and maintenance, gases are vented directly into the air rather than contained or flared. Venting can release large volumes of toxic gases.

Gas processing plant

The last stage of gas production involves the refining of the raw gas into the final product. This occurs at large gas processing plants, which have many sources of air emissions.

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Additional waste disposal sites²

Wastes from various stages of gas production and processing may be sent to treatment sources including landfills, injection sites and wastewater treatment sites, which can also release air pollution.

² “Public Health and Toxics.” EARTHWORKS. 20 March 2011, <http://www.earthworksaction.org/Health%20and%20Toxics.cfm>

Air Pollution and Human Health Impacts of Natural Gas Development

Air pollution can affect our health in many ways, with both *short-term* and *long-term* effects. Different groups of individuals are affected by air pollution in different ways. Some individuals are much more sensitive to pollutants than others. Sensitive populations, including young children and elderly people, often suffer more from the effects of air pollution. People with health problems such as asthma, heart and lung disease may also suffer more when the air is polluted. The extent to which an individual is harmed by air pollution usually depends on the **total exposure** to the damaging chemicals, i.e., the *duration of exposure* and the *concentration of the chemicals*. Total exposure must be taken into account when assessing air pollution risks.

Examples of **short-term effects** include irritation to the eyes, nose, and throat, and upper respiratory infections such as bronchitis and pneumonia. Other symptoms can include headaches, nausea, and allergic reactions. Short-term air pollution can aggravate the medical conditions of individuals with asthma and emphysema.

Long-term health effects can include chronic respiratory disease, lung cancer, heart disease, and even damage to the brain, nerves, liver, or kidneys. Continual exposure to air pollution affects the lungs of growing children and may aggravate or complicate medical conditions in the elderly.³

Chemicals such as benzene, toluene, ethylbenzene and xylene (BTEX) are known to be present around natural gas development sites, both from the gas deposits as well as chemical additives. Our independent testing found significantly high amounts of these toxic gases downwind of various sites. Health effects from BTEX include dizziness and confusion, eye, nose and throat irritation, birth defects, kidney, liver, and neurological damage, and cancer. For example, benzene is known to cause leukemia.⁴

Hydrogen sulfide was also found in the Bucket tests, warning signs for the gas are often visible near well pads. Long-term exposure to hydrogen sulfide is associated with an elevated incidence of respiratory infections, irritation of the eye, nose and throat, coughing, breathlessness, nausea, headache, and mental health impacts, including depression.⁵ It is recommended, that workers handling hydrogen sulfide be equipped with hydrogen sulfide monitors, respirators, and rescue packs for protection in the event of elevated exposure; the public has no such protection.⁶

Additional toxic substances were detected at high levels in the air samples, including toxic gases not previously associated with natural gas development, suggesting that substances possibly associated with fracking additives may have been released into the air.

³ "How Can Air Pollution Hurt My Health." *Health Effects of Air Pollution*, Lawrence Berkeley National Laboratory, March 2011, <http://www.lbl.gov/Education/ELSI/Frames/pollution-health-effects-f.html>

⁴ NRDC, *Drilling Down*, October, 2007, table on page vi

⁵ Chernaik, Mark. *Data Interpretation Synthesis Letter*. Science for Citizens. 16 Feb. 2011

⁶ Air Products, Material Data Sheet, http://avogadro.chem.iastate.edu/MSDS/hydrogen_sulfide.pdf

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Overall, air samples gathered for this project showed that neighbors of the natural gas operations in the target communities are breathing multiple chemicals that can cause an increased risk of cancer and other serious health effects. There are no health-based standards for exposure to multiple chemicals, although the negative health impacts are considered to be increased.

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Natural Gas Development in Colorado and New Mexico

Growth in Project Areas

GCM worked with two communities in the San Juan Basin—one in southwest Colorado and a second in northwest New Mexico. In addition, GCM worked with a third community in Garfield County in western Colorado.

- *Colorado's natural gas production has risen 450% since 1990 with over 27,000 active wells statewide.*⁷



- *Currently there are approximately 3,400 wells in La Plata County, CO.*⁸

Image from BP.com

- *There are approximately 21,000 wells in San Juan County, NM*

- *The approximate total of wells in the entire San Juan Basin is 35,000 wells*⁹

Image from Realtor.com

- *In western Colorado, Garfield County has an estimated 8,249 active wells with 2,037 new permits approved in 2010*¹⁰



⁷ "Background." Western Colorado Congress, 20 March 2011, <http://www.wccongress.org/gvca.htm#background>

⁸ "Natural Resources- Oil and Gas." La Plata County Planning Department, 25 March 2011, http://www.co.laplata.co.us/departments_and_elected_officials/planning/natural_resources_oil_gas

⁹ United States Department of Interior, Bureau of Land Management, **Farmington Resource Management Plan** (December 2003) Final RMP/Record of Decision

¹⁰ May 2011 Colorado Oil & Gas Conservation Commission Staff Report

Target Communities

GCM worked with communities in northwest New Mexico and southwest Colorado in partnership with the San Juan Citizens Alliance. The project also included communities in western Colorado in partnership with the Western Colorado Congress. The communities were trained in air monitoring and bucket sampling around natural gas development sites.

Northwest New Mexico: Aztec and Farmington Area

Of the three communities involved in this pilot project, northwest New Mexico has the longest history of complaints about natural gas drilling. Natural gas has been drilled for, and produced, in northwest New Mexico for over 60 years with natural gas facilities interspersed among residential areas. Community residents in northwest New Mexico have noticed strong odors since the late 1980s, reported as smelling like rotten eggs, petroleum and sewage, around the ever-expanding oil and gas industry. Residents have experienced nose, throat and eye irritation that occasionally would last for hours after smelling the odors. When the odors increased in frequency, so did the associated acute health effects.

Energy companies in the area, including BP, Energen, XTO, Devon, Conoco Phillips, Enterprise, Williams and Questar, are associated with drilling for and transporting natural gas, where operations at sites can include fracking by numerous companies. San Juan County in Northwest New Mexico consists of more than 100,000 residents potentially affected by natural gas production, either by living near a gas well or near the plants that process the natural gas.

There are many gas wells near schools, churches, private residences and community centers. Natural gas odor incidents are frequent, along with adverse health effects in the community. For example, in December 2009, one of the members of the San Juan Citizens Alliance and long-term area resident Shirley McNall went out to get her mail. She was immediately struck with an extremely potent rotten egg odor and overcome with dizziness and nausea. According to McNall, she fell to the ground and was forced to crawl back into the house. While the symptoms began to slowly subside, she reported numbness in her lips that lasted for three days after the incident.

During less severe odor incidents, residents commonly reported headaches, nausea and dizziness in addition to nose, throat and eye irritation.



Shirley McNall- Aztec, NM

The health effects and reported odors could be associated with chemical exposure. McNall and other residents have documented odors most frequently during the late evening through the early morning hours. This could be related to the industrial process and/or weather patterns that concentrate or bring the toxic fumes near homes.

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Community members call the New Mexico Oil and Gas Conservation Division frequently, often multiple times a week, to report these odors. However, no satisfactory permanent solutions have been reached. On occasion, a representative of the New Mexico Oil and Gas Conservation Division will conduct an on-site investigation. During one of these investigations, the representative informed the residents that the most likely cause of the odors is “treated” hydrogen sulfide. This is a major concern because hydrogen sulfide is highly toxic and, while its presence requires formal signage by law, no signage was present at the well under investigation.

Homeowners are not generally informed of the toxic risk when their property is in proximity to natural gas facilities. Split estate situations where mineral ownership is separate from private surface ownership creates confusion and uncertainty surrounding where wells can be drilled in relation to homes. Numerous contractors and subcontractors may be involved with natural gas facilities, further complicating responsibilities and actions. The New Mexico Environmental Department and the U.S. Environmental Protection Agency’s (EPA) efforts to monitor and evaluate air impacts from natural gas resources in northwest New Mexico have been limited.

Southwest Colorado: Durango

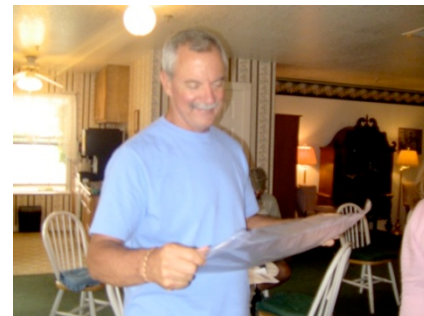
This troubling trend is not unique to the northwest corner of New Mexico. The expanding oil and gas industry has spread into communities in Colorado.

La Plata County, located in southwest Colorado where the southern Rockies meet the high desert country of northern New Mexico, is home to three municipalities, four river drainages, and a sovereign Indian nation. It is known for its outdoor activities including hiking, rock climbing, backpacking and white water rafting along the Animas River, and for the incredibly lucrative coalbed methane field that underlies it.

Coalbed methane development has been going on here since in the mid-1980s. The environmental degradation associated with development has been documented to include coal seam fires and hydrogen sulfide and methane seeps at the Fruitland formation outcrop. The full impacts of development on air quality and public health, however, remain largely unexamined.

Due to split estate status, energy companies can lease the mineral rights underneath the property of a homeowner. Insufficient setbacks and surface owner protections allow the oil and gas industry to place facilities directly next to homes and schools. Near Sunnyside Elementary School, air monitoring on January 7, 2011 showed elevated levels of four known carcinogens. Two of the carcinogens were recorded at levels that are considered to be an unacceptable long-term exposure risk.

Josh Joswick- Durango, CO



LaPlata County has an estimated 3,400 wells. Many county residents therefore live in or adjacent to the ‘gas patch,’ often times in close proximity to gas wells, compressor stations, dehydrators, and processing plants. This incompatible mix of industrial activity in rural residential areas has had an impact on

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people's lives. Gas patch residents in La Plata County report odors similar to their neighbors in New Mexico. These odors, smelling like burning oil, car exhaust, and burning rubber, are most frequently noticed around well sites.

Aaron Mallet, a La Plata County resident active with the Bucket Brigade, stated on September 28, 2010: "On a regular basis there is an acrid smell in the air that emanates from that well pad."¹¹ Residents have also documented headaches, sore throats and burning nasal passages during these odor incidents.

Western Colorado: Battlement and Silt Mesas

Lastly, GCM worked with the communities of Battlement and Silt Mesas in Garfield County, Colorado. Battlement and Silt Mesas are two rural communities experiencing impacts from nearby development of natural gas.

Battlement Mesa is an unincorporated retirement community of 5,500 residents in western Garfield County. Originally constructed by Exxon in the 1970s for workers in the oil shale industry,¹² it was later marketed as a destination for retirees seeking a peaceful place to spend their golden years. Exxon eventually sold the surface properties but retained the mineral rights to extract the fossil fuels beneath Battlement Mesa at any time in the future.

Community members watched as natural gas wells incrementally came closer to Battlement Mesa, and the residents began to wonder if drilling would be allowed within their retirement neighborhood.

Dave Devanney- Battlement Mesa, CO



In 2009, Battlement Mesa learned of a proposal to drill 200 natural gas wells within its borders, including sites near homes, along the Colorado River, on the golf course, and near a school. Battlement Mesa residents called for thorough scientific research of the potential public health impacts of natural gas development before any permitting decision. After hundreds of residents signed a petition, a groundbreaking Health Impact Assessment was commissioned for drilling within Battlement Mesa and

county officials delayed any new drilling inside of the retirement community until this process was completed. Drilling, however, began just outside the border of the community and community members began complaining of noxious fumes being emitted.

Battlement Mesa residents documented strong petroleum-like odors in the middle of the night and early mornings. Residents believed that these strong petroleum, diesel and chemical smells were caused by nearby fracking operations. Nearby residents began experiencing health effects such as throat and nose irritation, headaches, itching skin, burning eyes, and dizziness. Residents

¹¹ Mallet, Aaron. *Pollution Log* 28 Sept. 2011

¹² Oil Shale is a different formation than the source of shale gas.

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called the Colorado Oil and Gas Conservation Commission to formally report the odor events; they started documenting odor occurrences, and they contacted local authorities.

The Colorado Oil and Gas Conservation Commission cited the operator for failing to capture nuisance odors derived from its operations. The company was encouraged to use additional vapor recovery techniques during flowback operations to reduce odors (but never received a monetary penalty). Residents noticed a marked diminishment of the odors, but around the same time, in November of 2010, a local news channel highlighted nearby Silt Mesa residents' problems with natural gas development. Silt Mesa residents reported odors they thought were caused by natural gas activity, and Dave Devanney of the Battlement Concerned Citizens contacted them.

Silt Mesa is a network of irrigation canals and small ranches, sitting along the Colorado River between Rifle and Silt, Colorado. Drilling for natural gas is taking place near homes and water supplies, presenting many of the same challenges as on Battlement Mesa.

One Silt Mesa family with two young sons had three natural gas drill rigs surrounding its property, each with ongoing flaring. The nearest flare stack was less than one-half a mile from their home. Family members reported pungent odors of rotten eggs followed by severe headaches, nosebleeds and rashes. The nosebleeds were persistent and heavy, much different than the average nose bleed. The mother described it as "almost like hemorrhaging." The youngest son developed a full body rash, which prompted a doctor visit. Upon examination, the doctor immediately told the Silt Mesa family to evacuate their home.

Although the family was forced to vacate their home because of nearby industrial activity, the state did not issue any violations. According to Colorado rules, Silt Mesa is not a High Density area, therefore, drilling for natural gas in the area does not warrant additional safety precautions.¹³

Today, the Silt Mesa family has left their home and put it up for sale. An air sample taken on January 15, 2011, on their property, contained levels of hydrogen sulfide more than 185 times above the long term level set by the U.S. EPA ($2 \mu\text{g}/\text{m}^3$) to estimate increased risk of serious health effects.

This Silt Mesa family, as well as the Battlement Mesa residents, call frequently to report odor complaints and other incidents of non-compliance. They call the Colorado Oil and Gas Conservation Commission, the Garfield County Oil and Gas Department, the Colorado Department of Public Health and Environment, and occasionally, the Environmental Protection Agency. The communities have seen worse local air quality since natural gas development markedly increased in Garfield County, although limited air monitoring is conducted by local and state authorities.

Collectively, nine air samples were taken by the Bucket Brigades. The members of San Juan Citizens Alliance and Battlement Concerned Citizens have taken the results to local officials and

¹³ Colorado Oil and Gas Conservation Commission. "Series Safety Regulations" 2 June 2011. <http://cogcc.state.co.us/>

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the U.S. EPA, but, to date, the agencies have not taken any action. Most of the residents feel their concerns have fallen on deaf ears.

A press release was issued in Aztec, New Mexico and Durango, Colorado announcing the air sample results. The residents still have not received an adequate response from the regulatory agencies. On Monday, April 4, 2011, Katee McClure sent an e-mail to the New Mexico Environment Department inquiring about who is responsible for enforcing air regulations.

Although, the agency did respond in a timely manner, it provided incorrect information regarding standards for hydrogen sulfide pollution while failing to take responsibility or provide information for the responsible agency.¹⁴

¹⁴ McClure, Katee. 4 April 2011

Citizen Air Sampling: Bucket Brigade Projects

Community-Based Air Monitoring: A Crucial Piece of the Puzzle

Building a trail of evidence

Regulatory and environmental agency personnel are not available at all hours to come out during a pollution incident. In the case of Colorado and New Mexico, a proper citizen complaint system is not established. A proper citizen complaint system would include a telephone hotline followed by rapid response from regulatory agencies and timely air sampling during odor incidents. Community-based monitoring provides an opportunity for residents to respond immediately to the pollution incident with sampling equipment and to contact agency personnel.

GCM trained members of the Western Colorado Congress, the San Juan Citizens Alliance, and other community members to keep a record of pollution incidents. These records include: the location, nature, and duration of the incident; the wind direction, health effects or property damage; and how the incident was addressed – by a call to the regulatory agency or the company suspected or known to be the source of the pollution, or informative calls to other neighbors.

Pollution incident records are referred to as “pollution logs.” Pollution logs filled out by community members ensure that a record is maintained beyond regular agency business hours. Community members are also encouraged to take pictures and/or use a video camcorder to catch a visual image of the pollution.

Bucket Brigades provide evidence and hard science to support the anecdotal stories of health impacts that all affected communities know too well: strange odors causing nausea, stinging eyes, burning noses, sore throats, coughs, and other distressing health symptoms. Community-based monitoring engages community members in record maintenance, site identification, operation of monitoring equipment, documentation, and custody and shipping of the sample.

The information gathered by Bucket Brigades, combining science with community experience and reports, helps bridge the gap between communities, regulators and industry. Air sampling and monitoring can provide key evidence exposing chemical exposure, can be a tangible way to show that the air pollution has decreased in a community, and can help build relationships where community members coexist with their industrial neighbors.

Bucket Brigade Training & Methods

To begin a project, GCM conducts a research assessment of toxic hazards in a target community and identifies the appropriate environmental monitoring tools that will assist community members in investigating their health concerns and exposures. We review the data on pollution sources and toxins and prioritize the most serious for early action. Due to the lack of publicly available data regarding the air emissions from natural gas drilling and refining sites, we had little research available for reference in this project.

All Bucket Brigade trainings are conducted on site, in the local community. For this project,

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GCM was given a local tour by community members in areas near Durango, Colorado; Battlement/Silt Mesas, Colorado; and Aztec, New Mexico in late July, 2010. During the training, GCM provided a day-long classroom training, including background on pollution and environmental health, how to document pollution incidents, hands on training and how to use monitoring equipment. We worked with the local community members to co-design an environmental sampling plan.

The training and plans emphasize standard scientific methods. Community members learn how the monitoring equipment works, the best time to use it, and the appropriate paperwork to fill out before shipping a sample to the lab. The Bucket Brigade's work is strengthened by following stringent Quality Assurance/Quality Control (QA/QC) protocols and the use of EPA approved labs.

The Bucket Monitoring Equipment

Due to the nature of the uncertainty of the emissions associated with natural gas drilling, hydraulic fracturing and refining, this project chose to use the Bucket as the monitoring equipment. The Bucket is modeled after the Summa Canister,¹⁵ but has some advantages in its use.

The Bucket is portable, requiring only a tedlar bag and vacuum to take the grab sample. Air is “grabbed” out of the air for two to three minutes and captured in the bag. Once the sample is taken, the tedlar bag is sealed, removed from the bucket and sent to the lab for analysis.



The air sampling Bucket, gcmmonitor.org

¹⁵ State of Nevada, Division of Environmental Protection. “Summa Canister Sampling”.
<http://ndep.nv.gov/fallon/summa.pdf>

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The lab analysis is conducted by Columbia Analytical Services in Simi Valley, California. The lab utilizes EPA method TO-15 and ASTM D 5504-08 method for sample analysis. The TO-15 analysis includes a spectrum of more than 70 volatile organic compounds and the ASTM D 5504-08 method is used to test for 20 sulfur compounds.

Once the community members are trained on the equipment, the buckets are kept at various locations in the community – selected based on the location of odors and health symptoms that have been experienced and reported. When an odor incident occurs, Bucket Brigade members join together to bring a bucket to the site of the odor incident and take a sample of the air at the time of the odor.

Results & Discussion of Results

Individual sample results and overall trends:

For this project, communities in New Mexico and Colorado took a total of nine air samples between September 2010 and January 2011. This report documents serious toxic air pollution generated at various points of the life cycle of natural gas development. Targeted sampling sites included well pad, compressor station, gas separation plant, dehydrator and waste disposal site.

Serious cancer-causing chemicals were detected at elevated levels, including chemicals associated with the fracking process used increasingly by energy companies.

While bucket samples are short-term grab samples of the air breathed by community members living near natural gas development facilities, letters and pollution logs reveal that the odors are persistent and occur on an ongoing basis. We therefore consider the data to be indicative of long-term exposures, and the expert interpretation used in this report compares the data to pollutant levels linked to long-term health effects.

A total of 22 toxic chemicals were detected in the nine air samples, including four known carcinogens, toxins known to damage the nervous system, and respiratory irritants. The levels of chemicals detected were in many cases significantly higher than is considered safe by state and federal agencies. The levels were between three to 3,000 times higher than levels established by public health agencies to estimate increased risk of serious health effects and cancer based on long-term exposure.¹⁶

The most significant results:

- ***Benzene***, a known carcinogen, was found at high concentrations in four air samples at levels between 6.3 and 47 $\mu\text{g}/\text{m}^3$. These levels are 48.5 to 800 times higher than the level set by the US EPA of 0.13 $\mu\text{g}/\text{m}^3$ to estimate increased cancer risk from long-term exposure.¹⁷

Benzene can also cause serious non-cancer health effects which can damage the blood and nervous system. Levels of benzene in one of the nine samples, collected on January 7, 2011 near the Sunnyside Elementary School, Durango, Colorado, exceeded the level set by the U.S. EPA for benzene (30 $\mu\text{g}/\text{m}^3$) to estimate increased risk of non-cancer health effects.

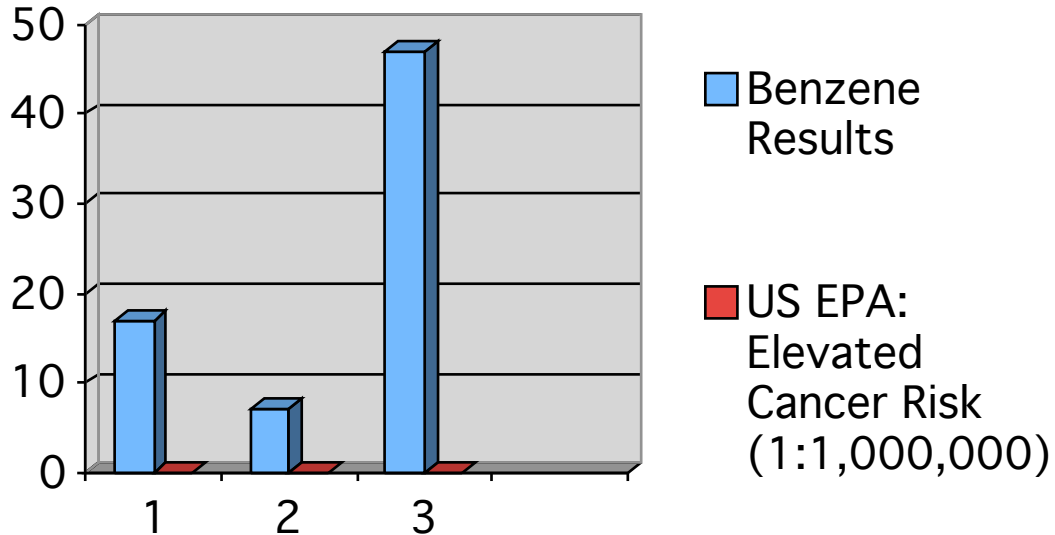
¹⁶ This report defines an elevated cancer risk as 1:1,000,000

¹⁷ <http://www.epa.gov/ttn/atw/toxsource/table1.pdf>

Sample 1: 200 Montana St Bloomfield NM

Sample 2: Bondad 33-10 #26 Williams Well, Durango, CO

Sample 3: Intersection of US 550 & CR 218 Durango, CO, near Sunnyside Elementary



- **Acrylonitrile**, a human carcinogen, was found in five samples at levels between 7.9 and 30 $\mu\text{g}/\text{m}^3$. These levels are 790 to 3000 times above the U.S. EPA level of 0.01 $\mu\text{g}/\text{m}^3$, set to estimate an increased risk of cancer from long term exposure. All of these levels correspond to what EPA would consider an “unacceptable cancer risk” in that long-term exposure is associated with a cancer risk of greater than 100 in a million.¹⁸

Acrylonitrile is also a respiratory irritant, causing degeneration and inflammation of nasal epithelium. Levels of acrylonitrile in the five samples exceeded the level set by U.S. EPA for risk of increased non-cancer health effects from long term exposure (2 $\mu\text{g}/\text{m}^3$) by 3 to 15 times.¹⁹

- **Methylene chloride**, a human carcinogen, was found in five samples at levels between 7.9 and 17 $\mu\text{g}/\text{m}^3$. These levels are 3 to 8 times higher than the level set by the U.S. EPA (2.0 $\mu\text{g}/\text{m}^3$) to estimate an increased risk of cancer from long-term exposure.

¹⁸ Communication from Miriam Rotkin-Ellman, Natural Resources Defense Council. 7 June 2011

¹⁹ The USEPA Reference Concentration (RfC) is an estimate of a continuous inhalation exposure concentration to people (including sensitive subgroups) that is likely to be without risk of deleterious effects during a lifetime.

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- ***Ethylbenzene***, a human carcinogen, was found in five samples at levels between 5.1 to 22 $\mu\text{g}/\text{m}^3$. These levels are 12 to 55 times higher than the level set by the US EPA ($0.4\mu\text{g}/\text{m}^3$) to estimate increased cancer risk cancer from long-term exposure.
- ***Xylene***, were found at a level of 100 and 154 $\mu\text{g}/\text{m}^3$. These levels exceed the U.S. EPA's level for estimating increased non-cancer health risks of 100 $\mu\text{g}/\text{m}^3$.
- ***Hydrogen sulfide*** was found in one sample at 370 $\mu\text{g}/\text{m}^3$ which is more than 185 times above the long term level set by the U.S. EPA ($2\mu\text{g}/\text{m}^3$) to estimate increased risk of serious health effects.

Long-term exposure to hydrogen sulfide is associated with an elevated incidence of respiratory infections, irritation of the eye and nose, cough, breathlessness, nausea, headache, and mental symptoms, including depression. The World Health Organization's Guideline Value for exposure to hydrogen sulfide is 7 $\mu\text{g}/\text{m}^3$ over a 30-minute period.

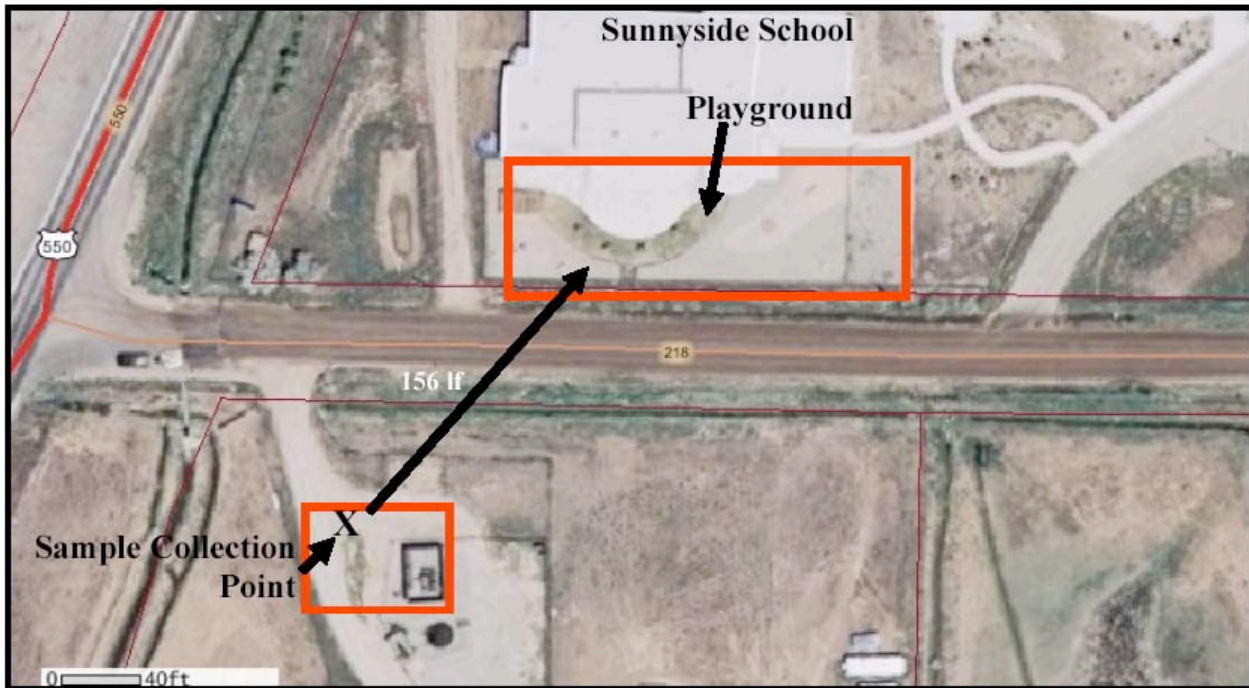
For the first time, at least two cancer-causing chemicals found at high levels, acrylonitrile and methylene chloride,²⁰ were detected by the air samples at a variety of natural gas development sites. Neither is associated with natural gas and oil deposits, but both have been shown to be associated with chemicals used in the fracking process to increase yields from oil and gas deposits.

The air samples found high levels of chemicals that can cause symptoms that match the odors and health effects reported by nearby residents for years. This confirms the need for agencies to take such complaints seriously and to better monitor and require pollution controls at all points of natural gas production and processing.

²⁰ Cherniak, Mark. Data Interpretation Synthesis Letter. 16 Feb 2011

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Image from San Juan Basin Health Department



**Bucket Brigade Sample Collection Event
January 7, 2011
Dehydrator Facility Located
156 lf from Sunnyside Kindergarten Playground**

Results near the Sunnyside School in La Plata County, Colorado

On January 7, 2011, two members of the Bucket Brigade team in La Plata County, Colorado, took an air sample less than 50 feet from a dehydrator that is less than 200 feet from the Sunnyside Elementary School playground near Durango. This natural gas dehydrator is a frequently suspected source of unknown chemical odors. The sampling team on site experienced odors. Subsequent analysis of the air sample revealed a number of toxic chemicals, including four known carcinogens.

A significant level of acrylonitrile, a human carcinogen, was detected in this sample (as it was in four other samples in this report) at a level above which is considered by the US EPA to be an unacceptable long-term exposure risk.²¹ Methylene chloride, a human carcinogen, was also detected in this sample (as it was in four other samples) at a level above which is considered to be an unacceptable long-term exposure risk.

Two more carcinogenic substances, benzene and ethylbenzene, were also detected in this sample at levels above that which is considered to be an unacceptable long-term exposure risk. The

²¹ <http://www.epa.gov/ttn/atw/toxsource/table1.pdf>

level of benzene in this sample, 47 ug/m³, is notable in that it is the highest level of benzene detected so far in this area by the Bucket Brigade. Besides acting as a carcinogen, benzene can also adversely impact the human immune system by decreasing circulating levels of lymphocytes. To prevent reduced lymphocyte counts, the U.S. EPA has an established a reference (long-term) concentration for benzene of only 30 ug/m³.

Mark Chernaik, PhD, interpreted the test results for this project. According to Dr. Chernaik, “The level of benzene in this sample is more than 50% above the U.S. Reference concentration for benzene. If this detected level of benzene in this sample represents ambient air quality that generally prevails at this location, then persons living or attending school at this location would be at risk to adverse impacts to the immune system.”²²

The levels of other aromatics in the sample, – 4-ethyltoluene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, – although not above health reference levels are strikingly similar to the levels of these aromatics in four other samples and seem to be a fingerprint for volatile organic compounds near an oil and gas facility in this area. The high levels of the tentatively identified compounds propane and butane also strongly suggest that the source of the volatile organic compounds is related to gas field activities.

Matching odors and health effects to sample results

Residents of natural gas production facilities involved in the Bucket Brigade air-testing project recorded their observations and health effects during testing. Once sample results were available, the observed odors and health effects noted in pollution logs were compared to the known health effects of the toxic chemicals found in the samples. Here are several examples:

“On Wednesday, Jan 19th air sample was taken at the Blanco, NM Enterprise Buena Vista Compressor Station in Pump Canyon north of several homes. Chris Velasquez and his family live “down wind” of this site. Chris was my guide and companion on the testing trip.

I smelled the heavy smell of oily burning plastic. My eyes burned and my nose, throat and mouth became irritated instantly. The soft tissue in my nose, throat and mouth are still sore today as I write this. I have been coughing and my nose is still runny. My eyes are still very red and irritated.”²³

The sample results confirmed the presence of several noxious benzene compounds, including chlorobenzene, 1, 2, 4-trimethylbenzene and xylene compounds. They are significant irritants to the respiratory system and combined exposure to these could have resulted in the health effects experienced by the sampler.

“Warren & I noted additional sharp natural gas/petroleum odors coming from the direction of the BP/CP wells when we did the air sample on January 18th. Warren noted that his eyes were burning. My throat was very irritated and my eyes burned. The musty

²² Chernaik, Mark. 25 Jan. 2011

²³ McNall, Shirley. 20 Jan. 2011

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sewage/feed lot odor is nauseating and causes throat irritation and burning eyes for me.

The wells are on BLM land that was granted to the City of Aztec in 1963 for Recreation & Public Use Purposes (R&PP). Some of that land has been granted to Aztec Schools for the new athletic fields and sports complex located about 800 ft. from the wells.”²⁴

Sample results from the January 18th sample confirmed the presence of 22 different toxic gases, including cancer-causing benzene. Many of the gases present in the sample irritate the respiratory system and the eyes. Again, the observations recorded by Bucket Brigade air samplers match the sample results.

²⁴ McNall, Shirley. 20 Jan. 2011

Recommendations

Given the close proximity of residential and public property, any new sites – whether drilling, fracking, refining, or disposal – should be located at least one-quarter mile from homes, farms, schools, playgrounds, and businesses. This space would provide a **buffer zone** for industry to continue its operations while reducing community exposure to chemical contaminants.

U.S. EPA should update air quality standards for oil and gas development, including the New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP), based on the following principles:

Comprehensiveness: All sources of air pollution in the oil and gas sector, including exploration, production, processing, transmission, distribution, and storage, and all pollutants released by these sources should be included in any updated air quality regulations, regardless of the level of emissions or major or area source status.

Air monitoring and transparency: Natural gas development sites including well pads, compressors, gas plants, and waste sites should be required to continuously monitor for volatile organic compounds and hydrogen sulfide in order to ensure compliance with regulations, emission limits and public health protections. All data should be publicly available via the web to provide full transparency to the public.

Effectiveness: The EPA should require the best available control technology and require practices and technologies that both reduce air pollution and promote more efficient oil and gas operations.

Full Health Protection: The EPA should consider prohibiting hazardous air pollutant emissions in certain circumstances, and ensure that any residual risk standards reduce lifetime cancer risk from oil and gas operations to below one in one million.

Forward Looking: EPA should develop mechanisms to ensure that any new equipment, facilities, technologies or practices will be subject to air pollution control requirements that may be required under any updated NSPS and NESHAP.

Enforceability: Any standards should be practicably enforceable by including monitoring, record keeping, and reporting requirements necessary to ensure continuous compliance with the standards and to allow the public, States, and the EPA to easily determine deviations and enforce any noncompliance.

CONGRESS should close the gaping loophole in the Clean Air Act's National Emission Standards for Hazardous Air Pollutants (NESHAPs). Oil and gas exploration and production operations are exempt from two key provisions of the NESHAPs, designed to protect public health, allowing the industry to avoid complying with standards that are applied to other industries.

STATES:

In 2009, EPA Administrator Lisa Jackson issued a ruling on a Title V petition holding that states must assess whether oil and natural gas operations should be aggregated in accordance with longstanding EPA policies governing New Source Review and Title V permitting.²⁵ States should follow the EPA's recent guidance and ensure that emissions from oil and gas operations are appropriately aggregated to ensure compliance with New Source Review and Title V. Aggregation provides an important opportunity to more accurately recognize integrated source operations under the Clean Air Act and ensure that oil and gas operations are regulated on a cumulative basis under New Source Review and Title V.

Until strong new rules are in place, the oil and natural gas industry can and should **voluntarily invest in equipment that reduces pollution escaping to the air**. Such equipment is readily available and financially profitable for companies. These investments would increase efficiency and production and reduce cancer causing chemicals from being emitted into the air in communities near production facilities –saving lives and protecting the health of neighboring families.

As the natural gas industry continues to grow, so will the number of families neighboring and affected by the emissions. Industry and government leaders have a unique opportunity to address public health and environmental issues by implementing these recommendations. For coexistence between communities and industry to be possible, chemical exposure has to be immediately addressed.

²⁵ <http://www.epa.gov/region7/air/title5/t5memos/oilgaswithdrawal.pdf>